Journal of DAIRY SCIENCE

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JOURNAL OF DAIRY SCIENCE

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The Style Manual for Biological Journals[1] has been adopted as the guide for authors.[2] Publication of papers is limited to members of A.D.S.A., but only one author of a joint paper need be a member. Those of outstanding merit may be accepted from nonmembers. Papers when accepted become the copyright of the JOURNAL and can be reprinted only by the Garrard Press. Reproduction of graphs, tables, and illustrations for books and other periodicals may be authorized by the Editor-in-Chief.

ORGANIZATION OF PAPERS

1. Title should appear at the top of the first page, be as brief as possible, and be indicative of the research, followed by the author(s) name(s) and affiliation(s).
2. Summary and its preparation.
   a. There are three reasons for the summary: first, convenience to readers; second, reduce costs and expedite work of abstracting journals; and third, to disseminate scientific information.
   b. The summary should be brief, specific, and factual. It should not exceed 200 to 225 words.
   c. The opening sentence should state the research objectives, but the title *should not be repeated.*
   d. It should be intelligible without reference to the original paper and contain complete sentences and standard terminologies. It should be assumed that the reader has some knowledge of the subject.
   e. The author(s) should emphasize newly discovered facts and observations, unique apparatus and techniques, numerical data with statistics, physical-chemical constants, and new methods and their accuracy.
   f. References to earlier work should be omitted, except in most unusual cases.
3. Statement of the problem, pertinent investigations, and reasons for the study.
4. Experimental procedures.
5. Results.
6. Discussion. (5 and 6 may be combined.)
7. Conclusions.
8. Acknowledgments.
9. References. All references must have author(s) name(s), name of periodical, volume, page number, and year of publication. If a book, publisher's name and address must be added.

[1] American Institute for Biological Sciences, 2000 P Street, N. W., Washington, D. C. Price $3.

[2] J. Dairy Sci., 44: 1788. 1961.

10. Manuscripts must be typed double-spaced[3] on 8½- by 11-inch bond paper. Lines on each page should be numbered from 1 to 26 or 28, to make it easier for the Editorial Board to review papers. The side margins should be one inch wide. Clipped-to, pasted-on, and written insertions are not acceptable. Do not staple pages together.
11. Figures (graphs) should be made with black India ink on white drawing paper, tracing paper, or blue linen and the sheets should not exceed 8½ by 11 inches. Graph papers with yellow, green, and red lines should not be used, because the lines cannot be filtered out. Curves should be identified with the symbols ○, ⊙, ●, □, ■, △, ▲, ▼, +, or ×, and they should be about 0.8 mm thick, for the axes about 0.5 mm thick, and for grid lines about 0.4 mm thick. Grid lines are necessary only if readings are to be made from the curves. Letters on the abscissae, ordinate, and the figure should be in upper case and be about 3 by 5 mm and about 0.5 mm thick, to be readable when graphs are reduced to column width. Titles for figures (graphs) must be on separate sheets. Following is a well-made figure reduced to size of the printed page:

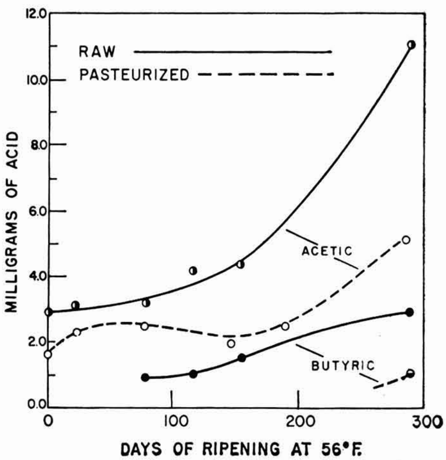

FIG. 1. Acetic and butyric acids in raw and pasteurized milk Cheddar cheese during ripening (milligrams in distillate obtained from 150 g of cheese oil).

12. Tables should be numbered on the center of the page with the title immediately below, and each table should be typed on a separate sheet of 8½- by 11-inch bond paper. They should be placed together at the end of the manuscript.

[3] Multilithing on bond paper is acceptable.

Titles should indicate the content of tables and facilitate comparisons, show relationships clearly, be self-explanatory, and save space. Label heading and subheadings accurately and concisely with the data centered under them. Use correct abbreviated dimensions. Data should be referred to and discussed but not repeated in the text, and they should be presented in only significant digits within the accuracy of the methods. Use the metric system whenever possible. Do not use vertical lines and only a minimum of horizontal ones.

Tables are costly. Use graphs whenever possible.

13. Colored illustrations can be reproduced. Authors should submit detailed specifications to the editor and costs will be supplied.
14. Abbreviations for titles of periodicals and for botanical, chemical, physical, mathematical, and statistical terms should conform to those in the Style Manual for Biological Journals.
15. Terms such as Cottage cheese, Cheddar cheese, Limburger cheese, etc., should be capitalized as indicated. Butteroil, skimmilk, buttermilk, etc., should be written as one word. Milk fat has replaced butterfat.
16. Critical reading of papers, before they are submitted, by persons other than the author(s) will help to clarify statements and eliminate errors.
17. All manuscripts should be submitted to the Editor-in-Chief in duplicate.
18. Receipt of manuscripts will be acknowledged. Authors will be notified within 30 to 60 days of the action taken by the Editorial Staff.

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1921—January, March, May, July, September, November
1922—January, May
1923—January, March, May, July, September, November
1924—January, May, July, November
1925—January, July, September
1926—January, March, May, July, November
1928—January
1930—November
1931—January, March, May, November
1932—July, September, November
1934—October
1938—November, December
1943—January, February, March, April, August, December
1946—January, March, April
1947—January, February, March, April, May, June, December

PEOPLE AND EVENTS

Annual Report National Student Branch The American Dairy Science Association

During the past year, the National Student Branch made great strides in establishing itself as an intricate part of the American Dairy Science Association. The Executive Board of the Student Branch recognized the assistance of the faculty advisors and the student affiliate chapters in the progress made during the year.

A program planning meeting was held in Washington, D. C., October, 1961, to lay the groundwork for the Annual Meeting held at the University of Maryland, June, 1962. The tentative program drawn up at the Washington meeting was presented to the program planning committee meeting of the senior organization, held at Chicago. The purpose of this procedure was to coordinate sectional meetings and to avoid serious conflicts.

Between November and June details for the annual meeting were completed by correspondence. All of the year's activities were finalized by tying all ends together at the executive board meeting on Sunday, June 17, 1962. A detailed program for the week was prepared, including the appointment of a nominating committee consisting of Keith Jenkins, Joseph Lineweaver, Camilla Cristman, and Dr. J. T. Lazar.

In the short span of time much was accomplished at the business meetings. (1) It was decided to obtain the Student Affiliate pins from a Japanese company and to sell them for $1 each to all student affiliate members. (2) The Student Branch Organization agreed to cooperate with Mr. W. W. Snyder, Editor of the Student News Section of the JOURNAL OF DAIRY SCIENCE, in featuring an affiliated chapter each month under the title of Spotlight. (3) The Secretary-Treasurer was instructed to send a copy of the minutes of all meetings of the student branch association to each affiliate chapter.

Dr. G. H. Porter discussed the judging and evaluation of the annuals and scrapbooks in conjunction with the Chapter Awards. Points which he made that should be kept in mind for another year were: (1) neatness; (2) highlighting activities; (3) the number of members participating in activities; and (4) uniformity and continuity by using the same type or style of writing throughout the entire report. The Student Affiliate Chapter Award was presented to the Georgia Dairy Science Club for the second consecutive year. Awards of merit were given to the Louisiana, Mississippi, and Virginia Chapters for their outstanding work.

The Graduate Student Scientific paper presentation program was considered a success this year. R. L. Bradley, of Michigan State University, received the $100 prize in the Manufacturing Section, and D. E. Otterby, of North Carolina State, won the award for the outstanding paper in the Production Section.

E. C. Flounders from Abbott's Dairies, Philadelphia, addressed the Student Affiliate luncheon, attended by 160 affiliates and guests. The main points he discussed under his topic, What Management Expects from the College Graduate, were:

1. Intelligence
2. Ability to handle people
3. Ability to adapt to the job
4. Ability to communicate
5. Ability to analyze

The Thursday morning breakfast was attended by 65 persons. The primary purpose of the program was to recognize those who helped make the third annual meeting a success. Dr. J. B. Mickle, senior advisor, and Miss Rebecca Murray, Maryland's Dairy Princess, were both honored. Miss Louise Knolle, American Dairy Association Princess, was honored earlier in the week. The present officers, advisors, Senior Branch Executive Board, and Past Presidents were each recognized.

Election of officers was held Thursday, June 21, with each represented chapter having one vote. The officers elected for 1962-1963 were: President: Norris Nichols—Oklahoma; 1st Vice-President: Robert Smariga—Maryland; 2nd Vice-President: Robert Allard—Ohio; 3rd Vice-President: Robert Rosser—Oklahoma; Secretary-Treasurer: Marie Jarvinen—Minnesota.

At the close of the Anual Meeting, the old and new officers and advisors met to discuss the pros and cons of this past year's program while making recommendations for the 1963 program to be held at Purdue University.

CAMILLA CRISTMAN
Secretary-Treasurer
National Student Branch, A.D.S.A.

UNIVERSITY NEWS

Wisconsin Offers New Program in Endocrinology

The University of Wisconsin Graduate School at Madison announces a Postdoctoral Training Program in Endocrinology. Its purpose is to increase qualified personnel for teaching and carrying on research in endocrinology. Breadth of training will be emphasized. The integrated program includes laboratory research, seminars, colloquia, workshops, and teaching under the coordinated auspices of faculty members from the colleges of Letters and Science, Medicine, and Agriculture. Medical candidates may obtain postdoctoral training in clinical endocrinology and metabolism. Examples of current research are studies having to do with the purification, biological

action, and chemistry of pituitary gonadotropic hormones, maintenance and activity of the corpus luteum, delayed implantation, chronic obesity, nutritional effects on pituitary-gonad relationships, prenatal mortality, and neural control of pituitary function, stress and adrenal function in birds.

Candidates for postdoctoral traineeships (M.D., Ph.D., D.V.M.) will be selected on the basis of professional promise and career interest. Appointments will carry a yearly stipened of $6,500. Applicants may apply any time during the year. Notification of appointments will be made December 1 and April 1, with the traineeship to begin either July 1 or September 1.

Send inquiries and requests for applications to W. H. McShan, Birge Hall, University of Wisconsin, Madison 6, Wisconsin.

Dr. L. H. Schultz Speaker at Crusade Against Mastitis

DR. L. H. SCHULTZ, professor of dairy husbandry, University of Wisconsin, was one of the principal speakers at the kick-off meeting of the Crusade Against Mastitis, launched July 24-25 by Babson Bros. Dairy Research Service at North Aurora, Ill.

Also present were DR. J. L. ALBRIGHT, assistant professor of dairy husbandry, University of Illinois, and his former mentor, DAVE RISLING, instructor in dairying, Modesto Junior College, Modesto, Calif.

In addition to his illustrated talk on Mechanical Milking, Dr. Schultz presented results of a study made of the mastitis situation on 45 dairy farms in the Madison area. Two significant points were observed: Those dairy farms with relatively poor sanitation practices had more cases of mastitis than those using a good sanitation program. Also, there was a close correlation between vacuum fluctuations in milking systems and herds with extensive mastitis.

Speaking on the Necessity for Mastitis Control was CLARENCE LUCHTERHAND, chief of milk certification, State of Wisconsin. He advocated following the recommendations of the National Mastitis Council, Inc., in a program of education among these in all occupations connected in any way with milk production.

L. A. BROOKS, professor of agricultural engineering, showed how to gauge and test various milking systems for efficiency. C. W. BURCH, department of veterinary science, gave the results of Mastitis Control Field Trials and summarized the Wisconsin Mastitis Control Program.

University of Kentucky Helps Sponsor Dairy Research Field Days

Progress in dairy research was taken to dairymen of Western Kentucky by means of two field days sponsored jointly by the Department of Dairy Science, University of Kentucky, Western Kentucky State College, and Murray State College.

The state colleges were hosts on successive days, with inspection of their dairy facilities the high light of the morning programs. BILLY ADAMS, Professor of Dairying at Western State College, Bowling Green, headed the program at that school, and E. B. HOWTON, Head of the Agricultural Department at Murray State College, Murray, was in charge of the program there.

In the afternoon of each day DR. LOUIS BOYD, Associate Professor of Dairying, University of Tennessee, discussed Efficiency of Roughage Utilization by Dairy Cattle. DR. D. M. SEATH, DR. DURWARD OLDS, and DR. D. R. JACOBSON of the Department of Dairy Science at the University described research and results of research being conducted in Lexington.

These first dairy field days held in this part of the state attracted over 150 dairymen and their families at Bowling Green and over 180 at Murray. This is the initial phase of a plan to alternate field days in various parts of the state in an effort to inform more dairymen about the results of recent research in dairy production.

Kentucky Appoints Dr. J. C. Wilk

DR. J. C. WILK, former instructor at the University of Minnesota, has joined the staff of the Department of Dairy Science of the University of Kentucky. He will be an extension specialist for 4-H dairy projects and breed improvement.

A native of Clearwater, Kansas, Dr. Wilk was raised on his family's farm and for 9 yr was either member or leader in 4-H club work. After receiving a bachelor of science degree from Kansas State University in 1951, he operated a dairy farm for 3 yr, served in the U. S. Marine Corps for 2 yr, and was with the American Jersey Cattle Club at Columbus, Ohio for 2 yr. Since 1958, he has been with the University of Minnesota where he received his M.S. and Ph.D. degrees in the field of dairy breeding. He is a member of Alpha Zeta and Gamma Sigma Delta.

The position Dr. Wilk will assume at Kentucky was that held by GARLAND BESTIN, who was recently advanced to district supervisor of county agents.

Kentucky to Sponsor Dairy Manufacturing Conference

Representatives of several universities, of industry, and of government will be featured on the staff of the Annual Dairy Manufacturing Conference of the University of Kentucky.

The conference, sponsored jointly by the Dairy Products Association of Kentucky and the University's Department of Dairy Science, will be held Nov. 19 and 20, 1962. The meeting place will be on the University campus at Lexington.

The two-day program has been streamlined to include meetings on all products in major production in the state. There will be included a chocolate ice cream clinic and a Cottage cheese clinic led by outstanding experts in the field.

For further information contact DR. A. W. RUDNICK, JR., Department of Dairy Science, University of Kentucky, Lexington.

Washington State University Dairy Team Named

An interdepartmental dairy committee has been formed to develop a teamwork attack on problems affecting Washington State's dairy industry.

Announcement of the committee was made by L. L. MADSEN, director of WSU's Institute of Agricultural Sciences, following a meeting of various faculty groups interested in the problem. The committee includes: DR. ELMER SEARLS, Extension marketing specialist, Puyallup, chairman; and DR. MARY ROSE GRAM, nutritionist, College of Home Economics; DR. T. H. BLOSSER, dairy science department chairman and DR. E. J. WORKING, agricultural economics department chairman, all of Pullman.

The faculty committee may call upon other members of the University to develop data and present information. The committee will also work with representatives of producers, handlers, state and federal regulatory agencies and consumers.

R. E. Brown of Illinois to Australia

DR. R. E. BROWN, Associate Professor of Nutrition, University of Illinois, Urbana, has received a Fulbright Grant for research on volatile fatty acid metabolism in ruminants in association with DRS. G. L. MCCLYMONT and E. F. ANNISON at the University of New England, Armidale N.S.W., Australia. Dr. Brown and his family sailed from San Francisco, September 6, 1962, and will remain in Australia nine months. They will return via Europe in August, 1963.

Ohio State Adds to Staff

DR. C. O. DAS, Head of the Department of Agricultural Biochemistry at Allahabad Institute of Agriculture, Allahabad, India, began

a three-months association with the Department of Dairy Technology, Ohio State University in mid-August. Dr. Das, who received his doctorate in Agricultural Biochemistry at Ohio State in 1948, will observe the operation of the various Department programs in anticipation of an expansion of similar activities at his home Institute.

Another recent addition to the Department's staff is Dr. D. B. Stussi, on leave from his position as Bacteriologist at the Swiss Federal Dairy Research Station in Liebefeld, Bern, Switzerland. Dr. Stussi received the doctorate degree from the Swiss Federal Institute of Technology in Zurich. While with the Department, he will be conducting cheese flavor research under a grant from the American Dairy Association.

Research assistants for the fall quarter include G. A. Purvis, of Rocky Ford, Colorado, Jaime Hidalgo-Abel, of Santiago, Chile, and D. H. Brown, of Warren, Ohio. Mr. Purvis received the B.S. and M.S. degrees from Colorado State University in 1954 and 1962. In the intervening period he served in the U. S. Army, was a management trainee with Safeway Stores ice cream department, and worked with the Colorado Department of Agriculture as a Dairy Chemist.

Mr. Abel received the degree of Bachelor in Industrial Chemistry from the Catholic University of Santiago in 1959. Since that time he has been chief chemist and bacteriologist at a milk pasteurization and by-products plant in Santiago.

David Brown is a 1962 Ohio State graduate. During his undergraduate career he worked extensively in the Department's research laboratories and gained considerable dairy plant experience through summer employment. He was the recipient of several scholarships, including the R. B. Stoltz Memorial Scholarship awarded each year to outstanding senior students. In the 1962 International Collegiate Dairy Products Judging Contest, he placed first in all-products. He will pursue the Master of Science Degree.

The 14th Annual Homecoming Brunch of Ohio State's Department of Dairy Technology will be held the morning of October 20 in the auditorium of the Agricultural Administration Building. Co-hosts for the affair will be the Department Staff and the student Dairy Tech Club. The program will feature an informal social period, followed by the brunch, the high light of which will be the presentation of the 1962 Department of Dairy Technology Award of Merit to an outstanding member of the Ohio Dairy Industry. After the brunch, alumni will attend the Homecoming football game between OSU and Northwestern, tickets for which have been made available by the Department.

University of New Hampshire Names Dr. C. H. Boynton Chairman

DR. C. H. BOYNTON was named Chairman of the Department of Dairy Science, University of New Hampshire, as of July 1, 1962.

Dr. Boynton has been a member of the Dairy Science staff at New Hampshire since 1945. As chairman, he replaces PROFESSOR K. S. MORROW, who has served in this capacity since 1934.

Completed Theses

Ph.D. Degree:

C. HILTON BOYNTON—Some histological and histochemical studies of the genitalia of dairy bulls as related to fertility. Rutgers University.

TSUNG CHU CHOU—The chemical nature of the characteristic flavor of cultured buttermilk. Ohio State University.

JOHN A. SIMS—Characteristics of milking flow among dairy cows. Iowa State University of Science and Technology.

JOHN D. SUTTON—Functional development of epithelial tissue of the reticulo-rumen in calves. Iowa State University of Science and Technology.

M.S. Degree:

LINDA GRAY—Anaerobic gas production of bovine spermatozoa. Washington State University.

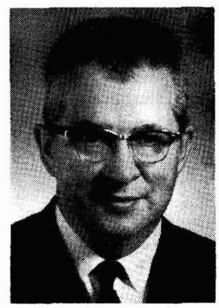
PADMANAHBA REDDY PETA—The effects of different levels of urea on the nutritive value of a high fiber concentrate mixture for dairy cattle when fed with a high-quality forage. University of New Hampshire.

INDUSTRY NEWS

Harvestore Products Appoints New Director of Research

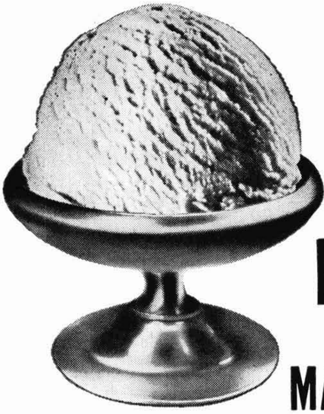
DR. C. B. KNODT of Wayzata, Minnesota, has been named to the newly created post of Director of Research of A. O. Smith Harvestore Products, Inc., it was announced recently by A. D. HYDE, President.

Dr. Knodt, who for 20 yr has been active in education and research in industry as an animal nutritionist, was previously on the staff of the Squibb Institute for Medical Research at New Brunswick, New Jersey, where he was Director of Nutritional Research.



C. B. Knodt

Dr. Knodt obtained his B.S. degree from the University of Minnesota in 1940, his M.S. from the University of Connecticut in 1942, and his Ph.D. from the University of Minne-



sota in 1944. Following this, he was on the staff of Cornell University and served for 8 yr as professor of dairy husbandry in charge of research work at Pennsylvania State University. He was also in charge of beef, dairy, and sheep research for General Mills, Director of Research for Burrus Mills, Inc., and Research Farm Director for Cargill, Inc.

He has published more than 90 scientific papers and has written many articles for farm magazines. His professional memberships include the American Dairy Science Association, American Society of Animal Science, American Institute of Nutrition, Society of Experimental Biology and Medicine, American Chemical Society, American Genetics Association, and the American Association for the Advancement of Science.

Borden's Appoints New Vice-President

F. V. Forrestal, who has charge of the Borden Foods Company's Eastern Hemisphere operations for the International Division, has been named assistant vice-president of the foods company, according to T. O. Hofman, vice-president of The Borden Company.

Formerly the International Division's area manager for Europe, Africa, and the Middle East, Mr. Forrestal spent the last 3 yr in Holland, where he also exercised executive supervision of Borden's manufacturing operations in the area. He first joined Borden's in 1949, in the foreign operations department. He left the firm in 1954 but returned in 1959 as assistant Eastern Hemisphere sales manager.

Mr. Forrestal will maintain his office at Borden headquarters, 350 Madison Ave., New York, N. Y.

Social Events, Ladies Activities Set for Week of Dairy Conventions and Exposition in Atlantic City

Three gala all-industry evening social events, plus a full schedule of activities for the ladies, have been set for the week of October 28-November 2 in Atlantic City, which will see the conventions of eight dairy industry groups and the staging of the 23rd Dairy Industries Exposition.

A Dairy Conventions Committee, composed of New Jersey and Pennsylvania dairy industry men and their suppliers and equippers, announces this schedule of events:

Sunday night, October 28, at the Hotel Dennis—A Poor Richard Party, which, planners predict, will provide participants a proverbial good time! Taking its themes from Benjamin Franklin's Poor Richard's Almanac, the party will feature colonial decorations and favors. As a salute to the city where Franklin lived much of his life, Philadelphia, a marching string band of 70 mummers will present a special program during the evening.

At other times, an orchestra will play for dancing. The main function of the evening will be to furnish a gathering place of welcome for friends who may not have met since the last convention. Refreshments will be available.

Tuesday night, October 30, at the Traymore Hotel—Presenting the Pacesetters Banquet—will be the only organized banquet during the week. It will honor college seniors from about 30 of the nation's dairy schools who have participated in the Collegiate Students' International Contest in Judging Dairy Products. Biographical material about each of the approximately 100 college students present will appear in the evening's souvenir program, and a most unusual after-dinner program has been planned. Once the main course has been removed, winners of the judging contest will be announced and a brief entertainment program will be presented. Then, the guests and the college students will adjourn to another room where three ice cream buffets will be in operation. Here, guests will make their own desserts and have an opportunity to become acquainted with the students, the pacesetters of tomorrow's industries.

Wednesday night, October 31, at the Chalfonte Hotel—Caribbean Carnival, an entertainment extravaganza, will take over the hotel's entire lounge floor. Four famous Caribbean night clubs will be created by use of realistic scenery, and continuous entertainment will be presented in all four. Guests will be invited to move about from club to club, and as one show is completed, to move on to the next. Steel bands, limbo dancers, calypso and marimba music, vocalists and variety acts will be presented in different shows in every room. Refreshments will be available. Favors in the form of straw hats for the men and beads for the women will be presented to all guests, and additionally, open stalls resembling the markets in Caribbean ports will offer Caribbean souvenirs for sale.

For the ladies, two hospitality parlors—one in the Dennis Hotel and one in the Chalfonte-Haddon Hall—will operate during the week, and here ladies may enjoy informal bridge tournaments, receive free tickets for special activities, and gain shopping tips. On Wednesday, in a site yet to be selected, a luncheon is planned.

The committee planning these events is composed of representatives of Milk Industry Foundation, which meets at the Dennis and

Shelburne hotels October 28-October 31; International Association of Ice Cream Manufacturers, which meets at the Chalfonte-Haddon Hall hotel October 31-November 2; and Dairy Industries Supply Association, which sponsors the 23rd Dairy Industries Exposition in Convention Hall, October 28-November 2.

These social events are open to all visitors in Atlantic City, regardless of organizational affiliation. Tickets will be available in advance from the national headquarters of the three associations, and in Atlantic City at the registration areas of the Dennis, Chalfonte-Haddon Hall, and Convention Hall.

The Dairy Conventions Committee is headed by a chairman, E. T. HOLSAPPLE, Welsh Farms, Inc., Long Valley, N. J. Assisting him are two co-chairmen, R. O. DAVISON, Kelco Company, Clark, N. J.; and T. K. WILSON, JR., Wilson Dairy Company, Atlantic City, N. J.

Subcommittees are responsible for the individual social functions.

Fifth International Food Congress Held in New York September 8-16

The Fifth International Food Congress and Exhibition was held in the United States for the first time, at the New York Coliseum, September 8-16.

The first of these world-wide triennial Congresses and Exhibitions was held in Paris, June, 1960. Thereafter, it was held in Ostende (Belgium), 1953; Rome, 1956; and Lausanne, 1959. An estimated 2,370 delegates from 26 countries, and 200,000 public visitors attended the Lausanne Congress.

Theme of the New York Congress was to dramatize the Life Line of Humanity—Food from Farm to Table. Its purpose: to show the world at large how—under the system of free enterprise and free competition, and through the teamwork of all segments of the industry from farm to table—the most basic need of humanity—food—can be brought to the people efficiently, conveniently, and abundantly.

Secretary of State Rusk Sees Lack of Proper Nourishment as Most Pressing World-Wide Problem

Secretary of State Dean Rusk recently said, "No more pressing problem faces the world than providing adequate nourishment for its many peoples."

"The food industries have made significant contributions in aiding efforts to resolve this problem," Secretary Rusk stated in a letter to Hans J. Wolflisberg, Chairman of the Fifth International Food Congress and Exhibition, held at the N. Y. Coliseum from September 8 to 16.

He expressed hope that the International Food Congress will serve to increase knowledge of basic food science so that "the nutri-

tional advantages we enjoy may be shared by all."

This international food festival included dramatic displays under thematic areas portraying the full scope of the world-wide food industry. The theme of the Fifth International Food Congress and Exhibition is The Life Line of Humanity—Food from Farm to Table." Key food industry executes from all parts of the world gathered and exchanged information during a four-day series of trade sessions and seminars. Each of these sessions was conducted by leaders of the U. S. food industry and other world authorities.

U. S. Government participation in this huge food exposition included displays by the U. S. Departments of Agriculture, Commerce, Interior, Labor, as well as the U. S. Public Health Service and the U. S. Food and Drug Administration.

Protect Consumer by FDA Control of Animal Feed Additives and Drugs—AVMA

The American Veterinary Medical Association (AVMA) recently urged passage of legislation to strengthen Food & Drug Administration (FDA) control over animal feed additives and drugs.

The Association, representing 17,000 U. S. and Canadian veterinarians, said the only way to prevent tissue residues in food-producing animals "is to provide the FDA with the authority needed to insure the consumer public that drugs for animals are safe, efficacious, and reliable.

"The possibility of tissue residues harmful to man in food products from animals receiving drugs or chemicals is not to be ignored," the AVMA warned a House subcommittee studying three feed additive and animal drug bills.

"The AVMA is vitally interested in having a constant supply of safe, efficacious, and reliable drugs for treating and preventing animal ailments. We are also concerned that the drugs used in food-producing animals not affect the animal product in any way deleterious to man."

The AVMA's views were submitted in a statement filed with the House Subcommittee on Health and Safety, which is currently conducting hearings on H. R. 12420, 12437 and 12715. The AVMA supports H. R. 12420 (The Nelsen Bill) and H. R. 12715 (The Dominick Bill), principally for a clause in them permitting the Secretary of Health, Education, and Welfare (HEW) to restrict a product if there is "substantial doubt as to its safety."

The AVMA also urged correction of the prior sanction clause in existing legislation, which permits the use of additives in products introduced before a certain date but bans them in products introduced after an arbitrary date. The AVMA called this clause "unfair and discriminatory."

"The AVMA urges that the scientists within the FDA be given full opportunity to use their scientific knowledge and judgment in determining a government decision on problems arising under the Food, Drug, and Cosmetic Act.

"The AVMA strongly supports the activities of the FDA and its supervision of foods, drugs, and devices for animals and man.

"The AVMA opposes any proposals to decrease the supervisory power of the FDA over the manufacture and use of non-prescription drugs and food additives. In fact, the AVMA feels that FDA supervision should be greater over food additives and non-prescription drugs than over prescription drugs, because with the latter there are professional practitioners controlling the dispensing and use of prescription products."

American Institute of Cooperation Announces Two Awards

The problems a farm supply cooperative faces in trying to serve, on an equitable basis, members with large-scale business or commercial operations and those with small operations, are the basis of the thesis winning the Stokdyk Award. The $500 annual award will go to K. R. ERLEWINE of the University of Nebraska, it was announced recently by J. K. STERN, President of the American Institute of Cooperation, national educational and research agency for farm business cooperatives.

The second-place Metzger Award of $100 was won by R. L. SLOAN of Oklahoma State University, for his research study entitled Relationship of Cost Characteristics of a Cooperative Association to Contracting Volumes of Grain Handled.

Dr. M. F. Brink Joins National Dairy Council Staff

DR. M. F. BRINK has joined the staff on the National Dairy Council as Associate Director of the Department of Nutrition Research, MILTON HULT, NDC President, has announced.

A 1955 graduate of the University of Illinois, Dr. Brink was a high school teacher of vocational agriculture and general science from 1955 to 1956. Starting in 1956, Dr. Brink was a graduate assistant in animal nutrition at the University of Illinois and received his Master's degree in 1958. After 1958, at the University of Missouri, he served as a graduate assistant in the animal husbandry department and was awarded his Ph.D. in animal nutrition in August, 1961.

Previous to joining the National Dairy Council, Dr. Brink was research biologist with the U. S. Naval Radiological Defense Laboratory, San Francisco.

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At NDC, he will work closely with NDC's Director of Nutrition Research, DR. M. S. READ, in meeting the increasing responsibilities and expanded NDC nutrition research activities in behalf of the dairy industry. Dr. Brink will assist in the conduct of NDC's regular nutrition research grant-in-aid program, the planning and direction of NDC nutrition research conferences and symposium programs, the study of all current nutrition literature related to the place of milk and milk products in the diet, and research interpretation services to the scientific community and the dairy industry.

Among other duties, Dr. Brink will develop and write major articles for Dairy Council Digest. Articles for the Digest are drawn from the most recent research information pertaining to selected subjects. The Digest is a technical NDC publication which regularly serves as a primary reference source for physicians, dietitians, nutritionists, and other health leaders on the nutritional values of dairy foods.

A member of a number of national professional and honorary organizations, Dr. Brink has published papers in professional journals on mineral nutrition.

Organization of the Vth Congress for Animal Reproduction and Artificial Insemination

The Vth Congress for Animal Reproduction and Artificial Insemination will be held at Trento, Italy, from September 6th to 13th, 1964.

This Congress proposes to define the world situation with regard to questions of fundamental importance concerning animal reproduction and artificial insemination by means of reports and scientific communications, organized in four Congress sections.

The scientific program has been drawn up by the Italian Committee on the basis of many suggestions submitted by more than 200 scientists from various countries who have been previously questioned on this matter.

The Congress is divided into four sections: 1) Biology of reproduction; 2) Morphology and physiology of reproduction; 3) Artificial insemination; and 4) Pathology of reproduction.

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HEAT DENATURATION OF β-LACTOGLOBULINS A AND B[1]

PATRICIA GOUGH AND ROBERT JENNESS
Department of Agricultural Biochemistry, University of Minnesota, St. Paul

SUMMARY

β-Lactoglobulin B was more rapidly denatured than β-lactoglobulin A by heat treatments of skimmilk or solutions of the isolated proteins at pH 6.7 in the temperature range of 67 to 75 C. Three criteria of denaturation, solubility at pH 5.0, sulfhydryl group activity, and specific optical rotation, all demonstrated the difference in denaturability of the two proteins. They were found to differ in energy of activation and in entropy of activation. Both proteins undergo both the primary and secondary stages in heat denaturation.

β-Lactoglobulins A and B have been shown to differ in electrophoretic mobility under certain conditions (2) and in capacity to form aggregates at pH's near the isoelectric point (7, 11, 13-15). Variations in such physical properties suggest a difference in the charge density of the two proteins as a result of differences either in the amino acid composition or in the arrangement of the residues into the structure of the molecule. Small differences have been observed in the amino acid constituents (5, 12), β-lactoglobulin A having two aspartic acid residues that are apparently replaced by two glycine residues in the β-lactoglobulin B molecule.

It seemed possible that the differences in the amino acid composition, and in the arrangement of the residues, could influence the relative resistance of the two types of β-lactoglobulin to the effects of heat. Heat denaturation of β-lactoglobulin prepared from herd milk has been studied by several workers (1, 4, 6, 9), but none of the earlier investigations was performed on protein that can be considered homogeneous by the present criteria. In the following experiments, a comparison has been made of the heat denaturation of β-lactoglobulins A and B.

EXPERIMENTAL PROCEDURE AND RESULTS

Preparation of β-lactoglobulin. Paper electrophoresis in veronal buffer at pH 8.6 and ionic strength 0.05, with a potential of 250 v for 16 hr, was applied to the fraction of milk proteins not precipitated by 20 g sodium sulfate per 100 ml to characterize each lactating cow of the University of Minnesota dairy herd as to type of β-lactoglobulin produced. A Spinco Model R paper electrophoresis apparatus with S and S No. 2043A gl paper strips was used for this characterization. Four cows were selected for the preparation of two lots of β-lactoglobulin A (designated here as specimens β-lactoglobulin A-1 and β-lactoglobulin A-2), and four cows for the preparation of two lots of β-lactoglobulin B (designated here as specimens β-lactoglobulin B-1 and β-lactoglobulin B-2), each lot being prepared from the combined milk of two cows. A single lot of β-lactoglobulin AB (from two cows that synthesized both A and B type protein) and two lots of β-lactoglobulin from herd milk (referred to here as specimens β-lactoglobulin herd milk 1 and β-lactoglobulin herd milk 2) were also isolated for use as controls in the experiments. The procedure of Larson and Jenness (10) was used for isolation and crystallization, the only modification being that whole milk rather than skimmilk was used as the starting material.

Rate of heat denaturation of β-lactoglobulin solution. Five-milliliter aliquots of 1% solutions (at a pH of 6.7 in phosphate buffer of ionic strength 0.1)[2] of β-lactoglobulins A-1, B-1, and herd milk 1 in loosely stoppered 18 by 150 mm test tubes were preheated at 60 C for 3 min, followed by heating at 73.0 C in a thermostatically controlled water bath. At the end of each time period, ranging from 7 to 97 min, one tube of each type of β-lactoglobulin was removed from the 73.0 C water bath and

Received for publication March 9, 1962.

[1] Paper No. 4737. Scientific Journal Series, Minnesota Agricultural Experiment Station. Data presented herein are taken from a thesis presented by Patricia Gough in partial fulfillment of the requirements of the Master of Science degree, University of Minnesota, June, 1961.

[2] The buffer was of pH 6.86 and ionic strength 0.1. Solution of 1% β-lactoglobulin reduced the pH to 6.7-6.74.

rapidly cooled by immersion into an ice-water bath. The denatured protein was precipitated by adjusting the pH of each sample to 5.0 with 1.8 ml of 0.1 N acetic acid and centrifuging. The undenatured protein concentration in the supernatants was determined by a micro-Kjeldahl analysis for nitrogen. The rate of denaturation of β-lactoglobulin B-1 was greater than that of β-lactoglobulin A-1; and β-lactoglobulin herd milk 1 was denatured at an intermediate rate. A graph of the per cent denaturation as a function of time of heating at 73.0 C appears in Figure 1.

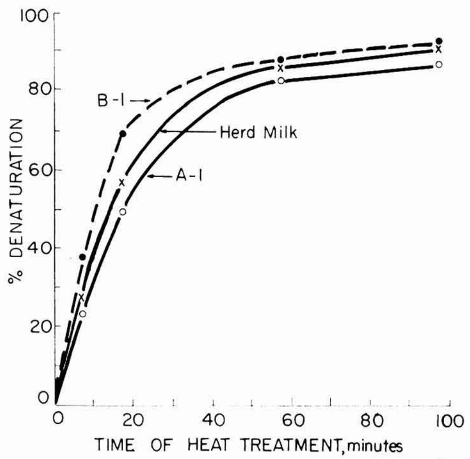

FIG. 1. Relationship between the per cent denaturation of β-lactoglobulins A-1, B-1, and herd milk 1, as measured by the protein precipitable at pH 5.0, and the time of heating at 73.0 C.

A second criterion used to compare the rates of denaturation of β-lactoglobulins A-1 and B-1 was specific optical rotation. A Schmidt-Haensch polarimeter, with a sodium lamp as a light source, was used to measure the optical rotation of 1% solutions of the protein at pH 6.7 in phosphate buffer of ionic strength 0.1 in a 2-dm 16-ml jacketed polarimeter tube at 20.0 C. The specific rotation of native β-lactoglobulins A and B did not differ greatly, but heating at 73.0 C for 30 min caused a greater increase in the rotation of β-lactoglobulin B-1 than in that of β-lactoglobulin A-1 (Table 1). The change observed with β-lactoglobulin from herd milk 2 was intermediate.

The third indication of rate of denaturation of the β-lactoglobulins was the decrease in the sulfhydryl group activity (due to oxidation during and following heat treatment) as measured by the *o*-iodosobenzoate-iodine titration procedure of Larson and Jenness (8). The difference in the activities of the native protein solutions was not significant (Table 1). Twenty-five-milliliter aliquots of 1% solutions in phosphate buffer of ionic strength 0.1 and pH 6.86 were preheated at 60 C for 3 min before being transferred to 25 by 200 mm test tubes that had been preheated at 73.0 C for 5 min; the solutions were heated at 73.0 C for 30 min, followed by rapid cooling. After refrigeration for 72 hr, in order that oxidation of activated sulfhydryl groups would be complete, each solution was titrated by the *o*-iodosobenzoate iodine procedure; the protein concentration of each solution was determined by a micro-Kjeldahl nitrogen analysis. The results indicated that the loss of activity of sulfhydryl groups was greater with β-lactoglobulin B-1 than with β-lactoglobulin A-1 (Table 1).

These experiments were repeated with β-lactoglobulins A-2, B-2, and AB to confirm that the differences are related to the β-lactoglobulins rather than to chance variations between cows. In this series, concentrations of the supernatants at pH 5.0 were measured refractometrically with a Zeiss dipping refractometer equipped with an L-1 heatable prism instead of by micro-Kjeldahl. The curves obtained

TABLE 1

Change in specific optical rotation and sulfhydryl group activity of β-lactoglobulin solutions as a result of denaturation by a heat treatment of 73.0 C for 30 min

B-Lacto-globulin	Specific optical rotation $[\alpha]_D^{20}$		Sulfhydryl activity Apparent (%) Cysteine		(%) Dena-tured	Acid precip-itable (%)
	Native	Heated	Native	Heated		
A-1	−33.5	−58.9	1.12	0.44	60.7	72.7
B-1	−33.8	−67.2	1.20	0.30	75.0	86.8
Herd-2	−33.5	−62.7	1.19	0.36	69.7	79.5
A-2	−32.9	−65.1	1.21	0.49	59.3	64.5
B-2	−34.3	−79.0	1.18	0.26	77.4	78.2
AB	−33.0	−61.0	1.13	0.36	68.2	68.2

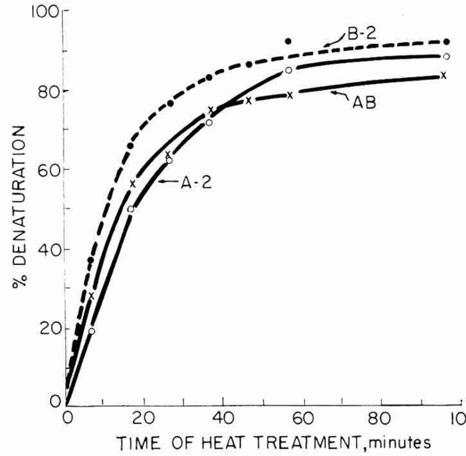

FIG. 2. Relationship between the per cent denaturation of β-lactoglobulins A-2, B-2, and AB, as measured by the protein precipitated at pH 5.0, and the time of heating at 73.0 C.

(Figure 2) are virtually identical to those for β-lactoglobulins A-1 and B-1. The curve for β-lactoglobulin AB, however, differs from that for β-lactoglobulin herd milk 1, in that it levels off and crosses the curve for β-lactoglobulin A-2. This difference may result in part from differences in proportions of the two proteins in the AB and the herd milk specimens. Data showing the effect of heating at 73 C for 30 min on the optical rotation and sulfhydryl activity of β-lactoglobulins A-2, B-2, and AB are included in Table 1. They are similar to the data for specimens A-1, B-1, and herd milk 1 except for the somewhat higher rotations of heated samples of A-2 and B-2 and for the fact that the change in specimen AB does not fall between those for A-2 and B-2. No explanation is evident for these discrepancies.

Rate of heat denaturation of β-lactoglobulins A and B in milk. The rates of denaturation by heat of β-lactoglobulins A and B as they exist in milk, capable of interaction with other constituents, were also compared. One composite sample of skimmilk from two cows that produced only β-lactoglobulin A and another from two that produced only β-lactoglobulin B were used. One hundred-milliliter portions were heated in a 500-ml, 3-necked, round-bottomed flask equipped with a thermometer and a condenser in a thermostatically controlled water bath at a temperature of 74.0 C for 30 min. Cooling was accomplished at the end of 30 min by immersing the flask in an ice-water bath.

The two samples of heated skimmilk, as well as unheated skimmilk from the same two pairs of cows, were fractionated according to the procedure of Aschaffenburg and Drewry (3) and the concentrations of the various protein fractions were determined by a micro-Kjeldahl analysis for nitrogen. The distribution of protein among the various fractions appears in Table 2. The quantity of β-lactoglobulin was twice as great in the unheated β-lactoglobulin A milk as in the unheated β-lactoglobulin B milk. On the assumption that the denaturation follows first-order kinetics, the proportionately greater change in β-lactoglobulin B milk in 30 min at 74 C suggests a higher rate of denaturation than in the β-lactoglobulin A milk. The per cent decrease in β-lactoglobulin A upon heating at 74.0 C for 30 min was 46.3%; that of β-lactoglobulin B was 71.4%.

Kinetics of heat denaturation. Since there was a difference in the rates of heat denaturaion of the two β-lactoglobulins at 73 C, experiments were undertaken to investigate the kinetics of the reaction at several temperatures. Six-milliliter aliquots of 1% solutions at pH 6.7 of each type of β-lactoglobulin-2 in phosphate buffer of ionic strength 0.1 were pre-

TABLE 2
Distribution of protein in milk (Aschaffenburg and Drewry fractionation) following heating at 74.0 C for 30 min

Fraction	β-Lactoglobulin A Milk		β-Lactoglobulin B Milk	
	Unheated	Heated	Unheated	Heated
	(mg N/ml milk)		*(mg N/ml milk)*	
Total Protein N	5.32	5.32	6.30	6.30
Casein N	4.19	4.55	5.37	5.66
Total Serum Protein N	1.13	0.77	0.93	0.64
Total Albumin N	0.93	0.59	0.84	0.53
β-Lactoglobulin N	0.56	0.30	0.28	0.08
Residual Albumin N	0.37	0.29	0.56	0.45
Proteose-Peptone N	0.15	0.16	0.07	0.08
Globulin N	0.05	0.02	0.02	0.02

heated at 60 C for 3 min in 18 by 150 mm test tubes. The tubes, lightly stoppered to avoid loss of water through evaporation, were transferred to a thermostatically controlled water bath, the temperature of which had been maintained at the desired level for 1 hr before use. Samples were heated at 67.00 ± 0.05, 69.00 ± 0.05, 71.00 ± 0.02, 73.00 ± 0.05, and 75.00 ± 0.02 C for various intervals of time.

At the end of the heat treatment, the tubes were rapidly cooled by immersion into an ice-water bath and the denatured protein was precipitated by adjusting the pH of each solution to 5.0 with 0.1 N acetic acid. The native protein remaining in the solutions was determined by a micro-Kjeldahl analysis for nitrogen. A series of curves that related per cent denaturation to time of heating showed β-lactoglobulin B-2 to be denatured the most rapidly of the three β-lactoglobulins, regardless of the temperature at which the denaturation was induced. Figure 3 compares β-lactoglobulins A-2 and B-2 at four of the temperatures.

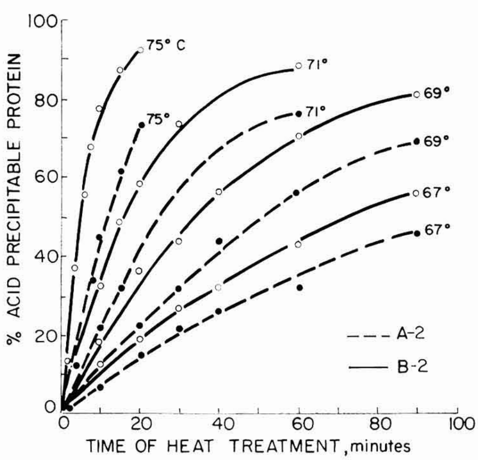

FIG. 3. The effect of time of heat treatment at various temperatures on the extent of denaturation of β-lactoglobulins A-2 and B-2, as measured by the per cent of the protein precipitated at pH 5.0.

For each beta-lactoglobulin solution, the log of the ratio between the original concentration of β-lactoglobulin and that after heating was plotted as a function of the time of heating at each temperature, in order that the specific velocity constants for the heat denaturation reactions might be calculated (Figure 4). Since the relationship between these two variables was linear, the reactions were first order with respect to the protein concentration, and the

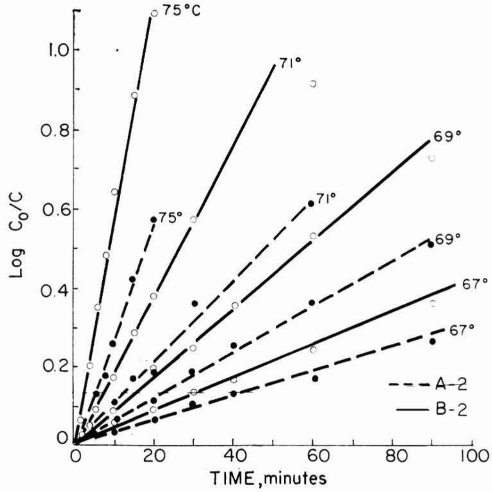

FIG. 4. The relationship between the change in β-lactoglobulins A-2 and B-2 concentration and the time of heat treatment at various temperatures.

slopes of the lines were, therefore, equal to the velocity constants for the reactions at the various temperatures.

An Arrhenius plot (Figure 5) of the log of

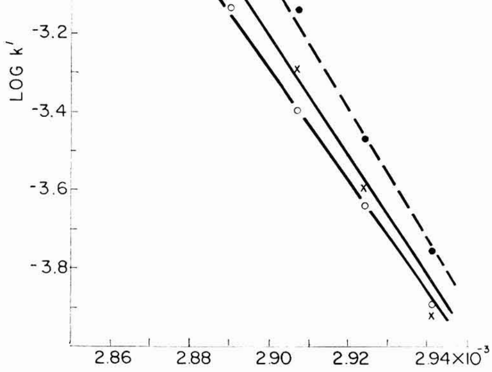

FIG. 5. Arrhenius plot relating the specific velocity constants for the denaturation reactions of the β-lactoglobulins to the temperature of heat treatment.

TABLE 3

Thermodynamic functions calculated for the process of heat denaturation of the β-lactoglobulins

β-Lactoglobulin	Tempera- ture *(C)*	Rate constant (k′) sec^{-1}	H* [a] cal/mole	F* [b] cal/mole	S* [c] cal/mole/ degree
β-Lactoglobulin A-2	67.0	1.289	64,924	26,044	114.4
E = 65.5 kcal	69.0	2.295	64.920	25,959	113.9
	71.0	4.036	64,916	25,577	114.4
	73.0	7.365	64,912	25,314	114.4
	75.0	12.02	64,908	25,129	114.3
β-Lactoglobulin B-2	67.0	1.765	76,424	25,835	148.8
E = 77.1 kcal	69.0	3.407	76,420	25,546	148.8
	71.0	7.305	76,416	25,173	149.0
	73.0	12.80	76,412	24,943	148.9
	75.0	22.70	76,408	24,693	148.6
β-Lactoglobulin AB	67.0	1.204	70,924	26,092	131.9
E = 71.6 kcal	69.0	2.543	70,920	25,743	132.1
	71.0	5.103	70,916	25,419	132.3
	73.0	9.041	70,912	25,176	132.2
	75.0	14.25	70,908	25,012	131.9

[a] H* = Heat of activation.
[b] F* = Free energy of activation.
[c] S* = Entropy of activation.

these velocity constants (k′) as a function of the reciprocal of the temperature (degrees Kelvin) of heat treatment was drawn, in order that the energy of activation for the denaturation reaction could be calculated. Since $\ln k' = -E/RT$, the energy of activation (E) is equal to 2.303 times the slope of the line obtained. Such calculations showed the energy of activation of β-lactoglobulin A-2 to be 65.6 kcal/mole, of B-2, 77.1 kcal/mole, and of AB, 71.6 kcal/mole. Other thermodynamic functions were also calculated and appear in Table 3.

Primary and secondary denaturation. Briggs and Hull (4) observed that heat denaturation of β-lactoglobulin (from herd milk) involves at least two distinct processes: 1. primary denaturation which is initiated only at temperatures above 65 C and which is not accompanied by a change in the electrophoretic mobility of the protein; and 2. secondary denaturation which occurs only after the first is initiated and which is accompanied by further aggregation of the β-lactoglobulin molecules and an increase in electrophoretic mobility. Since solutions of native β-lactoglobulin B do not appear to be aggregated (electrophoretic and ultracentrifugal evidence) under conditions of pH and temperature at which solutions of β-lactoglobulin A are aggregated although B can be incorporated into aggregates of A to form mixtures (7, 11, 13-15), the question arose as to whether the type of aggregation upon denaturation observed by Briggs and Hull could occur when either β-lactoglobulin A or β-lactoglobulin B were heated independently.

Primary denaturation of 0.5% solutions of β-lactoglobulins A-2, B-2, and AB, in phosphate buffer of ionic strength 0.1 and pH 6.86,[3] was accomplished by heating 25-ml aliquots of the solutions, deaerated in vacuo to prevent surface denaturation, in 25 by 200 mm test tubes at 100 C for 10 min. The tubes were rotated for the first minute to bring the solutions rapidly to water-bath temperature. Extent of this reaction was observed by micro-Kjeldahl analysis of the supernatants obtained after the denatured protein was precipitated at a pH 5.0 by the addition of 0.1 N acetic acid (Table 4). Primary denaturation occurred both in β-lactoglobulin A solutions and in β-lactoglobulin B solutions. The rate of this reaction at 100 C was so rapid that after 10 min the extent to which it had proceeded was the same for both β-lactoglobulins A and B.

Secondary denaturation, by which the aggregate is formed, occurred when the primary-denatured solutions were heated for 30 min at 70.0 C in a thermostatically controlled water bath. The extent of this reaction was observed by comparing the concentration of the faster-migrating aggregate to that of the slower-migrating native and primary-denatured β-lactoglobulin, using Tiselius electrophoresis with

[3] In this case the solution of the protein was equilibrated by dialysis versus a large volume of the buffer so that the pH of the solution was 6.86.

TABLE 4
Extent of primary denaturation of the β-lactoglobulins as measured by the per cent of the protein precipitated at pH 5.0

β-Lactoglobulin	mg N/ml supernatant	% Acid precipitable
Native—A-2	0.547	....
B-2	0.573	....
AB	0.597	....
Primary-denatured—A-2	0.070	87.20
(100 C—10 min) B-2	0.073	87.26
AB	0.097	83.75

phosphate buffer of pH 6.86 and ionic strength 0.1, the current constant at 10 ma for 3 hr. The patterns, Figure 6, show that secondary

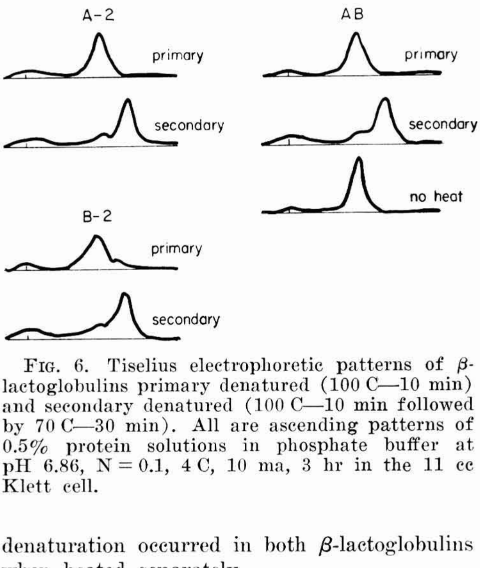

FIG. 6. Tiselius electrophoretic patterns of β-lactoglobulins primary denatured (100 C—10 min) and secondary denatured (100 C—10 min followed by 70 C—30 min). All are ascending patterns of 0.5% protein solutions in phosphate buffer at pH 6.86, N = 0.1, 4 C, 10 ma, 3 hr in the 11 cc Klett cell.

denaturation occurred in both β-lactoglobulins when heated separately.

DISCUSSION

The experiments presented herein show that β-lactoglobulin B is denatured at a more rapid rate than β-lactoglobulin A, regardless of whether the protein under study is isolated, purified, and dissolved in buffer at the pH of milk, or is present in milk itself with other normal constituents. Since the results were the same when different pairs of cows were used, the difference does not seem to be due to individual peculiarities of the cows.

Greater sensitivity of β-lactoglobulin B to heat is made very evident by the differences in the specific velocity constants for the denaturation reactions at different temperatures. The velocity constants for the heat denaturation of β-lactoglobulin AB are similar to those obtained by Anderson (1) and Larson and Jenness (9) for β-lactoglobulin from herd milk.

The calculated energy of activation of β-lactoglobulin AB was 71.6 kcal/mole, as compared to 80.6 kcal/mole determined by Larson and Jenness (9) for herd milk β-lactoglobulin on the basis of changes in sulfhydryl activity. Anderson (1) obtained the identical value of 80.6 kcal/mole using the criteria of acid precipitability and optical rotation. Although Anderson showed that the rate of denaturation and the energy of activation depend strongly on pH, the difference between the present result and those reported earlier is probably not due to differences in pH. In all three investigations the solvent for the protein was a phosphate buffer of pH 6.86 and ionic strength of 0.1. One per cent solutions of β-lactoglobulin in this buffer have a pH of 6.70-6.74. [Larson and Jenness (9) reported the pH of the buffer rather than that of the solution.] Perhaps the difference arises in part from a difference between the β-lactoglobulin AB (from two cows) and herd milk β-lactoglobulin in the proportion of the two proteins present.

The slopes of the lines representing the denaturation reaction of β-lactoglobulins A, B, and AB were definitely different, with B having the steepest slope and, therefore, the greatest energy of activation.

Although observations have been made by several workers (11, 13-15, 29), that native solutions of β-lactoglobulin B do not form aggregates under conditions where such aggregates are observed to occur with solutions of native β-lactoglobulin A, there was no difference evident in the ability of either type to undergo the secondary denaturation process. Apparently, these two types of aggregation involve entirely different groups on the protein molecule and are not at all related.

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INFLUENCE OF HOMOGENIZATION, COPPER, AND ASCORBIC ACID ON LIGHT-ACTIVATED FLAVOR IN MILK

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SUMMARY

This study reports on some factors that influence light activated flavor induced in milk by exposure to fluorescent light under conditions that produced distinct light flavor with little or no lipid oxidation as measured by the thiobarbituric acid test. Homogenization increased susceptibility to light flavor, but decreased susceptibility to both copper-induced and light-induced oxidized flavors. Both addition of copper, and of neocuproine to chelate natural copper, demonstrated that copper catalyzes light flavor. Destruction of ascorbic acid by ascorbic acid oxidase decreased susceptibility to light flavor, but added ascorbic acid did not inhibit light flavor, as it does oxidized flavor.

Exposure of milk to light may result in activated or oxidized flavor, or both. Unfortunately, the flavors develop concurrently, and suitable tests are lacking for measuring changes responsible for or accompanying activated flavor. The resulting difficulties in research on activated flavor account for many confusing and contradictory reports on light-induced flavors. The present study was undertaken to clarify the influence of homogenization, copper, and ascorbic acid on the development of light-induced flavors in milk.

Recent reviews of research on light-induced flavors of milk include those of Strobel et al. (8), Stull (9), and Wildbrett (11).

Light induces at least two distinctly different types of flavors in milk: the well-known oxidized flavors, resulting from lipid oxidation; and flavors resulting from degradation of protein, described by such terms as activated, solar activated, burnt feather, burnt protein, scorched, cabbage, and mushroom. In the United States, the terms light, sunlight, and sunshine flavor usually refer to flavor in which the activated or radiated-protein characteristics predominate, even though, under many conditions of exposure, changes in both protein and lipid may contribute to the off-flavor. In this study, the term activated is used to describe flavor assumed to be caused by chemical changes in protein constituents exposed to light. Sensory evaluations alone cannot provide assurance that activated flavor is not accompanied by some flavor attributable to concurrent lipid oxidation. Therefore, we describe the flavor as light when the estimation of activated flavor is determined by sensory evaluations and may be influenced by lipid oxidation, even though the panel members attempted to differentiate between activated and oxidized flavors.

The dominant flavor characteristic induced by light depends upon many factors, particularly the product and the conditions of exposure and storage. Homogenized milk is more susceptible to activated flavor than is unhomogenized milk, but is less susceptible to oxidized flavor. The flavor predominating in homogenized milk exposed to light is usually activated flavor after relatively short exposure and oxidized flavor after long exposure [e.g., compare results of Dunkley et al. (2), Birdsall et al. (1), and Smith and MacLeod (5, 6)].

The influence of copper on activated flavor has not been reported. Patton (3) presented evidence that ascorbic acid promotes activated flavor, and Weinstein and Trout (10) found that increasing the ascorbic acid concentration in milk did not prevent activated flavor, as it does oxidized flavor.

EXPERIMENTAL PROCEDURES

The methods and materials have been described (2). Briefly, the milk was produced by the University herd of Holstein and Jersey cows receiving dry feeds, was pasteurized and homogenized in the University creamery, and was exposed within 2 hr of being processed. Light exposures were by the agitated procedure, i.e., milk was exposed at 42 ± 2 F in half-

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TABLE 1
Influence of homogenization on light activated and oxidized flavor in milk

Treatment	Storage time (hr)	Light flavor score [a]		Oxidized flavor score [a]		TBA	
		Unhomog.	Homog.	Unhomog.	Homog.	Unhomog. ($A \times 10^3$)	Homog. ($A \times 10^3$)
Experiment 1							
Control	0	....	....	....	....	13	17
	24	0.2	0.1	0.1	0.1	14	14
	48	0.2	0.1	0.1	0.1	16	17
Exposed [b]	0	....	....	....	....	23	22
	24	0.5	2.7	1.7	0.3	49	18
	48	1.0	2.3	2.1	0.2	65	15
Cu added [c]	0	....	....	....	...	15	20
	24	0.6	0.1	3.3	0.1	107	16
	48	0.3	0.2	3.5	0.1	153	29
Experiment 2							
Control	0	....	....	....	....	15	16
	24	0.1	0.2	0.2	0.1	16	15
	48	0.0	0.0	0.0	0.1	16	17
Exposed [b]	0	....	....	....	....	24	17
	24	1.3	3.2	1.6	0.1	45	19
	48	0.8	3.0	1.1	0.2	66	19
Cu added [c]	0	....	....	....	....	14	21
	24	0.4	0.2	3.4	0.1	101	17
	48	0.0	0.2	3.7	0.0	154	20

[a] Average of 18 judgments for Experiment 1, 12 for Experiment 2: 0 = none, 4 = strong.
[b] 40 min.
[c] 0.1 μg/g copper added.

filled clear-glass quart milk bottles mounted horizontally over two 40-watt Cool White fluorescent lamps on an assembly that was rocked at 75 oscillations per minute. Flavors were scored by a panel of six highly trained judges (nine for Experiment 1, Table 1) on a scale of: 0, none; 1, questionable; 2, slight; 3, distinct, objectionable; and 4, strong, very objectionable. In experiments in which the panel scored both light and oxidized flavor, reference samples of both defects and an untreated control were provided. For analysis of variance of flavor scores, results for samples stored 24 and 48 hr were combined.

Methods for the thiobarbituric acid (TBA) test, additions of copper and neocuproine, and preparation of crude ascorbic acid oxidase were as outlined by Smith and Dunkley (7). The crude ascorbic acid oxidase was dried by acetone precipitation of the prevaporated juice.

RESULTS

Homogenization. Table 1 contains the results of two experiments that demonstrate the influence of homogenization on light and oxidized flavors in milk. For both experiments, analysis of variance of combined results for samples stored 24 and 48 hr showed that the scores for light flavor for the exposed homogenized and unhomogenized samples differed significantly between themselves and from all other samples ($P < 0.001$). Likewise, the oxidized flavor scores for the homogenized and unhomogenized samples containing added copper differed significantly between themselves and from all other samples ($P < 0.001$). Also, the scores for oxidized flavor for the exposed unhomogenized samples differed significantly from the scores of all other samples ($P < 0.001$). The scores for light flavor are consistent with others' results in showing that homogenized milk is more susceptible to activated flavor than is unhomogenized milk. The exposed unhomogenized sample received a higher score for oxidized flavor than for light flavor. The TBA results were consistent with the flavor scores in indicating oxidized flavor in the unhomogenized sample but not in the homogenized sample. These results show that homogenization inhibits light-induced as well as copper-induced oxidized flavor.

The reliability of the judges in differentiating between activated and oxidized flavors was indicated by the scores for exposed samples and the samples containing added copper. In 56 of 60 judgments, the exposed homogenized sample received scores of 2 or above for intensity of light flavor, but only three scores above 1 for oxidized flavor. In 56 of 60 judgments, the unhomogenized sample containing added copper received scores of 3 or above for oxidized flavor, and scores of 0 (50 judgments) or 1 (four judgments) for light flavor. The remaining four scores were 3 or 4 (one and three times, respectively) for light flavor, and 0 or 1 (one and three times, respectively) for oxidized flavor. We believe that these four were errors in identification, for the sample was protected from light. Three of these errors were by one panel member. Deletion of this individual's scores from Experiment 1 would have given respective average scores for light and oxidized flavors of 0.1 and 3.8 for 24 hr, and 0.1 and 3.7 for 48 hr (instead of 0.6, 3.3, 0.1, and 3.7, respectively). Thus, eight of the nine panel members were able to differentiate reliably between activated and oxidized flavors.

The TBA tests indicated little or no lipid oxidation except in the unhomogenized milk exposed to light or containing added copper. The exposed homogenized milk had a distinct light flavor, yet the average difference in TBA absorbancy between the exposed and unexposed samples was only 0.002 (which is within experimental error).

Copper. The results in Table 2 are representative of several experiments showing that copper increases light flavor in milk. The sample with copper added developed more intense light flavor than the control. Addition of neocuproine to chelate the natural copper prevented the development of such an intense light flavor. For both the 30- and 60-min exposures, all differences among the scores were very highly significant ($P < 0.001$).

The TBA results were slightly higher for the samples with added copper than for the control or neocuproine-treated samples. The results indicate that a slight lipid oxidation may have contributed to the differences in flavor scores between the control and the samples with added copper, but not between the control and the samples containing neocuproine. However, since the differences in flavor scores were greater between the neocuproine-added and the control samples than between the copper-added and control samples, we believe that lipid oxidation had very little, if any, influence on the scores for light flavor.

Ascorbic acid. Table 3 contains representative results showing the influence of ascorbic acid on light flavor. Destruction of ascorbic acid by ascorbic acid oxidase markedly reduced the intensity of activated flavor ($P < 0.001$), but added ascorbic acid had little effect.

Differences among the TBA results were not significant. Hence, the scores for light flavor were entirely attributable to activated flavor.

DISCUSSION

The TBA test was included as a measure of lipid oxidation. Unfortunately, no corresponding test is available for estimation of the extent of chemical changes responsible for or accompanying activated flavor development. However, the low TBA results for all samples except those criticized for oxidized flavor indicate that the scores for light flavor were attributable to activated flavor. Furthermore,

TABLE 2
Influence of copper on light activated flavor in homogenized milk

Exposure time (min)	Storage time (hr)	Flavor score for [a] Control	Copper [b]	Neocuproine [c]	TBA Control ($A \times 10^3$)	Copper [b] ($A \times 10^3$)	Neocuproine [c] ($A \times 10^3$)
0	0	....	....	....	29	....	....
	24	0.1	....	....	24	....	....
	48	0.2	....	....	18	....	....
30	0	....	....	....	24	31	27
	24	2.0	3.6	0.5	19	30	22
	48	1.8	3.0	0.3	21	32	14
60	0	....	....	....	26	28	28
	24	2.7	3.7	1.1	22	27	26
	48	3.2	3.5	0.9	24	33	17

[a] Average of 12 judgments of light flavor: 0 = none, 4 = strong.
[b] Copper added at 0.1 $\mu g/g$.
[c] Neocuproine added at 4.5×10^{-6} M.

TABLE 3
Influence of ascorbic acid on light activated flavor in homogenized milk

Exposure time (min)	Storage time (hr)	Flavor score for [a] Control	A.A.[b] added	A.A.[c] destroyed	TBA Control ($A \times 10^3$)	A.A.[b] added ($A \times 10^3$)	A.A.[c] destroyed ($A \times 10^3$)
0	0	....	....	....	16	....	....
	24	0.2	....	....	14	....	....
	48	....	....	....	13	....	....
30	0	....	....	....	21	17	22
	24	2.8	3.0	0.3	17	15	16
	48	2.7	2.6	0.3	16	17	16
60	0	....	....	....	24	23	22
	24	3.3	3.8	1.3	22	17	21
	48	3.4	3.0	1.2	17	16	16

[a] Average of 12 judgments of light flavor: 0 = none, 4 = strong.
[b] Ascorbic acid added at 50 mg/liter.
[c] Ascorbic acid destroyed by ascorbic acid oxidase.

most of the panel members were highly consistent in differentiating between light and oxidized flavors. The member less reliable in identifying the defect was retained on the panel because his scores for intensity of light flavor, when present without oxidized flavor, were highly reproducible.

It is well established that homogenization of milk increases susceptibility to activated flavor and decreases susceptibility to copper-induced oxidized flavor. It has not been clear, however, whether homogenization inhibits light-induced oxidized flavor, for some investigators have not differentiated between activated and oxidized flavors. Results in Table 1 demonstrate that homogenization inhibits both light-induced and copper-induced oxidized flavor.

Although copper is recognized as an important catalyst of oxidized flavor, its role in reactions resulting in activated flavor has not been established. Results reported above show that copper catalyzes activated as well as oxidized flavor. Since the Strecker degradation, considered to be responsible for activated flavor (3, 4), is an oxidative reaction, the catalytic activity of copper is not unexpected.

The influence of ascorbic acid provides a helpful distinction between activated and oxidized flavors, and a means of preparing milk with a distinct activated but little or no oxidized flavor. Destruction of ascorbic acid inhibits development of both activated and oxidized flavors. In contrast, increasing the concentration of ascorbic acid inhibits oxidized flavor but not activated flavor. In our laboratory we have prepared reference samples with a distinct activated flavor by exposing homogenized milk to light after increasing the ascorbic acid concentration by as much as 1%. Such samples are helpful in training new panel members and in testing scorers for ability to identify light flavor and evaluate its intensity.

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HIGH-TEMPERATURE–SHORT-TIME STERILIZED EVAPORATED MILK. IV. THE RETARDATION OF GELATION WITH CONDENSED PHOSPHATES, MANGANOUS IONS, POLYHYDRIC COMPOUNDS, AND PHOSPHATIDES

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SUMMARY

Polyphosphates, manganous salts, polyhydric compounds, and phosphatides are important additives for prolonging the storage life of high-temperature–short-time sterilized milk concentrates. A sixfold and threefold increase in the storage life of 3 to 1 and 2 to 1 concentrates was, respectively, obtained by adding per 100 g milk 0.05 g sodium polyphosphate containing an average of 4.8 P atoms per chain; and a similar increase was obtained by adding approximately the same quantity of $MnSO_4$. In concentrations greater than about 1 g per 100 g milk solids, the polyphosphate conduced to age-thickening. The polyphosphates function also as stabilizers against heat coagulation during sterilization. The antigelation activity of the polyphosphates increased with increasing concentration and chain length. The cyclic tetrametaphosphate and adenosine triphosphate were more effective than the corresponding linear polymer and sodium tripolyphosphate, respectively.

Added orthophosphates were found to conduce to gelation.

Nearly a twofold increase in storage life was brought by the incorporation in 2 to 1 concentrates of 9.6 g per 100 g product of either lactose, sucrose, dextrose, or sorbitol. At higher concentration levels specific effects were met which limited the activity of the sugars, but not that of sorbitol. In stabilizing the lipid phase, added phosphatides stabilize HTST sterilized milk concentrates both against heat coagulation during sterilization and gelation during storage.

Theoretical considerations postulating the existence of two kinds of micellar structures, one active in gelation phenomena, the other in heat coagulation, served as a guide in the selection of the additives used in the present study.

Gelation represents a single aspect of a many-sided instability problem encountered in the manufacture and storage of sterile milk concentrates. It is unique in the sense that only in the storage of high-temperature–short-time (HTST) sterilized milk products does it assume serious proportions. Upon the solution of the gelation problem may depend the successful application of HTST sterilization techniques to the development of improved fluid milk concentrates. The study of additives constitutes an inviting and obvious way to approach the problem as demonstrated by well-known observations on the ability of additives to retard coagulation during sterilization of conventionally prepared evaporated milk.

Studies in our laboratory, over a period of years and restricted to technologically applicable compounds, have disclosed the value of four groups of substances—polyphosphates, manganous salts, polyhydric compounds, and phosphatides—all of which, to some significant degree, possess the capacity of prolonging the storage life of HTST sterilized milk concentrates.

It is the object of this paper to report on the results of our studies, emphasizing for the moment their practical rather than their theoretical value.

METHODS AND MATERIALS

Methods. The techniques described in Parts 1 and 2 of this series of papers were used throughout the experiment (10, 11). With the exception of high-pressure homogenization, carried out with a Manton-Gaulin high pressure

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homogenizer[1] capable of homogenizing at 8,000 psi, all operations were carried out on a laboratory scale. Homogenization was usually carried out at 160 F in two stages—7,500 and 500 psi. Forewarming for 17 min at the temperature of boiling water was carried out under nitrogen in a rotating film evaporator. Concentration under vacuum was effected in the same evaporator to a point slightly greater than the desired concentration, and final adjustment was made by the addition of a weighed quantity of water to the weighed concentrate. The concentrates sealed in bomb microviscometers were sterilized in an oil bath for either 5 or 15 sec at 137.4 C, then cooled in a water bath to room temperature. Samples were stored at 30 C in the same viscometers. Sedimentation and creaming were minimized by mounting the viscometers with their axes horizontal in a rotating device. Prior to a viscosity measurement, the position of the liquid thread in the viscometer was reversed twice in a centrifuge. Each viscometer tube contained a glass bead, and thus it could be arranged to function in the manner of the Höppler falling ball viscometer.[1] Viscosity measurements were made periodically on the same samples in triplicate throughout the experimental period. Fat and solids were determined according to the procedure recommended by Mojonnier and Troy (14), and homogenization indices by turbidimetry (2).

[1] The use of trade names is for the purpose of identification only, and does not imply endorsement of the product or its manufacturer by the U. S. Department of Agriculture.

A plastometer was available consisting of a turntable mounted on a variable-speed, quick-starting motor. The viscometer tubes in radial grooves could be subjected to a relative centrifugal force varying from zero to 35 times gravity.

Many, but not all, procedural details may be inferred by referring to data in the various tables. In experiments with different condensed phosphates, additive concentrates were adjusted for comparison purposes so that, at each concentration level, the milks contained the same number of available orthophosphate groups (19).

Unless stated otherwise, in experiments with condensed phosphates and manganous salts, the additive in solution was added to the concentrate just prior to sterilization. In experiments with polyhydric compounds, the additives were added to the milks prior to processing.

In several experiments with phosphatides, the milks were modified with synthetic serums to yield products with a weight ratio between fat and protein of 4.5 to 2.4 in one experiment (see Table 10) and 5.0 to 1.9 in another (see Table 11). The serum diluents had the same pH as milk and approximately the same ionic strength as milk serum.

Materials. Commercially available condensed phosphates under various trade names were

TABLE 1

Some properties of the polyphosphate additives

Source	Ratio Na_2O/P_2O_5	Average no. of P atoms per chain (calculated)	Average no. of P atoms per chain (experimental)	Weight phosphorus mg per g (experimental)
Laboratory prepared	1.05	40.0	31.9	303
Laboratory prepared	1.18	11.0	10.8	289
Laboratory prepared	1.25	8.0	7.8	286
Laboratory prepared	1.30	6.7	6.7	286
Commercial [a]	......	......	4.8	263
Commercial [b]	2.0	2.0	......	139
Commercial [c]	......	......	7.0	286
Commercial [d]	1.0	......	......	258
Commercial [e]	......	3.0	......	156
Commercial [f]	1.67	3.0	......	252

[a] Sodium polyphosphate glass.
[b] Sodium pyrophosphate + 10 H_2O.
[c] Sodium hexametaphosphate glass.
[d] Sodium tetrametaphosphate + 4 H_2O.
[e] Adenosine triphosphate.
[f] Granular sodium tripolyphosphate.

obtained from a number of manufacturers. The commercial compounds and crystalline sorbitol, dextrose, lactose, sucrose, and $MnSO_4 \cdot H_2O$ were of the highest quality. Dextran was obtained through the courtesy of Dr. Allene Jeanes of the Northern Utilization Research and Development Division, U. S. Department of Agriculture, Peoria, Illinois. Purified lecithin and cephalin were prepared from vegetable lecithin according to the instructions of Thornton et al. (17) and Folch (4), respectively. The alcohol-insoluble phosphatides were purchased from Central Soya Company[1] and were specified to contain 4.0% chemical lecithin, 28.5% chemical cephalin, 55.0% inositol phosphatides, 4.0% soybean oil, and 8.5% miscellaneous.

Table 1 lists the commercially available polyphosphates which were tested and some of their properties. In addition, a number of chain polyphosphates were prepared in the laboratory from mixtures of monobasic and dibasic phosphates according to a method outline by Van Wazer and Holst (23). The average number, $\bar{n}$, of phosphorous atoms per chain and the weight of phosphorus per gram were determined by titration (19). This information is also contained in Table 1.

RESULTS AND DISCUSSION

Salient features of the data on the effect of polyphosphates, manganous sulfate, polyhydric compounds, and phosphatides, are contained in Tables 1-6, 7, 8, and 9-11, respectively.

Theoretical considerations. As a first step in this study, a working hypothesis was formulated which will be discussed briefly. The existence in equilibrium of two micellar species is postulated, reactive (denatured) and unreactive. The tendency of casein monomers to pass in and out of the micelle to a degree depending on the amount of cross-linking or stabilizing agents (among which are calcium ions) present in the micelle gives rise to a reactive form consisting of a core with protruding monomer filaments. As the temperature is raised, calcium ions tend to enter the micelle and stabilize it further by drawing together the monomer filaments, thus giving rise to an unreactive smooth and compact form characterized by the absence of protruding filaments. Denaturation reactions with negative temperature coefficients have been observed (7). This form as the temperature is lowered tends to revert to the reactive one at a rate and to a degree depending on the equilibrium temperature. However, prolonged heating stabilizes the unreactive form against reversion. Unreactive micelles behaving as emulsoid particles, although quite stable at storage temperature, interact at elevated temperatures through the agency of polar groups on their surfaces mediated by calcium ions. Activated micelles, on the other hand, behave as if they were the centers of long-range attractive forces, and it is interaction mediated by calcium ions between the monomer filaments belonging to these micelles which leads to structure formation. Ad-

TABLE 2

Storage life of skimmilk concentrates (28%) solids with and without added sodium polyphosphate glass (4.8 phosphorous atoms on an average per chain)

Additive concentration	Viscosity before sterilization	Storage time in days										Min. viscosity	Storage life[b]
		0	8	16	21	28	35	49	69	91	130		
g per 100 g milk solids	(centipoises)	Viscosity at 30 C centipoises										centipoises	days
None	7.0	12.0	8.4	19.2	gel							8.4	16
0.14	7.5	13.4	8.2	9.1	20.0	gel						8.2	20
0.29	8.0	11.4	7.0	6.8	7.2	10.2	33.8	gel				6.7	32
0.56	8.5	11.4	6.7	6.5	6.3	6.4	6.3	6.4	7.7	16.9	gel	6.3	89
0.56[a]	12.1	22.9	8.9	8.5	8.5	8.5	8.5	8.5	9.2	11.6	19.3	8.5	128

Sterilization temperature—137.4 C.
Sterilization time—5 sec.
[a] Polyphosphate added after sterilization.
[b] Time in days required for viscosity to attain a value equal to twice the minimum value.

TABLE 3

Results of laboratory-scale experiments showing how the storage life of high-temperature–short-time sterilized whole milk concentrate (26% solids) is extended with added amorphous sodium polyphosphate (4.8 P atoms per chain) and shortened with added monophosphate salts

Additive	Viscosity at 86 F before sterilization	Viscosity after sterilization	Minimum viscosity	Storage life at 86 F
	(centipoises)			(days)
None	4.4	4.5	4.1	107
Monophosphate buffer salts	4.4	4.5	3.9	55
Amorphous sodium polyphosphate (4.8 phosphorous atoms per chain)	4.4	4.3	3.3	274

Ratio between solids and fat	3.25:1
Homogenization (before forewarming) at	2,500 psi and 160 F
Forewarming for 15 sec at	280 F
Concentration to solids concn. of	26%
Sterilization for 15 sec at	280 F
Buffer salt (g per 100 g 12.6% fluid milk)	0.053
Polyphosphate (g per 100 g 12.6% fluid milk)	0.049
Storage life = time required for viscosity to reach a value equal to twice minimum	
Viscosity in centipoises of polyphosphate containing concentrate after 274 days	3.3

TABLE 4

Storage life of whole milk concentrates (36% solids) with and without added sodium polyphosphate glass (4.8 phosphorous atom on average per chain)

Additive concentration	Viscosity before sterilization	Viscosity after sterilization	Minimum viscosity	Time to reach minimum viscosity	Storage life [a] at 30 C
(g per 100 g milk solids–nonfat)	(centipoises)			(days)	(days)
None	14.5	35.3	31.0	4	9
0.59	19.3	29.5	21.8	4	91
0.66	19.5	27.5	19.8	4	120
0.74	19.8	26.5	18.6	6	150

Sterilization temperature—137.4 C.
Sterilization time—5 sec.
[a] Time required for viscosity to reach a value equal to twice the minimum value.

ditives capable of diffusing into the micelle and capable of forming cross-linkages between protein monomers would have the same effect as heat, tending to bring about a retraction of monomer strands, thus compacting the micelle and shifting the equilibrium in favor of the unreactive form.

Stabilization by polyphosphates. The polyphosphates with respect to their value as additives for stabilizing high-short concentrated milk products possess the following important properties:

1. A high proton donor capacity per molecule of the corresponding acids.
2. A marked stability against hydrolysis and reversion to the monomeric phosphates.
3. A metal complexing capacity (20).
4. Physiological and pharmacological properties consistent with their use in foods.

Well known among protein chemists is the high proton donor capacity of the condensed phosphoric acids which permits them to function as protein precipitants—an interaction involving the positively charged groups on the protein and negatively charged polyphosphate anions (8).

Interactions of this character at the normal pH of concentrated milk result in a building

TABLE 5

Influence of some commercially available polyphosphates on storage life of a HTST sterilized milk concentrate (28.2% milk solids).[a] Sterilization temperature and time, 137.4 C and 5 sec

Additive	Additive concentration[b]	Viscosity before sterilization	Viscosity after sterilization	Minimum viscosity	Time to reach min. viscosity	Storage life at 30 C
	(g per 100 g milk solids)	*(centipoises)*			*(days)*	*(days)*
None	......	9.0	12.8	11.0	4-6	11
Pyrophosphate	0.61	13.2	12.6	8.9	4-6	33
Tripolyphosphate	0.56	11.8	12.9	8.3	4-6	59
Adenosine triphosphate	0.93	9.9	14.5	11.1	4-6	80
Polyphosphate $\bar{n} = 4.8$	0.54	10.8	12.6	8.1	4-6	90
Hexametaphosphate	0.50	10.2	12.8	7.5	4-6	148
Tetrametaphosphate	0.55	9.0	11.6	7.9	5-8	159

[a] Skimmilk used in this experiment had been stored at 4 degrees for 1 wk. It was derived from a fresh milk as that used to obtain data shown in Table 6.

[b] Concentration refers to weight of additives in anhydrous state. Additives contain same number of available orthophosphate groups.

TABLE 6

Influence of polyphosphate glasses, and orthophosphates on storage life of a HTST sterilized skimmilk concentrate containing 28.2% milk solids. Sterilization temperature and time, 137.4 C, and 5 sec, respectively

Additive	Additive concentration	Viscosity before sterilization	Viscosity after sterilization	Minimum viscosity	Time to reach min. viscosity	Storage life
Av. no. of P atoms per chain ($\bar{n}$)	*(g per 100 g milk solids)*	*(centipoises)*			*(days at 30 C)*	*(days at 30 C)*
None[a]	......	9.0	11.1	9.4	4-6	16
A($\bar{n} = 1$)[b]	0.13	9.8	14.6	10.2	4-6	9
B($\bar{n} = 6.7$)	0.29	9.7	9.2	6.2	4-6	85
B($\bar{n} = 6.7$)	0.48	10.2	9.9	6.7	4-6	135
B($\bar{n} = 6.7$)	0.63	11.7	10.4	6.7	4-6	148
C($\bar{n} = 7.8$)	0.29	9.7	10.8	6.8	4-6	85
C($\bar{n} = 7.8$)	0.48	10.4	10.7	7.1	4-6	151
C($\bar{n} = 7.8$)	0.63	11.7	10.4	6.6	4-6	170
D($\bar{n} = 10.8$)	0.29	9.5	10.9	7.4	4-6	103
D($\bar{n} = 10.8$)	0.47	10.3	11.3	7.1	4-6	167
D($\bar{n} = 10.8$)	0.65	11.5	11.5	7.2	4-6	180
E($\bar{n} = 31.9$)	0.28	9.5	10.6	7.3	4-6	109
E($\bar{n} = 31.9$)	0.45	10.4	12.0	7.5	4-6	169
E($\bar{n} = 31.9$)	0.62	12.2	13.1	7.8	4-6	180

[a] Control sample for B, D, C, and E, but not for A; Control sample for A contained 29.4% solids and had a storage life of 13 days.

[b] Additive consists of a mixture of orthophosphates, pH 6.5.

up of the net negative charge on the micelles, an effect which conduces to an expansion of the micelles and to swelling. Expansion is engendered by electrostatic repulsion, and swelling by osmosis in view of the Donnan effect. The increase in hydrodynamic volume is con-

TABLE 7

Life of skimmilk concentrates (28.3% milk solids) with and without added manganous sulfate

Concentration of $MnSO_4 \cdot H_2O$	Viscosity before sterilization	Viscosity after sterilization	Minimum viscosity	Time to reach minimum viscosity	Storage life at 30 C [a]	Remarks
(g per 100 g milk solids)	*(centipoises)*			*(days)*	*(days)*	
0	9.0	14.3	10.1	4	14	
0.135	8.4	13.8	9.9	8	26	
0.27	8.0	15.6	10.6	11	56	Concentrate exhibits plastic flow and thixotropy at end of storage life
0.54	7.6	49.0	15.3	13	120	Concentrate exhibits plastic flow and thixotropy at end of storage life

All viscosity measurements at 30 C.
Sterilization temperature 280 F; time 5 sec.
[a] Time in days required for viscosity to attain a value equal to twice the minimum value.

TABLE 8

Influence of various sugars and sorbitol on storage life of HTST sterilized skimmilk concentrates (19.2% milk solids). Sterilization temperature 137.4 C, sterilization time 15 sec

Additive	Additive concentration	Viscosity before sterilization	Viscosity after sterilization	Minimum viscosity during storage	Storage life at 30 C
	(g per 100 g prod.)	*(centipoises)*			*(days)*
None (control)	......	2.8	3.0	2.6	111 [a]
Lactose	9.6	3.1	3.4	3.4	180 [b, c]
	17.5	4.2	4.4	4.4	192 [b, d]
	24.2	5.3	5.7	5.7	110 [b]
Dextrose	9.6	3.4	3.4	3.4	175 [b]
	24.2	5.2	5.3	5.3	249 [b]
None (control)	......	2.8	3.1	2.5	98 [e]
Sucrose	9.6	3.5	3.8	3.4	190 [b]
	17.5	4.5	4.5	4.5	315 [b]
	24.2	5.7	5.7	5.7	144 [b]
Sorbitol	9.6	3.2	3.1	3.1	172 [b]
	17.5	4.0	3.8	3.8	360 [b]
	24.2	5.1	4.8	4.8	607 [b]

[a] Coagula visible after 124 days; marked coagulation after 134 days.
[b] Thickening but no coagulation observable during storage period.
[c] Viscosity after 210 days—12 centipoises.
[d] Viscosity after 350 days—15 centipoises.
[e] Coagula visible after 109 days; marked coagulation after 115 days.

sistent with an increase in viscosity. The effect of charge in concentrated milks is particularly striking when concentrations of polyphosphate greater than 1 g per 100 g milk solids in 3 to 1 milks are employed, and in such concentrates, a marked thickening effect is observed. At lower concentrations, such as those reported in this paper, the thickening effect which is small in the unsterilized product is more than compensated for by effects which take place in

TABLE 9

Effect of various phosphatide preparations on storage life of concentrated homogenized[b] milk (26% solids) sterilized at 137.4 C for 15 sec

Sample	Apparent viscosity			Storage period required for:		
	Before sterilization	After sterilization	Minimum during storage	Onset of viscosity increase	Viscosity to reach twice minimum	Cream layer after 70 days[b]
	(centipoises)			(days)	(days)	
Concentrated milk	4.9	16.4	7.2	38	65	6
Concentrated milk plus 0.33% chemical lecithin[c]	4.9	13.1	6.6	41	88	0
Concentrated milk plus plus 0.33% chemical cephalin[d]	4.9	14.4	6.1	41	88	0
Concentrated milk plus 0.33% crude animal lecithin	4.9	16.1	6.2	41	85	0

[a] Samples stored in capillary tubes and held quiescent in vertical position at 30 C.

[b] Milk homogenized in two stages and recycled to yield a product with homogenization index of 87%.

[c] Phosphatidyl choline.

[d] Phosphatidyl ethanolamine.

TABLE 10

Improvements of storage life effected by addition of cephalin to modified milk[a] concentrates (26% solids) sterilized at 137.4 C for 15 sec

Sample	Apparent viscosity			Storage period required for:		Remarks
	Before sterilization	After sterilization	Minimum during storage	Onset of viscosity increase	Viscosity to reach twice minimum	
	(centipoises)			(days)	(days)	
Unforewarmed concentrate, no cephalin	3.5	Forms gel	Forms gel	0.0		Coagula visible after sterilization
Unforewarmed concentrate, with added cephalin	4.6	11.9	11.9	99	126	Highly thixotropic structure after sterilization
Forewarmed concentrate, no cephalin	3.0	4.3	4.3	49	77	
Forewarmed concentrate, with added cephalin	3.7	5.4	5.0	400	400	Extremely fragile structure forms in some samples

Additive-containing milks contain 0.3 g cephalin per 100 g unconcentrated milk.

Viscosity measured after sample had been inverted twice.

[a] Modified milks (ratio between fat and protein—4.5 to 2.4) prepared by blending cream and skimmilk with a synthetic serum, pH 6.5, ionic strength 0.075 containing per liter: 50 g lactose, 3.43 g $Na_2HPO_4 2H_2O$, 0.75 g citric acid, 2.80 g KCl and NaOH to bring pH to 6.5. Milks homogenized at 65 C in two stages—7,500 and 500 psi.

TABLE 11

Influence of alcohol-insoluble phosphatides on storage life of modified milk [c] concentrates sterilized at 137.4 C for 15 sec

Sample	Phosphatide concentration	Viscosity before sterilization	Viscosity after sterilization	Minimum viscosity	Storage [a] life	Remarks
	g per 100 g concentrate	(centipoises)			(days)	
Modified skimmilk concentrates	0	2.1	2.1	1.9	162	Marked body deterioration after 179 days; marked coagulation
Modified whole milk concentrate	0	3.0	5.7	5.3	88	Stirred-out viscosity[b] at end of 137 days —45 centipoises
Modified whole milk concentrate	0.2	3.3	4.0	3.8	122	
Modified whole milk concentrate	0.4	3.5	3.9	3.8	157	
Modified whole milk concentrate	0.6	3.6	4.0 3.9	3.9	175	Soft, homogenous, highly thixotropic body prevails after end of storage life. Stirred-out viscosity after 218 days —13.3 centipoises

[a] Time in days for viscosity to reach a value equal to twice minimum vaule observed during storage.

[b] Stirred out by alternately freezing sample in dry ice–acetone bath and thawing.

[c] Modified skim prepared by blending 28 lb milk with 10.6 lb of a synthetic serum, pH 6.5 ionic strength, 0.075 containing per liter: 50 g lactose, 0.46 g citric acid, 2.80 g KCl, 1.46 g NaCl, and 0.32 g NaOH. Modified whole milks prepared by mixing 9.5 lb, modified skim with 0.5 lb butter oil containing graded concentrations of phosphatides. Dispersions of phosphatides in water unstable. Hence, they were dissolved in butter oil which had been separated from butter at 50 C and clarified at 120 C. Milks homogenized at 65 C in two stages—7,500 and 500 psi.

milk concentrates during sterilization and storage.

In milks containing cyclic phosphates, reversion to a thinner body takes place largely during storage. The stabilizing effect observed during sterilization of concentrates containing linear condensed phosphates may be attributed to the complexing of calcium, and thus the chain polyphosphates, like the orthophosphates, function as stabilizers against heat coagulation. The augmented attenuation of body during storage may be postulated to result from a shift in equilibrium favoring intramicellar stabilization as opposed to intermicellar interaction. The thinning out of body is particularly pronounced in the concentrate containing the cyclic phosphate. Inasmuch as the cyclic phosphates do not form strong complexes with calcium, the entire decrease in viscosity to a value considerably lower than that of the control milk before its sterilization can reasonably be attributed to a type of intramicellar interaction involving volume contraction.

The thickening in concentrates containing high concentrations of polyphosphate is reversible in character, for on diluting the concentrates to the concentration of normal milk, the viscosity and smooth texture of the original milk is restored (data are not recorded in this paper). Thickening brought about by the addition of large quantities of polyphosphates increases during storage of the concentrate, although structure formation is delayed.

Antigelation effectiveness per phosphorous atom increases with increasing chain length of the linear polyphosphates, an effect which is more pronounced among the polymers of short-chain length. This effect may be associated with the greater effectiveness of the long-chain polyphosphates compared to the shorter-chain compounds as protein precipitants and, hence, to their greater affinity for proteins (8).

Adenosine triphosphate is more effective than the corresponding sodium tripolyphosphate. It appears, therefore, that the adenosine moiety augments the affinity for proteins of the polyphosphate grouping. In support of this observation are the observations of Leviton and Pallansch on the binding of riboflavin and riboflavin phosphate (11).

Influence of polyphosphate concentration. Storage life of HTST sterilized milk concentrates is significantly increased in the presence of added polyphosphate. The increase varies with additive concentration, and the rate of increase is more pronounced at the lower concentrations. Employed at a concentration level of approximately 0.05% based on the original milk, the effect of the polyphosphates with more than four phosphorus atoms per chain, is to prolong the storage life at 30 C of 3 to 1 milk concentrates from 2 or 3 wk to many months and, correspondingly, the storage life of two to one concentrates from three or four months to more than nine months. Limiting the effectiveness of the polyphosphates is their slow conversion to the orthophosphates. Inasmuch as the orthophosphates tend to accelerate the gelation rate (see Table 6), this net result of the hydrolysis of polyphosphates would be magnified to the extent that the orthophosphates are formed. The greater the chain length of the polyphosphates, the slower would be the hydrolysis to and subsequent accumulation of orthophosphates in milk concentrates, and the less noticeable would be the contribution of increasing orthophosphate concentration to a reduction in storage life. The cyclic phosphates, because they resist hydrolysis to the chain polyphosphates to an appreciable degree have, when employed as additives, the advantage of a greater over-all stability (compared to the corresponding linear compounds) against conversion to orthophosphates (1).

Possibly another limiting factor with respect to the effectiveness of the linear polyphosphates is their complexing affinity for calcium and similar metal ions. Inasmuch as calcium ion itself possesses antigelation activity, the net effect of complex formation would be the reduction in effective concentrations of both calcium and polyphosphate (12). The cyclic phosphate, unable to complex with Ca^{++} to the same degree as the linear polyphosphates, at least not until it has been hydrolyzed to the corresponding linear polyphosphate, would not be subject to the aforementioned limitation.

There is a strong temptation to associate the behavior of the polyphosphates with their calcium-complexing capacity leading to the sequestration of calcium ions. In conflict with this idea, however, are these observations: added calcium augments storage life, whereas added orthophosphates diminish it; the cyclic phosphate with its relatively weak complex-forming capacity is quite effective in retarding gelation. It appears, therefore, that the ability to complex with metals is a property of the polyphosphates which, if related to its antigelation function at all, comes into play as result of intramicellar interaction involving the formation of a calcium caseinate–condensed phosphate complex.

Suitability of polyphosphates as food additives. The addition to evaporated milk of stabilizing salts to the extent of 0.1% by weight of the finished product has been legalized in the United States. The use of polyphosphates as food additives is not novel. Their use to the extent of 3-3.5% in processed cheese appears to be sanctioned in all processed cheese producing countries. Kiermeier and Möhler not only have tabulated the quantities of added condensed phosphates in various food products (9), but have also examined the question of the suitability of these substances as food additives, referring to the work of Schreier and Nöller (15).

Stabilization by manganous salts. Calcium salts stabilize slightly and orthophosphates destabilize high-short sterilized milk concentrates against gelation during storage. These salts function in the opposite sense during the sterilization of milk, the calcium salts acting to destabilize and the orthophosphates to stabilize against heat coagulation.

The effect of divalent manganese compared with the action of divalent calcium ions is quite large. The 8-9 fold extension of storage life brought about by its addition (0.54 g per 100 g milk solids) to 3 to 1 sterile skimmilk concentrate is of the same order of magnitude as that observed when the higher polyphosphates at the same concentration level are added to milk. The prolongation is roughly proportional to the concentration of added Mn^{++}.

Mn^{++}, when added to the concentrate before sterilization, brings about a significant decrease in viscosity in proportion to the quantity added. In this respect, it functions in a sense opposite to that observed when polyphosphates are added to milk. Manganese is known to form complexes with casein, and to the extent that it does, it would lower the negative charge on the micelles in milk; a certain amount of contraction would be expected as well as a reduction in the electroviscous effect, and a loss of water in consequence of the Donnan effect. It is doubtful, however, that the contraction in micellar volume arising from these effects would account entirely for the decrease in viscosity, inasmuch as the charge on the protein is in virtue of bound calcium already reduced to the point where the Donnan effect is small. It is not unreasonable, therefore, to account for the observed decrease in viscosity by assuming that the concomitant contraction in hydrodynamic volume is a consequence of cross-linking.

Sterilization is attended by an increase in viscosity, an increase which remains nearly independent of Mn^{++} at low levels of concentration, and which rises abruptly when the concentration of added $MnSO_4 \cdot H_2O$ reaches 0.54 g per 100 g milk solids.

Much of the observed increase in viscosity disappears during storage at a rate which decreases as the concentration of $MnSO_4$ is increased. If the increase in viscosity attending sterilization can be ascribed to the reversible formation of aggregates of modified micelles mediated by manganous ions, the subsequent thinning out of body may be ascribed to a reversal of this process, and age-thickening to the slow internal change in the structure of the micelles followed by aggregation of the changed micelles.

Judged solely from the extent of their action in prolonging storage life with respect to gelation, manganous salts are as efficient as the polyphosphates. The amount of manganese added to a pint of milk in the preparation of HTST sterilized milk concentrates would be far in excess of the amount of manganese found in human rations (16).

Possessing a number of valence levels manganese salts catalyze the formation of hydroperoxides in the oxidation of fatty acid esters in anhydrous nonpolar solvents (18). Inasmuch as this reaction is inhibited in the presence of polar solvents, an effect attributed to the formation of solvates, it may very well be that in aqueous solution steric hindrance would prevent Mn^{++} from functioning as a catalyst.

It has been found that manganese in butter exists in true solution in the serum phase, whereas copper and iron are bound to the colloidal constituents (proteins and phosphatides) of the serum (3). Thus, it is reasonable to assume that the effect of manganese in the oxidation of milk fat would not parallel that of copper and iron.

Garrett (5) added 0-0.12 mM $MnCl_2$ to a liter of milk and 0.06 mM Cu^{++}, and found that the intensity of the oxidized flavor which developed in 96 hr was reduced from a maximum of five arbitrary flavor units (in the absence of added Mn^{++}) to zero. Added $MnCl_2$, unlike added copper salts, did not influence the development of oxidized flavor adversely, nor did it catalyze the oxidation of ascorbic acid.

It appears, in view of the aforementioned evidence, that the evaluation of manganous salts with respect to whatever flavor changes they may engender in milk concentrates must await further investigation. Concerning the utility of such salts in retarding gelation, there can be no question.

Stabilization by polyhydric compounds. To produce any measurable effect in milk concentrates, polyhydric compounds compared with manganous salts and polyphosphates must be used in high concentrations. Added to 2 to 1 sterile milk concentrates to the extent of 9.6 g per 100 g product the polyhydric compounds lactose, sucrose, dextrose, and sorbitol extended storage life 1.7 to 2 fold. The increase in viscosity (approximately 10%) brought about by the addition of these polyhydric compounds to the unsterile concentrates, reflecting as it does the increase in the viscosity of the continuous phase, is in no way commensurate with the increase in storage life. It appears, therefore, that the added storage life is not a consequence of a diminished micellar diffusion rate (the rate would be inversely proportional to the viscosity) but is rather a consequence of certain properties possessed in common by the polyhydric compounds.

Present in milk in higher concentrations, these compounds begin to exhibit differences in behavior which reflect differences in molecular groupings and structure. Thus, the disaccharides lose much of their effectiveness as the concentration in 2 to 1 milk is increased beyond 17.5 g per 100 g product. Sorbitol becomes increasingly effective as its concentration is increased. An interesting feature associated with the use of polyhydric compounds is that in their presence, sedimentation is visibly retarded, and flocculation such as one may observe in control milks in the late stages of age-thickening is largely absent.

It would be difficult to interpret the action of polyhydric compounds without assuming that interaction between these compounds and micellar proteins is involved. Such interaction is indicated in the results with dextran (data not included in this paper). Sterilization of dextran containing concentrates results in an appreciable increase in viscosity not shared by the control concentrates.

Stabilization by phosphatides. The participation of the lipid phase in coagulation phenomena has been the subject of a previous report in this series of publications (13). The quasi-inert behavior of this phase with respect to gelation was considered to indicate the existence of two diametrically opposed tendencies, one prompting the fat globules to behave as oriented protein particles, and the other, as oriented phospholipid particles. Behaving as protein, the lipid phase would tend to promote coagulation (a concentration effect) and, behaving as phosphatide particles, the fat globules would tend to hinder the development of graininess and structure formation by interfering with the free diffusion of interacting protein particles. Many milks behave as if they were out of balance with respect to the composition of the interfacial region. Modified milks rich in fat and relatively deficient in proteins may be prepared which show this imbalance to an exaggerated degree. Such milks respond to corrective measures and improved heat and storage stability is realized, as the results in Tables 9-11 show, if phospholipids are added to compensate for compositional deficiencies in the interfacial region.

The experiments in which the protein content of the milk was reduced by means of a synthetic serum and the fat content was correspondingly increased, illustrates strikingly how the fat rather than the protein phase may limit both the heat and storage stability of concentrated milks.

The possibility of producing highly stable milk concentrates with a high ratio between fat and protein is indicated. Such concentrates would have the same total solids as conventional HTST sterile concentrates, and would be richer in milk flavor. Much more work remains to be carried out in this connection, however, for although structure formation requires a definite minimum concentration of interacting elements, it is unlikely that aggregate formation is likewise limited.

The two purified phosphatides, lecithin and cephalin, appear to be equally effective, although marked deterioration in body was less noticeable in the cephalin-containing product. Equilibrium conditions in the interfacial region are probably reached slowly, if at all, and consequently variables such as rate and duration of heating and cooling, and the manner in which additives are incorporated (whether in the aqueous or in the fat phase, for example) influence results. It would be logical to incorporate additives in the lipid phase, for in this way labile substances are protected against hydrolysis and precipitation and diffusion into the interphase is expedited.

Forewarming, it appears, can play a part in the manufacture of HTST concentrated milk products no less important than the part it plays in the manufacture of conventional evaporated milk (see Table 11). Thus, forewarming serves to stabilize HTST milk concentrates against heat coagulation, a point of importance (notwithstanding the general impression that heat stability is not an important factor in HTST sterilization), and it serves to prolong storage life by retarding the developments of structure.

Footnote. Following the completion of the studies reported in this paper, the very recent and pertinent paper by Hoff et al. on irradiation induced gelation became available (6). Milk concentrates sterilized by ionizing radiation, it appears, become quite unstable toward heat and coagulate instantly at 90 C. These concentrates are also quite labile during storage and acquire within days a gel-like structure. Inasmuch as HTST sterile milk concentrates, unlike irradiated concentrates, are not instantaneously coagulated at 90 C, it would appear that irradiation-induced gelation is unrelated to gelation in HTST sterilized milk. However, in view of the observations of Hoff et al. that manganese salts and polyphosphates are effective inhibitors of irradiation-induced gelation, and in view of the observations recorded in this paper on the effects of these compounds in HTST sterilized milk concentrates, it appears likely that the gelation mechanisms are related.

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CARBOHYDRATE METABOLISM OF LACTIC ACID CULTURES.[1, 2] I. EFFECTS OF ANTIBIOTICS ON THE GLUCOSE, GALACTOSE, AND LACTOSE METABOLISM OF *STREPTOCOCCUS LACTIS*

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SUMMARY

Streptococcus lactis UN metabolized glucose, galactose, and lactose and produced varying amounts of lactic, formic and acetic acids, carbon dioxide, ethanol, and glycerol. Lactic acid constituted the major product, accounting for 26 to 93% of the metabolized sugar. Possible mechanisms of production of the various metabolites are discussed. Under the conditions of the study, *S. lactis*, normally a homofermenter, functioned as a heterofermenter. The results indicate that the organism metabolized the sugars partly through classical glycolysis and partly through the hexosemonophosphate shunt pathway.

Penicillin and streptomycin inhibited almost completely the growth of the organism, the utilization of carbohydrates, and the production of various metabolites for the first 18 to 24 hr. However, upon extended incubation up to 48 hr, the organism grew, metabolized sugars, and produced acid and the various metabolites. In general, in the presence of the residual antibiotics, the emerging cells produced lactic acid and carbon dioxide at a reduced rate. Penicillin was more inhibitory toward the fermentation of the monosaccharides than toward that of the disaccharide, and the reverse was true for streptomycin. Aureomycin and terramycin inhibited completely the growth, the sugar metabolism, and the acid production up to 48 hr of incubation.

Fermentation patterns of *Streptococcus lactis* have been found to vary from strain to strain under similar conditions of growth and also in the same strain under different conditions of growth. Platt and Foster (15) and Angelotti (2) observed that *S. lactis*, when grown on different carbohydrate substrates, produced formic, acetic, and butyric acids, acetoin, diacetyl, n-butanol, ethyl alcohol, glycerol, and carbon dioxide in addition to lactic acid, indicating that *S. lactis*, normally a homofermenter, metabolized sugars heterofermentatively. Wiken (21) and Wood (22) have reported that there exists a thin or diffused line of demarcation between homofermentative and heterofermentative lactic organisms.

Effects of antibiotics in milk and on starter cultures have been reviewed by Albright, Tuckey, and Woods (1). However, most of the reviewed articles were concerned only with the study of the inhibition of the acid production by antibiotics in milk, and very little has been reported on the mode of action of antibiotics on the carbohydrate metabolism of *S. lactis* or on different metabolites produced by *S. lactis*. Angelotti (2) observed that, concomitant with the development of resistance to terramycin, *S. lactis* partially lost its ability to metabolize sugars and produce acid. Shahani (17) reported that terramycin inhibited very markedly the aerobic utilization, but very mildly the anaerobic utilization, of carbohydrate by *S. lactis*. Also, the antibiotic inhibited very severely the activity of young cells, but had little or no effect upon the activity of the resting cells, indicating that terramycin might be more inhibitory toward protein metabolism than carbohydrate metabolism.

Albright et al. (1) and Gale (5), in their review articles, reported that penicillin and polymyxin inhibited the cell wall or membrane formation of several microorganisms and that aureomycin, terramycin, streptomycin, and chloromycetin inhibited the nucleic acid or protein synthesis. However, all the studies reviewed were of microorganisms other than lactic organisms.

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The purpose of this investigation was to study the differences in the carbohydrate-metabolic patterns of *S. lactis* when grown on lactose and on its constituent monosaccharides, glucose and galactose, and to study the effect of several antibiotics upon these metabolic patterns.

METHODS

Culture and media for fermentation studies. Streptococcus lactis strain UN, obtained from the Department of Bacteriology, University of Nebraska, was used throughout this study. In the initial stages, three media—milk medium, micro inoculum broth (Difco), and the APT medium of Evans and Niven (4), as modified by Platt and Foster (15), were compared for use in the growth studies. The APT medium was finally selected for use because of the consistency of the results obtained. The medium contained 1% (w/v) glucose, galactose, or lactose as the only carbohydrate source.

The culture of *S. lactis* was maintained on sterile milk medium and transferred every 15 days. Prior to its use in growth studies, the culture was transferred three times in the APT broth (pH 6.8) containing 1% of the carbohydrate under study and incubated at 30 C. Fermentation studies were carried out in 250-ml Erlenmeyer flasks containing 95 ml of the sterile medium inoculated with 5 ml of an 18-hr broth culture of *S. lactis* (18-20% transmission at 640 mμ) and incubated at 30 C, in the stationary condition. In the trials designed to study the effect of antibiotics on the metabolism of various sugars, 0.05 to 0.1 ml of an aqueous solution of penicillin, streptomycin, aureomycin, or terramycin was added to the flasks before incubation to yield ten units or 10 μg of an antibiotic per milliliter. To the control flasks was added an equal amount of sterile water. At intervals of 6, 12, 18, 24, 36, and 48 hr of incubation the flasks were removed for various analyses.

Analytical methods. The rate of growth in the fermented broth was determined turbidimetrically at 640 mμ. The bacterial cells were removed from the fermented broth by centrifugation, and the supernatant was analyzed for total titratable acidity, residual sugar, and different metabolic products.

The total titratable acidity was determined in an aliquot by titrating it against a 0.1 N alkali. Lactose was estimated by Folin and Wu's method as described by Hawk et al. (9), glucose and galactose by Nelson's modification of Somogyi's method (14), and lactic acid by the method of Barker and Summerson (3). For determining volatile acids, the paper chromatographic method of Kennedy and Barker (11), applied to the distillate of the fermentation broth, revealed that it contained only acetic and formic acids. Total acids were determined in the distillate by titration; formic acid was determined by the colorimetric method of Grant (6) and by difference acetic acid was estimated (15). Glycerol was determined by the method of Lambert and Neish (12). Carbon dioxide and neutral volatile compounds were determined by the method of Neish (13). The determination of neutral volatile compounds like n-butanol, diacetyl, acetoin, n-propanol, and ethanol involved distillation of the fermented broth, celite-water column chromatography of the distillate, and dichromate oxidation of different compounds present in different fractions of the eluate obtained from the celite column. The method revealed that only ethanol was present.

RESULTS

Rate of growth, sugar utilization, and acid production. The average results of four to six series of trials with each carbohydrate and each antibiotic are presented in Figure 1. In the absence of any antibiotic, the organism was found to grow luxuriantly in all the three sugars. Although, in the initial stages of incubation, there were some differences in the growth rate of the organism in the three media, at the end of 48 hr the growth in all three media was almost the same (Figure 1a).

In the earlier stages of incubation, the organism metabolized glucose and lactose more rapidly than galactose. However, at the end of 48 hr of incubation, the organism utilized an average of 91, 88, and 83% of glucose, lactose, and galactose, respectively.

The maximum total titratable acidity obtained in fermentations of the three carbohydrates was almost the same, differing only in the time required to reach the maximum level (Figure 1c). In all three sugars the maximum acidity was attained in 24 to 36 hr. In galactose and lactose, the total acidity decreased slightly after 36 hr of incubation; whereas, in glucose, once the initial maximum peak had been reached no decrease in acidity was observed up to 48 hr of incubation. In general, although the organism metabolized galactose more slowly, its rate of growth and total acidity produced were comparable to those obtained in the glu cose or lactose broth.

Effect of antibiotics. In Figure 1 are also presented data of the inhibitory effects of penicillin and streptomycin upon the rate of growth,

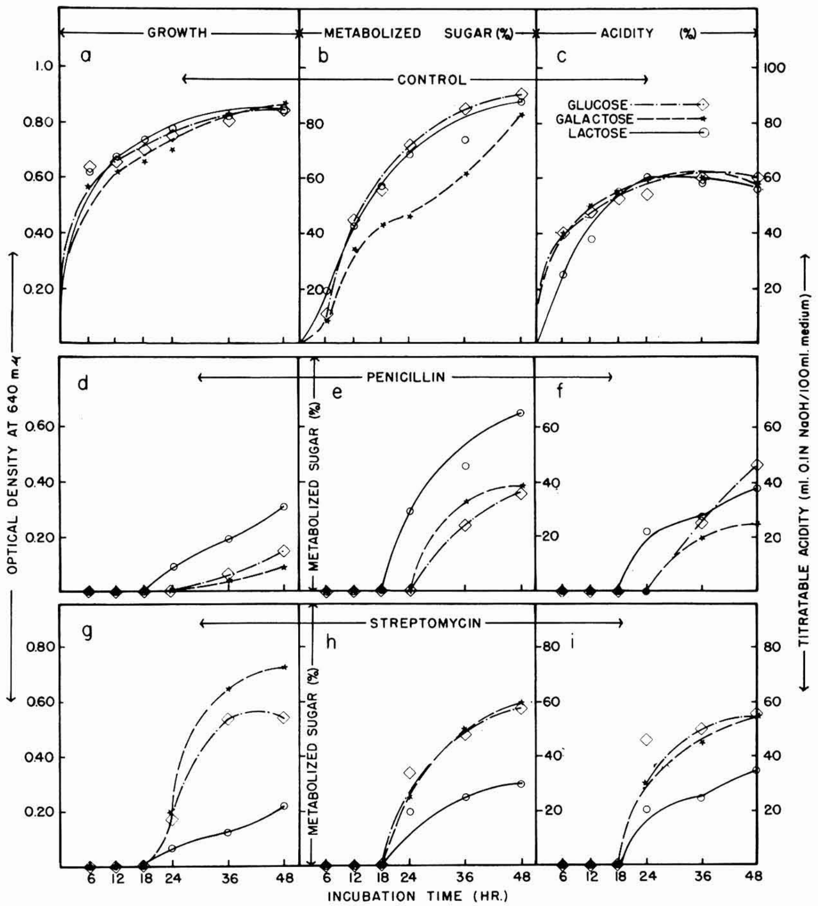

FIG. 1. Rate of growth, carbohydrate metabolism, and acidity production of *Streptococcus lactis* in the absence and in the presence of antibiotics.

sugar utilization, and acid production of *S. lactis*. The other two antibiotics, aureomycin and terramycin, inhibited completely the growth and carbohydrate metabolism of *S. lactis* during the entire 48-hr incubation period.

In glucose or galactose broth, penicillin inhibited completely the growth, sugar utilization, and acid production up to 24 hr of incubation, and in lactose, up to 18 hr of incubation, after which the organism started growing slowly, metabolizing the carbohydrates and producing acid. However, although the organism showed growth, its sensitivity towards the antibiotic was further evidenced by morphologic changes. In place of the normal regular chain of cocci, the emerging cells became elongated and swollen, with a tendency towards becoming Gram-negative.

After 18- and 24-hr incubation periods, the growth medium was assayed for the antibiotic concentration, and it was observed that the medium still contained 60 to 70% of the added antibiotic. The fact that after the initial complete inhibition of growth for 18 to 24 hr the organism could multiply in the presence of the antibiotic, and the organism had changed in morphology and in Gram-staining, indicate that the growth may have been due to the multiplication of emerging mutants.

At the end of 36 hr of incubation, the growth of the culture was found to have been retarded in the presence of penicillin by 80 to 92% in the three media. At the end of 48-hr incubation, the inhibition still persisted but to a lesser degree. In general, penicillin inhibited the glucose or galactose metabolism more severely than the lactose metabolism.

Streptomycin also inhibited completely the growth of the organism, but only up to 18 hr, following which the organism grew slowly, utilizing the three sugars and concomitantly producing acidity. However, the organism did not develop any changes in morphology or in Gram-staining, as observed in penicillin. Compared to penicillin, streptomycin was less inhibitory towards the glucose or galactose metabolism but more inhibitory towards the lactose metabolism.

Production of various metabolites. Data relative to the pH changes and the production of various metabolites by *S. lactis* are presented in Table 1. For the sake of comparison, the per cent sugar metabolized was calculated in terms of μM/100 ml broth and is also presented in Table 1.

During the carbohydrate metabolism of *S. lactis* with the increase in the acidity, the pH of the medium decreased from the initial value of 6.8 to 3.9 or 4.0, after which it remained fairly stationary.

S. lactis produced lactic acid as the major metabolic product, along with varying concentrations of formic and acetic acids, glycerol, ethanol, and carbon dioxide. In glucose or galactose fermentation, the yield of lactic acid obtained was maximum at 36 hr of incubation, after which it declined slightly. In lactose metabolism, however, continuously increasing yields of lactic acid were observed up to 48 hr of incubation.

During the glucose or lactose fermentation, the formic acid production increased up to 36 hr of incubation, then declined. Considerably more formic acid was produced during galactose or lactose fermentation than during the glucose fermentation.

The production of acetic acid or carbon dioxide was a continuous process throughout the fermentation of the carbohydrates. Considerably more acetic acid was produced during galactose fermentation than during the glucose or lactose fermentation; whereas, more carbon dioxide was produced during the lactose fermentation than during the fermentation of the monosaccharides.

Analysis for several neutral volatile products revealed that only ethanol was produced; contrary to the observations of the previous workers (2, 15), the organism did not produce any detectable concentrations of n-butanol, n-propanol, isopropanol, diacetyl, or acetoin. In glucose and lactose media, a high level of ethanol was produced within the initial 12 hr of incubation, which remained fairly stationary thereafter; whereas, in galactose medium the ethanol production continued up to 48 hr. Nearly 11 to 12 times more ethanol was produced in galactose fermentation than during the fermentation of the two other sugars.

While glycerol production progressed during the entire 48 hr of glucose fermentation, during the galactose or lactose fermentation it reached

TABLE 1

Glucose, galactose, and lactose fermentation patterns of *S. lactis*

Substrate	Incubation time *(hr)*	pH	Metabolized sugar μM/100 ml medium	Fermentation products μM/100 ml medium					
				Lactic	Formic	Acetic	Carbon dioxide	Ethanol	Glycerol
Glucose	6	4.2	555	444	29	82	231	7	277
	12	4.0	2,500	1,922	85	159	250	60	827
	18	4.1	3,089	2,471	93	179	282	56	865
	24	3.9	4,000	3,411	103	186	290	55	885
	36	3.9	4,722	5,888	123	223	296	55	935
	48	3.9	5,077	5,511	54	232	206	50	1,756
Galactose	6	4.9	450	576	167	180	229	112	88
	12	4.4	1,875	2,403	199	640	244	554	504
	18	4.2	2,403	3,555	240	721	285	560	721
	24	4.1	2,553	4,777	248	766	290	568	787
	36	4.1	3,424	6,000	262	716	292	588	585
	48	4.0	4,627	4,200	286	723	304	605	567
Lactose	6	4.3	542	553	511	169	365	52	258
	12	4.2	1,200	1,330	680	175	425	93	528
	18	4.2	1,580	2,220	869	190	431	93	553
	24	4.0	1,900	3,249	771	228	453	93	508
	36	4.0	2,069	6,207	793	220	456	66	472
	48	4.0	2,450	8,333	511	209	458	53	455

the maximum level within 18 to 24 hr, then declined.

Effects of antibiotics upon the production of various metabolites. In Tables 2 and 3 are presented the data relative to the inhibitory effects of penicillin and streptomycin, respectively. Simultaneous with the inhibition of growth and sugar metabolism, the antibiotics inhibited completely the production of the various metabolites during the initial 18 to 24 hr of incubation. Once the organism started to grow in the presence of the antibiotics and to metabolize sugar, it produced all the metabolites that were produced in the absence of the antibiotics.

As presented in Table 2, at the end of the 48-hr incubation period, penicillin had retarded significantly the production of lactic and acetic acids and carbon dioxide in all the three media. The production of the other metabolites was affected to a variable degree. The antibiotic inhibited strongly the formic acid production of the organism in the galactose broth, had no effect on the formic acid production in the lactose broth, and had a stimulatory effect on the formic acid production in the glucose broth. The antibiotic retarded the production of ethanol in the galactose and lactose fermentation, but stimulated it in the case of glucose fermentation. Similarly, while glycerol production was inhibited in the glucose broth, it was stimulated in the galactose and lactose broths.

Streptomycin also inhibited sugar metabolism and the production of various metabolites (Table 3). Compared to penicillin, streptomycin was less inhibitory toward the metabolism of the monosaccharides than toward the metabolism of the disaccharide. At the end of 48 hr of fermentation, streptomycin had inhibited significantly the lactic acid production in lactose broth (72%), but in glucose broth it showed only mild inhibition, and in galactose broth the lactic acid production was stimulated. The antibiotic inhibited the production of other metabolites either mildly or showed a stimulatory effect.

DISCUSSION

S. lactis grew at almost the same rate in glucose, galactose, or lactose broth although, on a molar basis, lactose was metabolized at about half the rate of the monosaccharides (Table 1), since the molecular weight of the disaccharide is about twice that of the monosaccharides. When grown on any of the three carbohydrate sources, the organism produced almost the same amount of total titrable acidity but different amounts of formic and acetic acids, carbon dioxide, ethanol, and glycerol. The fact that the organism produced similar compounds, although the amounts were different, in all the three media, indicates that the three carbohydrates were metabolized by the organism through similar pathways.

A transition of *S. lactis* cultures from a homofermentative to heterofermentative type as a result of a variation in carbohydrate source is characteristic. The production of metabolites other than lactic acid indicates that under the conditions of this study *S. lactis,* normally a homofermenter, functioned as a heterofermenter, as has been reported for several streptococci (2, 15). Also, in another study, Shahani and Vakil (18) observed that *S. lactis* possessed the lactose dehydrogenase system which converted lactose to lactobionate, and the latter produced gluconate and galactose. The organism was able to utilize lactobionate and gluconate and produced amounts of fermentation products comparable to those observed in the present study. These observations suggested that *S. lactis* utilized the carbohydrates partly through the Embden-Meyerhof cycle and partly through the hexose monophosphate pathway.

The rate of lactic acid production was markedly faster in the earlier than in the later stages of incubation. This could be because after about 18 hr of the incubation period essentially resting cells are metabolizing sugar in a medium with a pH of 4 or below—a condition not optimum for the lactic acid production. The lactic acid production accounted for as much as 26 to 93% of metabolized sugar. Other workers (8, 15, 20) have shown that 78 to 98% of metabolized glucose and 21 to 57% of metabolized galactose were converted into lactic acid.

In the present investigation, the other metabolites produced, in the order of the amount of sugar metabolized, were glycerol, acetate, carbon dioxide, formate, and ethanol. Five to 25% of the metabolized sugar was converted into glycerol and 0.3 to 13% into each of the other compounds.

Two possible pathways of the formate production have been suggested (20, 22)—one by phosphoroclastic cleavage of pyruvate into formate and acetate, and the other by the reversal of formic hydrogenlyase action, as shown in the following reaction:

$$HCOOH \xrightleftharpoons{\text{formic hydrogenlyase}} H_2 + CO_2$$

The organism produced both acetate and formate as well as carbon dioxide. However, no efforts were made to determine how formate was produced by *S. lactis.*

TABLE 2

Effect of penicillin on the carbohydrate fermentation patterns of *S. lactis*

Subst. + Antib.	Incubation time (*hr*)	pH	Metabolized sugar		Lactic		Formic		Acetic		Carbon dioxide		Ethanol		Glycerol	
			μM/100 ml medium	Inhib.[a] (%)	Prod.[b]	Inhib. (%)	Prod.	Inhib. (%)	Prod.	Inhib. (%)	Prod.	Inhib. (%)	Prod.	Inhib. (%)	Prod.	Inhib. (%)
Glucose + Penicillin	6	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	12	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	18	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	24	6.7	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	36	5.3	1,322	72	1,600	73	92	25	107	52	125	58	66	−20	529	43
	48	5.2	2,055	59	2,480	55	73	−34	115	50	230	25	71	−42	1,417	20
Galactose + Penicillin	6	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	12	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	18	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	24	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	36	6.4	1,844	46	1,066	82	25	90	175	76	124	57	168	71	676	−15
	48	5.8	2,163	53	1,444	66	19	93	180	75	181	40	374	38	683	−20
Lactose + Penicillin	6	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	12	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	18	6.7	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	24	6.0	744	61	1,539	53	348	55	59	67	247	45	30	67	526	− 4
	36	5.5	1,238	39	4,440	29	390	51	70	68	389	15	34	48	507	− 7
	48	5.1	1,805	26	6,660	20	500	2	34	83	437	5	38	28	472	− 4

[a] Inhib. = Per cent inhibition when compared with the control values (without antibiotic—Table 1) for the same incubation periods.

[b] Prod. = Production μM/100 ml medium.

TABLE 3

Effect of streptomycin on the carbohydrate fermentation patterns of *S. lactis*

Subst. + Antib.	Incubation time (*hr*)	pH	Metabolized sugar μM/100 ml medium	Metabolized sugar Inhib.[a] (*%*)	Lactic Prod.[b]	Lactic Inhib. (*%*)	Formic Prod.	Formic Inhib. (*%*)	Acetic Prod.	Acetic Inhib. (*%*)	Carbon dioxide Prod.	Carbon dioxide Inhib. (*%*)	Ethanol Prod.	Ethanol Inhib. (*%*)	Glycerol Prod.	Glycerol Inhib. (*%*)
Glucose + streptomycin	6	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	12	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	18	6.7	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	24	4.4	1,900	52	2,777	19	93	10	97	48	125	57	41	25	538	39
	36	4.2	2,688	43	5,222	12	142	−15	161	28	137	54	71	−29	838	12
	48	4.0	3,200	35	5,333	3	70	−30	239	− 3	250	18	56	−12	1,548	11
Galactose + streptomycin	6	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	12	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	18	6.7	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	24	5.2	1,394	45	2,222	54	204	18	380	50	106	63	286	50	681	6
	36	4.5	2,800	34	4,200	30	222	15	520	27	125	57	301	49	629	− 7
	48	4.5	3,033	18	5,588	−33	248	13	690	5	231	24	605	0	207	− 7
Lactose + streptomycin	6	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	12	6.8	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	18	6.7	0	100	0	100	0	100	0	100	0	100	0	100	0	100
	24	6.0	555	71	666	80	820	− 6	128	28	235	48	100	− 7	506	0
	36	5.5	694	67	1,440	77	848	− 6	188	15	267	41	102	−48	453	5
	48	5.2	833	66	2,361	72	652	−28	200	4	361	21	110	−107	437	4

[a] Inhib. = Per cent inhibition when compared with the control values (without antibiotic—Table 1) for the same incubation periods.
[b] Prod. = Production μM/100 ml medium.

Gunsalus and Niven (8) and White et al. (20) observed that while metabolizing glucose or galactose at pH 7.0 to 9.0, *Streptococcus liquefaciens* and *Streptococcus pyogenes* produced formate, acetate, and ethanol in the ratio of 2:1:1. However, at a lower pH they did not observe such a relationship. They suggested that since the combined values for acetate and ethanol equaled the formate, they may have originated from a three-carbon precursor, possibly pyruvate (7). However, Platt and Foster (15) observed a much lower C_1 (formate + CO_2):C_2 (acetate + ethanol) ratio, which they ascribed to a possible CO_2-fixation. In the present study, the observed C_1:C_2 ratios of 1.3:1 in the glucose metabolism and 1:2.2 in the galactose metabolism seem to proximate the findings of the previous workers. Also, as observed by Platt and Foster, CO_2 rather than formate was almost always the major oxidized product.

Preliminary studies indicated that *S. lactis* used in this work possessed an aldehyde dehydrogenase–alcohol dehydrogenase system, as was shown to be present in beef liver (16) and in *S. pyogenes* (20). Also, the finding that acetate was present in higher concentrations than ethanol corroborates the observations of White et al. (20). It appears that *S. lactis* oxidized ethanol to acetate, as was reported for *S. liquefaciens* (8).

On the basis of the present data, the exact pathways of formation of the various metabolic products cannot be established. The above discussion presents possibilities for future lines of approach which will be considered further in the subsequent reports of this series.

S. lactis UN was sensitive toward all four antibiotics. Aureomycin and terramycin inhibited the organism completely for 48 hr of incubation (maximum incubation studied). Penicillin and streptomycin inhibited its growth and its carbohydrate metabolism for 18 and 24 hr, following which the organism grew and metabolized the sugars, but at a reduced rate. Since at the end of 18 to 24 hr of incubation the medium still contained 60 to 70% of the added penicillin or streptomycin, the emerging growth may have been essentially due to the growth of mutants capable of growing in the medium containing antibiotics. At the end of the 48 hr incubation in the media containing penicillin, the production of lactate, carbon dioxide, and acetate had been retarded, and the production of the other metabolites had been affected to a variable degree. On the other hand, in the streptomycin series, the carbon dioxide production had been retarded in all three carbohydrate media, and the lactate production had been retarded in the lactose medium. In general, penicillin was more inhibitory toward the metabolism of the monosaccharides than toward that of the disaccharide. However, the reverse was true in the case of streptomycin.

Gale (5) reported that penicillin impaired the synthesis of cell wall material, which Strominger (19) has recently confirmed to be primarily due to the failure of the incorporation of UDP-N-acetyl glucosaminelactyl peptide into cell wall in the presence of penicillin. The observations that penicillin caused *S. lactis* cells to become elongated and swollen are in agreement with the report of Hunter (10) and Gale (5), who suggested that the elongated or swollen cell formations might be due to the failure of the cells to complete cell-division or due to osmotic damage to the cells effected by penicillin.

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METHOD FOR REMOVING IODINE ^{131} FROM MILK

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SUMMARY

Fresh samples of raw whole milk containing iodine^{131} (either added and stored for 24 hr at 4 C before use, in vivo labeled, or market milk samples contaminated with fresh fallout) were passed through a column (2.0×4.8 cm) containing 15 ml of Dowex 2-X8 anionic resin previously charged with an aqueous solution containing NaCl, NaH_2PO_4, and $Na_3C_6H_5O_7$ at pH 6.6. The concentration of each anion in the charging solution expressed in mM/liter was 4.03 (mM Cl/liter) + 4.64 (mM inorganic P/liter) + 20.4 (mM citrate/liter), where the expressions in parentheses represent the composition of the milk to be treated and the numerical coefficients provide for the difference in affinity of these anions for the resin.

Analysis of treated milk indicated that approximately $98 \pm 2\%$ of I^{131} was removed from 120-130 resin bed volumes of milk (and about 95% from 230 resin bed volumes). The removal of I^{131} did not vary with flow rates of 5-20 ml per min, and the anionic composition was essentially unchanged. Also, the rate of removal was not affected by temperatures, which ranged from 1-30 C, indicating that cold temperatures may be maintained during the process, thereby minimizing bacterial growth. All the I^{131} in milk was removed except the protein-bound I^{131}, which was not available for ion exchange. Although the protein-bound I^{131} in milk from individual cows may vary from 0-10%, it is negligible in market milk contaminated with fresh fallout. The flavor of resin-treated milk was comparable to that of untreated milk. The absorbed I^{131} on the resin may be stripped with 2 N HCl prior to resin regeneration.

Murthy et al. (16) described a method for removing cationic radionuclides (Sr^{90}, Ba^{140}, and Cs^{137}) from milk. A method for the removal of iodine^{131} (I^{131}) is described in this paper.

Of the several fission products formed from nuclear weapons testing and nuclear reactor accidents, the only anionic type of radionuclide observed in measurable amounts in milk is I^{131} (2, 19). Although the International Committee on Radiation Protection had set a maximum permissible concentration (MPC) of 2,000 $\mu\mu c$/liter for I^{131} (9, 10), the Federal Radiation Council has recently published guide lines in which the acceptable levels of population exposure for I^{131} have been substantially decreased. Recognizing that similar concentrations of I^{131} would give a higher dosage to the smaller thyroid glands of children, because of size and sensitivity, than to those of adults, the council has recommended 100 $\mu\mu c$ of I^{131} as an average maximum daily intake. Thus, the annual dose to the thyroid of an exposed population (children) would be 0.5 rem (5).

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The nature of I^{131} in milk of various species of animals has been reviewed (13). In cows' milk, 90-100% of the I^{131} is in the inorganic form as the iodide and the remainder is bound with the proteins.

In several methods for the removal of I^{131}, ion-exchange resins in both column and batch techniques have been employed. In addition, an electrolytic process in which ion-exchange membranes are used has also been investigated.

Column experiments with commercially available synthetic ion-exchange resins in the chloride form removed 96-98% of the I^{131} from milk labeled in vivo and from milk labeled in vitro. The presence of nonionic I^{131} in milk resulted in a slightly lower removal from that labeled in vivo than from that labeled in vitro. The removal of I^{131} was found to be independent of flow rates (3) under the experimental conditions studied.

Batch process studies with ion-exchange resins in the chloride form removed 89.9-93.0% of the I^{131} from milk labeled in vivo, but the anionic composition of the milk was altered considerably. An increase of 50% in chloride and decrease of 12% in phosphate content were observed (4).

When milk was treated in membrane cells consisting of a cation-anion-anion-cation system, approximately 60-70% of the I^{131} was removed at an applied voltage of 14 v and 99.8% at 50 v. This treatment produced no changes in taste, odor, pH, appearance, density, or sodium content; however, the chloride content increased from 60 to 100 ppm and there was bacterial spoilage (8).

These experiments showed that synthetic ion-exchange resins will remove I^{131} from milk, but its anionic composition is drastically altered in the process. Equilibration of a suitable anionic exchange resin with a synthetic solution containing chlorides, citrates, and phosphates under appropriate conditions seemed necessary for removing I^{131} without significant changes in the anionic composition of the milk. An investigation has resulted in the method described here.

EXPERIMENTAL PROCEDURE

Materials. Milk that was labeled in vitro was prepared by adding an aliquot of an I^{131} solution of known activity to milk and allowing the mixture to equilibrate at 4 C for at least 24 hr prior to use. That labeled in vivo with approximately 0.5 μc I^{131} and 0.03 μc Sr^{85} per liter was obtained from the Dairy Products Laboratory, USDA, Beltsville, Maryland. The I^{131} tracer, obtained from Oak Ridge National Laboratory, was carrier-free NaI^{131} in basic sulfite solution, pH 7-11. Market milk samples contaminated with fresh fallout were purchased locally during October-November 1961.

The anion-exchange resin used was Dowex 2-X8 (Cl^-), 20-50 mesh size, with a total exchange capacity of approximately 1.33 meq/ml of wet resin.

Resin regeneration procedure. Since Dowex 2-X8 resin, as purchased, was in the chloride form, it was necessary to regenerate it on a chloride, phosphate, and citrate (Cl:P:Cit) cycle. The regeneration of the resin was performed as follows: First, the anionic composition of milk was determined. Based on this analysis, a mixed salt solution of chlorides, phosphates, and citrates was prepared according to the formula described under Results and Discussion. The pH of the salt solution was adjusted with 2 N NaOH to the same value as that of milk. The charging solution was passed (downflow) through a glass column (2.0 × 4.8 cm) containing 15 ml of the resin, at approximately 2-3 ml per minute, until the composition of the effluent was the same as that of the influent; approximately 350 ml of solution per 15 ml of resin was required. After equilibrium was reached, excess salts were removed by washing the resin with distilled water.

Procedure. The milk containing I^{131} was allowed to flow at 12-14 ml per minute through the exchange column containing 15 ml of Dowex 2-X8 anionic resin in the Cl:P:Cit cycle. The treated milk was analyzed for I^{131} activity and anionic composition.

Analytical methods. The following methods were used:

1. The pH was determined by use of a Beckman Model Zeromatic pH meter.
2. The radioactivity was determined by gross γ-counting or by gamma spectroscopy, according to the method described by Branson et al. (1).
3. Chloride was estimated as silver chloride, according to A.O.A.C. method modified by Murthy and Whitney (14).
4. Inorganic phosphorus on an aliquot of the filtrate obtained from trichloroacetic-acid precipitation of the proteins in the milk (4) was measured by developing the color according to Fiske and Subbarow's procedure (6).
5. Citric acid on an aliquot of the filtrate obtained from trichloroacetic-acid precipitation of the proteins in the milk (14) was determined by developing the color according to Marier and Boulet's method (12).

RESULTS AND DISCUSSION

Resin-charging procedure. Preliminary investigations for charging the anionic resin were conducted by methods similar to those for cationic resin (16). With a mixture of chloride, inorganic phosphate, and citrate in the same proportions but at five times the concentration observed in milk and at the pH of milk, the results were unsatisfactory because the treated milk (27 column volumes) showed an increase of 35% in chlorides and a decrease of 64% in citrates. No significant change in phosphates was observed.

To determine the proportions of chlorides, phosphates, and citrates required on the resin so that the composition of the milk would remain unaltered after treatment, seven 15-ml portions of Dowex 2-X8 (Cl^-) resin were equilibrated by passage of 1.5 liters of raw whole milk through the columns. The excess milk was removed by washing columns with warm distilled water. The absorbed anions were eluted with 300 ml of 2 N $NaNO_3$ in 0.16 N HNO_3 and analyzed. In calculations of the mole fractions the values for citrates and inorganic phosphates were considered in their trivalent forms. The results showed the mole fraction of anions on the resin as follows: 0.632 ± 0.019 for chlorides, 0.075 ± 0.006 for phosphates, and 0.293 ± 0.020 for citrates. The values in the milk were: 0.503 ± 0.007 for chlorides, 0.350 ± 0.008 for phosphates, and 0.147 ± 0.004 for citrates. The ranges in the above values represent standard deviations between replicate samples. These results indicate that only a small portion of inorganic phosphate in milk was available for ion-exchange reactions and the observed order of absorption was chlorides > citrates > phosphates. It has been shown (7) that when a mixed solution containing equivalent concentrations of hydrochloric acid, phosphoric acid, and citric acid (total strength 0.1 N) is passed through a De Acidite column, the order of absorption is hydrochloric > phosphoric > citric, whereas with IR-4B resin, NaH_2PO_4 is preferentially absorbed to Na_2HPO_4. In milk, however, the citrates exist mostly in the trivalent form and inorganic phosphates mostly in the monovalent and divalent forms. Therefore, the behavior of various species of these anions would be expected to depend upon their relative concentrations, ionization constants, solubility, and pH.

To determine the effect of slight variations in pH of milk on the mole fractions of anions on the resin, 1.5-liter portions of fresh raw whole milk were adjusted to pH's of 6.4, 6.6, and 6.8, either with dilute CH_3COOH or NaOH, and passed through 15-ml portions of resin in the chloride form, as described before. Analysis of resin eluates showed that as pH was increased from 6.4 to 6.8 the mole fraction of citrates increased from 0.252 to 0.279, that of chlorides decreased from 0.675 to 0.645, and that of phosphates did not change appreciably (0.073 to 0.077).

The effect of varying the anionic composition of milk on anions absorbed on resin was also investigated. A controlled factorial experiment was performed on eight milk samples contain-

TABLE 1
Effect of variation in anionic composition of milk on mole fraction of anions on resin

Milk composition code numbers			Concentrations in milk (mM/liter)			Concentrations on resin (mole fraction)		
Chloride	Inorganic phosphate	Citrate	Chloride	Inorganic phosphate	Citrate	Chloride	Inorganic phosphate	Citrate
0	0	0	32.50	21.18	8.847	0.596	0.0734	0.329
		1	32.17	20.97	12.092	0.568	0.0719	0.360
	1	0	32.17	24.30	8.758	0.598	0.1076	0.294
		1	32.50	24.30	12.09	0.594	0.0680	0.338
1	0	0	42.17	20.97	8.758	0.656	0.0657	0.278
		1	42.17	21.00	12.09	0.679	0.045	0.276
	1	0	42.17	24.30	8.850	0.711	0.069	0.220
		1	42.17	24.30	12.09	0.678	0.0585	0.264
0	0	0	32.50	21.18	8.847	0.596	0.0734	0.329
		2	31.85	20.76	15.336	0.532	0.0673	0.401
	2	0	31.85	27.42	8.670	0.577	0.1236	0.302
		2	31.62	28.00	15.410	0.532	0.0859	0.382
2	0	0	51.85	20.76	8.670	0.714	0.0582	0.228
		2	51.50	20.64	15.200	0.664	0.0442	0.292
	2	0	51.50	27.86	8.800	0.738	0.0762	0.186
		2	52.16	28.00	15.400	0.706	0.0578	0.236

TABLE 1-A

Analyses of variance of mole fractions of anions on resin corresponding to (0-2) concentrations in milk

Effect	Degrees of freedom	Variances of mole fractions on resin			F-Ratio to error variance		
		Chlorides	Phosphates	Citrates	Chlorides	Phosphates	Citrates
Average effects:							
A = Chlorides in milk	1	0.042778	0.001619	0.027848	120.16(**)	39.01(**)	69.62(**)
B = Phosphates in milk	1	0.000276	0.001260	0.002492	0.78(N.S.)	30.36(**)	6.48(*)
C = Citrates in milk	1	0.004560	0.000726	0.008844	12.81(*)	17.49(**)	22.11(**)
Interaction effects:							
A × B	1	0.000904	0.000173	0.000338	2.54(N.S.)	4.17(N.S.)	0.85(N.S.)
A × C	1	0.000092	0.000016	0.000181	0.26(N.S.)	0.39(N.S.)	0.45(N.S.)
B × C	1	0.000172	0.000162	0.000005	0.48(N.S.)	3.90(N.S.)	0.01(N.S.)
A × B × C	1	0.0000001	0.000092	0.000060	0.00(N.S.)	2.23(N.S.)	0.15(N.S.)
Error (between replicate milk samples)	6	0.000356	0.000042	0.000400			

N.S.—Not significant at 5% probability level.
* Significant at 5% probability level.
** Significant at 1% probability level.

ing the eight possible combinations of high and low concentrations of each of three anions at two levels. Sample compositions were adjusted by the addition of 1 N NaCl, NaH_2PO_4, or $Na_3C_6H_5O_7$. The samples were stored at 4 C overnight and then passed through resin columns to determine mole fractions of each anion absorbed on the resin. The results are presented in Table 1. Analysis of variance was applied to data on mole fractions of anions on the resin and is shown in Table 1-A. The results from Table 1-A and the data in Table 1 show that increasing the concentration of any anion in the milk caused a statistically significant increase in mole fractions of the same anion and a significant decrease in the mole fractions of the other two anions absorbed on the resin. An exception to this general rule was that increasing the concentration of phosphates in the milk had no significant effect on the mole fraction of chlorides absorbed on the resin.

TABLE 2

Mole fractions of anions on resin predicted from a mathematical additive model

Milk composition code numbers			Mole fractions on resin					
			Chlorides		Phosphates		Citrates	
Chloride	Phosphate	Citrate	Observed	Predicted	Observed	Predicted	Observed	Predicted
0	0	0	0.596	0.577	0.073	0.084	0.329	0.338
		2	0.532	0.530	0.067	0.066	0.401	0.405
	2	0	0.577	0.589	0.124	0.109	0.302	0.302
		2	0.532	0.541	0.086	0.090	0.382	0.369
2	0	0	0.714	0.724	0.058	0.056	0.228	0.220
		2	0.664	0.676	0.044	0.037	0.292	0.287
	2	0	0.738	0.735	0.076	0.081	0.186	0.184
		2	0.706	0.687	0.058	0.062	0.236	0.251

Model: $y_{Cl} = .6323 + .0731\, x_{Cl} + .0057\, x_P - .0238\, x_{Cit.}$
$y_P = .0732 - .0142\, x_{Cl} + .0124\, x_P - .0094\, x_{Cit.}$
$y_{Cit.} = .2944 - .0590\, x_{Cl} - .0182\, x_P + .0333\, x_{Cit.}$
where: y = predicted mole fraction of the indicated anion on resin
$x = 1$ at the higher level (2) of the indicated anion in milk
$x = -1$ at the lower level (0) of the indicated anion in milk

The effects of increases in anion concentrations in the milk on mole fractions of anions absorbed on the resin were independent (additive), within the limits of the experimental error. That is, there were no detectable interaction effects among pairs of anions. A purely additive mathematical model, fitted by least squares (Table 2), predicted mole fractions on the resin well enough so that standard deviations between observed and predicted mole fractions, calculated with four degrees of freedom for each type of anion, did not differ significantly from respective standard deviations calculated from mole fractions of anions absorbed by the resin from seven independently equilibrated samples of an average milk. Standard deviations of the errors of predictions were ± 0.017 for chlorides, ± 0.010 for phosphates, and ± 0.012 for citrates, whereas standard deviations between replicate samples were ± 0.019 for chlorides, ± 0.006 for phosphates, and 0.020 for citrates. Thus lack of fit in a purely additive mathematical model was no greater than experimental error.

Figure 1 shows the interrelationship of mole fractions of anions on the resin. Although the analysis of variance indicated that varying the concentrations of phosphates, chlorides, and citrates in milk caused statistically significant changes in the mole fractions of phosphates on the resin, the changes were so small that, for practical purposes, it may be said that the mole fraction of phosphates on the resin was not affected. The partial correlation coefficients between mole fractions of anions on the resin calculated for chloride vs. citrate (−0.970), chloride vs. phosphate (−0.030), and citrate vs. phosphate (−0.276) indicated that only the citrate vs. chloride correlation was significantly different from zero. This suggested that in

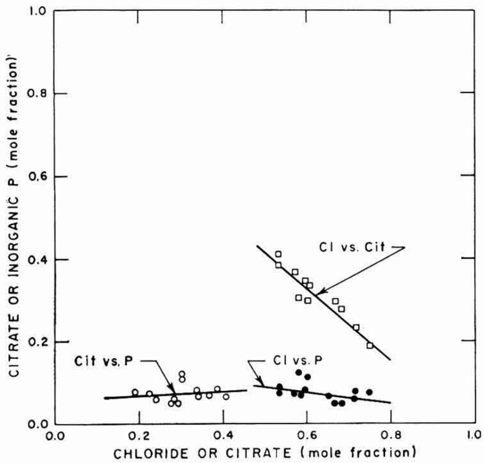

FIG. 1. Interrelationship between mole fraction of anions on the resin equilibrated with milk of varying composition.

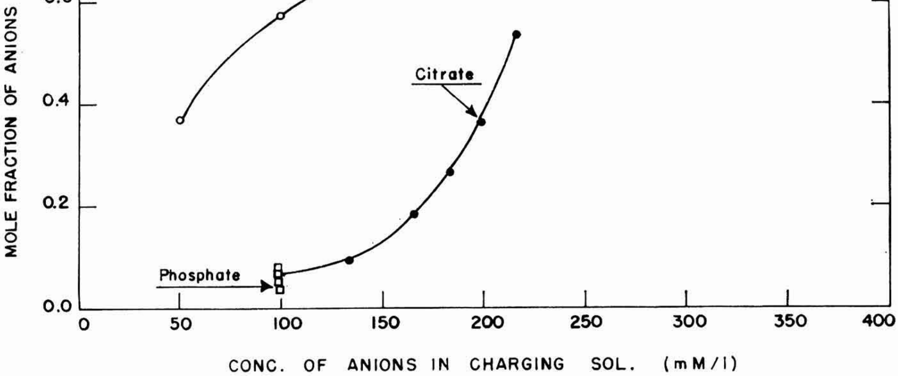

FIG. 2. Relationship between mole fraction of anions on resin equilibrated with milk or charging solution and composition of charging solution.

preparing charging solutions consideration should be given to the effects of varying chloride and citrate concentrations while keeping phosphates constant.

With the phosphates held constant at 100 mM/liter, the citrate and chloride concentrations were varied in the charging solutions in such a way that the total concentration of the three anions was 1.0 N. A graph of the mole fractions of anions on the resin vs. concentration of the respective anions in the charging solutions is presented in Figure 2. It can be seen that the mole fraction of phosphates in the resin changed very little for different charging solutions. Since the mole fractions of all three anions add to 1.0, and because the phosphates are held constant at 100 mM/liter and the total concentration of all the three anions is 1.0 N, the citrate curve is implied by the chloride curve and the chloride curve by the citrate curve. Thus, either of the two curves in Figure 2 may be used to predict the composition of a charging solution that would deposit the same mole fractions of anions on the resin as were deposited by a milk sample.

To simplify preparation of the charging solution, the values for the average anionic composition of seven milks, the average mole fractions of anions on the resin obtained with the above milks, and the information presented in Figure 2 were used to develop a formula. The average anionic composition of milks is 30.93 ± 0.40 mM/liter for chlorides, 21.57 mM/liter for inorganic phosphates, and 9.21 $\pm$ 0.55 mM/liter for citrates; the observed mole fractions of corresponding anions are 0.632 ± 0.019, 0.075 ± 0.006, and 0.293 ± 0.020, respectively. As Figure 2 shows, to obtain these mole fractions on the resin, the charging solution should contain approximately 125 mM of chlorides, 100 mM of phosphates, and 185 mM of citrates, per liter of solution. By dividing the concentration of respective anions in the charging solution by those in milk, numerical coefficients may be obtained and substituted in the following formula:

4.03 (mM Cl/liter) + 4.64 (mM Inorg P/liter) + 20.4 (mM citrates/liter),

where the expressions in parentheses represent the anionic composition of milk to be treated for the removal of I^{131}. The formula selects the concentration of an anion in the charging solution so that its ratio to the concentration of the same anion in a nonaverage milk sample to be treated is equal to the ratio of the concentration of the anion in the average charging solution to its concentration in the average milk.

To validate this technique, sufficient quantity of fresh raw whole milk was obtained, analyzed for anions, and a charging solution prepared using the above formula. The pH of the solution was adjusted to that of the milk before the required volume was made up. Three 15-ml portions of Dowex 2-X8 (Cl^-) were treated with 350-ml portions of the charging solution. Raw whole milk in 1.5-liter portions was passed through the charged columns and through two uncharged columns. Analysis of absorbed anions on the resins (Table 3) showed that the resin equilibrated with the charging solution had approximately the same composition as that equilibrated with the milk. Also, the anionic composition of resin-treated and untreated milk were compared and found not to differ significantly.

Although the above technique of preparing charging solution is satisfactory, where the anionic composition of milk varies greatly with the seasons or because of geographic location (9, 16, 17), it is appropriate to determine experimentally the mole fraction of anions deposited on the uncharged resin by the nonaverage milk and then use Figure 2 to compute the coefficients in the formula.

To determine the effectiveness of the Cl:P:Cit

TABLE 3

Relationship between composition of milk, charging solution, and mole fraction of anions on resin

Sample	Chloride	Inorganic phosphate	Citrate
Average mole fraction and its standard deviation	0.632 (±0.019)	0.075 (+0.006)	0.293 (±0.020)
Charging sol. (mM/liter)	125.0	100.0	185.0
Resin equilibrated with charging solution (mole fraction)	(1) 0.644	0.059	0.297
	(2) 0.657	0.059	0.284
	(3) 0.659	0.059	0.283
Milk (mM/liter)	30.93	21.57	9.21
Resin equilibrated with milk (mole fraction)	(1) 0.628	0.065	0.307
	(2) 0.628	0.068	0.304

TABLE 4

Effect of Cl:P:Cit. resin[a] treatment on the anionic composition of milk and the removal of I^{131}

Sample	Chloride	Inorganic phosphate	Citrate	I^{131} Removal
	(g/liter)			(%)
Untreated	1.08	0.644	1.84	....
Treated (effluent)				
1st 25 ml.	1.14	0.629	1.77	98
4th 25 ml.	1.14	0.642	1.86	96
8th 25 ml.	1.12	0.647	1.80	96
12th 25 ml.	1.10	0.646	1.82	95
16th 25 ml.	1.10	0.642	1.86	....
Average (treated)	1.12	0.641	1.82	

[a] 15 ml. of resin 2.0 × 4.8 cm column.

resin for the removal of I^{131}, and to confirm the adequacy of the system for maintaining a constant anionic composition in the treated milk, portions of milk labeled with I^{131} in vitro were treated with the resin as described under Procedure. Results (Table 4) showed a constant removal of 95-98% of I^{131}, with no appreciable change in the anionic composition of milk.

Effect of flow rates on the removal of I^{131}. Commercial processing requires handling of large volumes of milk and, therefore, in the evaluation of any iodine removal method this point must be taken into consideration. To obtain information on speed of operation, portions of milk labeled in vitro with I^{131} were passed through columns containing 15 ml of Cl:P:Cit resin at flow rates of 10, 15, 20, 25, and 30 ml per min, respectively. When analyzed for radioactivity, the corresponding effluents indicated I^{131} removals of 99, 99, 99, 98, and 98%. This suggested that increases of flow rates up to 20 ml per min did not seriously reduce the removal of I^{131} from milk.

Capacity of resin for the removal of I^{131}. To determine the volume of milk that could be treated with a given amount of resin and maintain a high percentage removal of I^{131}, several trial removals by techniques similar to that described before were made. The results presented in Figure 3 show a constant removal of 98 ± 2% from 120 resin bed volumes of milk (and approximately 95% from 230 resin bed volumes), beyond which a gradual decrease was observed.

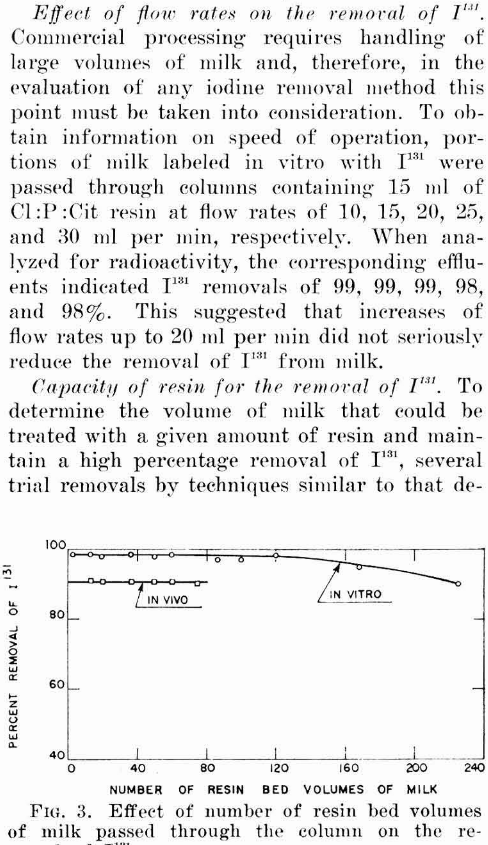

FIG. 3. Effect of number of resin bed volumes of milk passed through the column on the removal of I^{131}.

Effect of temperature on the removal of I^{131}. During ion-exchange treatment, milk should not be exposed to temperatures which favor bacterial growth. Therefore, the influence of temperature on the efficiency of I^{131} removal was determined. Portions of milk labeled in vivo and in vitro were adjusted to 5, 10, 15, 20, 25, and 30 C and passed through columns containing Cl:P:Cit resin maintained at the temperature of the milk. Analysis of treated milk showed removals of 98 ± 2% of I^{131} at all the temperatures.

Anionic composition of milk. During the course of this study several milk samples, before and after resin treatment, were analyzed for chlorides, citrates, and inorganic phosphates. The results presented in Table 5 clearly show that the resin treatment does not affect the anions investigated.

Comparison of I^{131} removal from milk labeled in vivo and in vitro. In view of the differences observed in the relative distribution of I^{131} in various fractions of milk labeled in vivo and in vitro, it was considered important to establish whether any significant differences existed in the removal of I^{131} from milk samples thus labeled. For this purpose, a fresh sample of cows' milk labeled in vivo and containing approximately 0.5 μc of I^{131} and 0.03 μc of Sr^{85} was fractionated with trichloroacetic acid. Analysis of fractions indicated that 91% of the I^{131} was present in the inorganic form as the iodide, whereas the 9% remaining was in the protein-bound form (PBI^{131}). Passage of this milk through a Cl:P:Cit resin column showed a removal of 90 ± 2% of I^{131}, indicating that

TABLE 5
Effect of Cl:P:Cit. resin treatment at pH 6.65 on the anionic composition of milk

Sample	Resin treatment	Chloride	Inorganic phosphate	Citrate
		(g/liter)		
1	Before	1.06	0.648	1.70
	After	1.07	0.653	1.75
2	Before	1.07	0.615	1.70
	After	1.08	0.618	1.66
3	Before	1.10	0.638	1.68
	After	1.10	0.654	1.68
4	Before	1.10	0.670	1.72
	After	1.10	0.662	1.74
5	Before	1.07	0.669	1.79
	After	1.06	0.673	1.90

all the inorganic I^{131} was removed by the treatment except that which was protein-bound. In contrast, all the I^{131} in milk labeled in vitro was removed by this technique.

To determine the practicality of this process, market milk samples contaminated with I^{131} from fresh fallout were treated with the resin as described before. The results presented in Table 6 show that all the I^{131} in milk was removed. The low removals observed in Samples 1 and 5 are due to decreased sensitivity of the instrument to detect low levels of radioactivity. Fractionation of milk with trichloroacetic acid also showed no detectable PBI^{131}, substantiating that the I^{131} in these samples was all in the inorganic form.

Flavor of resin-treated milk. Several fresh raw whole milk samples were treated with Cl:P:Cit resin as described before. A portion of each served as a control. The various samples were pasteurized at 145 F for 30 min and submitted to laboratory personnel for evaluation. The judgments of those in the group indicated no difference between the untreated and treated milks.

Regeneration of the resin. In order to reuse the spent resin, the absorbed I^{131} must be stripped prior to regeneration. For this purpose, several 15-ml portions of Cl:P:Cit resin

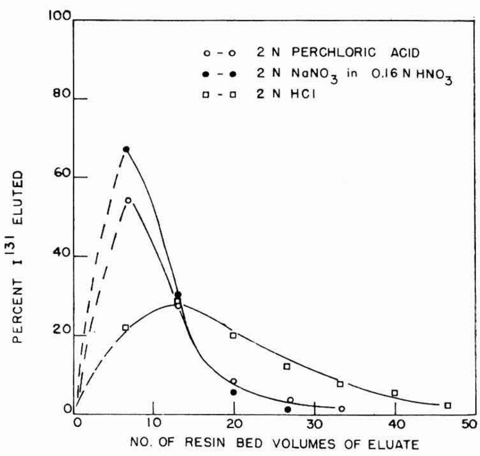

FIG. 4. Effect of perchloric, acidified $NaNO_3$ and HCl on the elution of absorbed I^{131} from the resin.

TABLE 6
Effect of Cl:P:Cit. resin treatment on the I^{131} removal from environmental milk samples

Sample	I^{131} Content Untreated	Treated	I^{131} Removal
	($\mu\mu c$/liter)		(%)
1	145 ± 10	15 ± 8	90
2	95 ± 8	0 ± 5	100
3	90 ± 8	0 ± 5	100
4	80 ± 8	0 ± 5	100
5	36 ± 8	4 ± 5	90

with absorbed I^{131} were treated with 2 N HCl, 2 N $NaNO_3$ in 0.16 N HNO_3, and 2 N $HClO_4$ acid, respectively, and the efficiency of I^{131} elution was determined. The results presented in Figure 4 indicate that all the three reagents are efficient in removing 98% of the absorbed I^{131}. The use of $HClO_4$ and $NaNO_3$ was considered objectionable in processing milk; however, 2 N HCl appears to be satisfactory.

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DETERMINATION OF PROTEIN-REDUCING SUBSTANCE VALUES OF MILK BY FERRICYANIDE REDUCTION METHODS

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SUMMARY

Methods described for the determination of protein-reducing substance (P.R.S.) values of milk by Choi et al., Cardwell and Herzer, and Mulay have been reviewed and their results compared. Differences in procedures resulting in subsequent lower or higher P.R.S. values for raw, pasteurized, pasteurized homogenized milk, and admixtures with reconstituted milk are discussed. Lowest P.R.S. values are obtained by the method of Choi et al., somewhat higher values by the method of Cardwell and Herzer, and highest values by the method of Mulay. The method of Mulay was modified by replacing aqueous $CaCl_2$ for a 50:50 water:ethanol mixture, and by lowering the reaction temperature of $K_3Fe(CN)_6$ to 85 C for 10 min, from the original temperature of 100 C for 5 min.

Milk possesses the ability to reduce potassium ferricyanide [$K_3Fe(CN)_6$] to potassium ferrocyanide [$K_4Fe(CN)_6$]. The reducing capacity of a given milk sample is increased by heat treatment and by the addition of reconstituted milk. Since the ferricyanide reduction method of Choi et al. (2) has been recommended and is approved as a screening test to determine the presence of reconstituted milk in natural market milk (5), it seems timely to compare results obtained by this method with those of other existing methods. Additional work to improve the method of Mulay (6) is also presented.

The data in Table 2 show P.R.S. values of raw milk samples from cows of several breeds as reported by four groups of workers employing three different methods outlined in Table 1. Although the milk samples examined by the different workers were dissimilar, it is nevertheless evident that breed or composition affects the P.R.S. value of milk. Both Clay et al. (3) and Mulay (6) report higher P.R.S. values for Holstein than for Jersey milk, whereas Cardwell and Herzer (1) report the opposite. Considering the work of Crowe et al. (4), it would seem more likely that higher P.R.S. values would be expected with Holstein milk because of its higher casein:lactose ratio.

Pasteurization and homogenization of milk increases its P.R.S. value. This increase is greater with Holstein (64%) than with Jersey (58%) milk (4). Mulay's method results in a much greater increase in P.R.S. values between raw and pasteurized milk than does the method of Choi et al. Mulay's method, as compared with the method of Choi et al., employs a 50% higher concentration of $K_3Fe(CN)_6$, a pH of 6.6-6.8 as against pH 4.6-4.8, and a heat treatment of 100 C for 5 min as against 70 C for 20 min, all such conditions known to contribute to greater ferricyanide reduction during the test. Choi et al. (2) report a 7% increase in P.R.S. value due to pasteurization of milk, whereas Clay et al. (3) report a 29% increase, both using the same method and mixed herd milk. Junker (5) reports from 80 to 140% variations in P.R.S. values with the method of Choi et al. (2), when used by 22 collaborators on identical samples of milk.

The methods of Cardwell and Herzer and of Mulay are outlined in more detail than is the method of Choi et al. If such detailed outline in procedure is essential for a closer duplication of results by different workers, then a more detailed description of procedure should improve the usefulness of the method of Choi et al.

Table 3 represents data on the influence of additions of reconstituted milk upon the P.R.S. values of natural raw, and pasteurized milk. All three methods register an increase in P.R.S. values with larger increments of added reconstituted milk. However, in no instance is the increase in values directly proportional to the increase in per cent of added reconstituted milk. The methods of Choi et al. and of Cardwell and Herzer register a declining rate of increase, whereas Mulay's method in general shows a rising rate of increase.

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TABLE 1
Procedures for methods described by Choi et al., Cardwell and Herzer, and Mulay

Consecutive steps in procedure	Conditions at each step with:		
	Choi et al.	Cardwell and Herzer	Mulay
1. Pipette milk	15 ml + 15 ml H_2O [a]	9 ml + 18 ml H_2O [a]	10 ml (100 F)
2. Coagulate milk	3 ml of 5% CH_3COOH	3 ml of 5% CH_3COOH	0.2 ml rennet (15 min, 100 F)
3. Wash and centrifuge curd (3×)	15 ml H_2O [a], 1,000 rpm 5 min each	18 ml acidified H_2O (pH 4.7) Babcock speed, 3 min each	15 ml of 50% aqueous ethanol, 2,000 rpm, 5 min each
4. Add saturated urea	3 ml + 12 ml H_2O [a]	3 ml (20-30 min, 32 C)	3 ml (15-20 min, 100 F)
5. Add phthalate buffer (pH 5.6)	5 ml + 15 ml H_2O [a]	5 ml + 12 ml H_2O [a]	None
6. Add $K_3Fe(CN)_6$ (1%)	5 ml	5 ml	5 ml
7. Heat sample	70 C, 20 min	70 C, 20 min	100 C, 5 min
8. Cool sample	Ice water	Ice water, 5 min	Tap water, 3-5 min
9. Add CCl_3COOH (10%)	5 ml	5 ml (32 C)	5 ml + 15 ml H_2O [a] (100 F)
10. Filter	Whatman, No. 40	Whatman, No. 40	Whatman, No. 40
11. Adjust filtrate	5 ml + 15 ml H_2O [a]	10 ml (32 C)	5 ml + 5 ml H_2O [a] (100 F)
12. Add $FeCl_3$	1 ml of 0.1% (10 min)	1 ml of 0.2% (10 min, 32 C)	1 ml of 0.2% (10 min, 100 F)
13. Read sample	Phaltz-Bauer fluoro-photometer, 6100 Å	Beckman, Model B Spectrophotometer, 610 mμ	Coleman Junior Spectrophotometer, 610 mμ

[a] Distilled water.

TABLE 2
Protein-reducing substance values of raw, pasteurized, and pasteurized homogenized milk samples reported by previous workers

	Choi et al. (2)	Clay et al. (3)				Cardwell and Herzer (1)			Mulay (6)	
Breed [a]	M	H	G	J	M	H	G	J	H	J
Raw, minimum	1.50	.... [a]	......	......	......	1.54	1.66	2.00	1.96	0.42
maximum	1.80	......	......	......	......	2.13	2.20	2.63	5.74	4.90
average	1.62	2.47	2.29	2.25	......	1.84	2.03	2.33	3.73	2.97
Raw milk values	1.62				2.39				3.73	2.97
Past. (145 F, 30 min)	1.74				3.08				6.14	4.70
Increase in P.R.S. values	7%				29%				64%	58%

M = Mixed, H = Holstein, G = Guernsey, J = Jersey.
[a] Not determined.

NEW DEVELOPMENTS

The method of Mulay (6) was modified by replacing the 50% aqueous ethanol with 0.01 M aqueous $CaCl_2$ (Table 1, Step 3) and by changing the ferricyanide reaction from 5 min at 100 C to 10 min at 85 C (Table 1, Step 7). The data in Table 4 show results obtained on the same milk samples by the two methods. It is evident that the heat treatment of 85 C for 10 min gave values close to those of 100 C for 5 min. This was true with both curd-washing procedures. Although some differences in P.R.S. values were found between the two curd-washing procedures, such variations were not greater than were variations between duplicate runs with the same procedure. Thus, the more easily controlled, lower heating temperature and the

TABLE 3

Effect of added reconstituted milk on protein-reducing substance values of natural, raw, and pasteurized mixed herd milk

Investigator	Treatment of milk	No. of trials	Reconstituted milk added	Increase in P.R.S. over control	Increase per 1% reconstituted milk
			(%)	(%)	
Mulay (6)	Raw	6	3	39	13.0
	Raw	6	5	70	14.0
	Raw	6	7	118	16.7
Choi et al. (2)	Pasteurized	45	3	38	12.7
	Pasteurized	45	5	55	11.0
	Pasteurized	45	10	95	9.5
Cardwell and Herzer (1)	Pasteurized	1	3	35	11.7
	Pasteurized	1	5	50	10.0
	Pasteurized	1	7	64	9.1
Mulay (6)	Pasteurized	10	3	37	12.3
	Pasteurized	10	5	73	14.7
	Pasteurized	10	7	102	14.6

TABLE 4

Protein-reducing substance values of pasteurized homogenized mixed herd milk as affected by modification of Mulay's method

Milk sample	Heat treatment C-min	Milligram $K_4Fe(CN)_6$ per 100 ml milk when washing curd with: 50% aqueous ethanol	0.01 M aqueous $CaCl_2$
B	100–5	3.69–4.30	4.15–4.15
	85–10	3.92–[a]	4.20–[a]
C	100–5	4.62–3.00	3.64–3.78
	85–10	5.46–5.60	5.46–6.02
D	100–5	5.60–5.46	4.62–4.62
	85–10	4.62–4.80	4.62–4.90
Avg	100–5	4.64	4.14
	85–10	4.67	4.76

[a] Duplicate values not determined.

more economical washing procedure were adopted for further work.

The modified method was checked for performance on raw, pasteurized, and pasteurized homogenized milk without and with added reconstituted milk. The results obtained with this modified method were similar to those obtained with the original method (Table 5).

TABLE 5

Protein-reducing substance values of raw, pasteurized, and pasteurized homogenized milk without and with reconstituted milk

	Treatment of milk: Raw [a]			Pasteurized [a]			Pasteurized-homogenized [b]		
Reconstituted milk (%)	0	3	5	0	3	5	0	3	5
Mg $K_4Fe(CN)_6$ per 100 ml milk	4.30	6.30	7.28	4.60	7.28	8.12	3.15	5.30	6.09
Increase in P.R.S. over control (%)	0	46	70	0	58	76	0	63	93

[a] One trial each; [b] average of two trials.

TABLE 6
Comparison of protein-reducing substance values obtained on the same milk by the method of Choi et al. and Mulay (modified)

Treatment of milk	No. of trials	Per cent reconstituted milk added	Mg $K_4Fe(CN)_6$ per 100 ml milk with: Choi et al.	Mg $K_4Fe(CN)_6$ per 100 ml milk with: Mulay's modified	Per cent increase in P.R.S. over control with: Choi et al.	Per cent increase in P.R.S. over control with: Mulay's modified
Raw	2	0	1.78	1.69		
Pasteurized-homogenized	3	0	2.07[a]	2.97[a]		
	3	3	2.62	4.32	21	45
	3	5	2.90	5.19	40	75
	2	7	3.27	5.51	52	110
	2	10	3.54	7.35	64	182

[a] 2.15 and 2.57 averages for the two trials with 7 and 10% added reconstituted milk.

The modified method was also compared with the method of Choi et al. on samples of the same milk. These data, shown in Table 6, indicate that in general the values are higher with the modified method of Mulay. Also, the increment increase in P.R.S. value, with up to 7% of added reconstituted milk, is about twice that obtained with the method of Choi et al. All tests were made in an air-conditioned laboratory at 25 C.

Repeatability of P.R.S. values by the modified method of six replications with one sample of raw milk on two consecutive days was: First day, 4.15 minimum, 4.76 maximum, and 4.41 average; second day, 3.92 minimum, 4.70 maximum, and 4.30 average. A similar check with pasteurized cream line milk gave these values: First day, 5.18 minimum, 5.74 maximum, and 5.35 average; second day, 5.18 minimum, 6.02 maximum, and 5.76 average. These data, although limited in number, show high repeatability for the modified method of Mulay.

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COMPARISON OF ORANGE G DYE, FORMOL TITRATION, AND KJELDAHL METHODS FOR MILK PROTEIN DETERMINATIONS [1]

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SUMMARY

A highly significant correlation of +0.975 between Orange G dye and Kjeldahl methods of protein determinations demonstrated that for most practical purposes the protein content of milk can be determined as effectively by the use of the rapid Orange G dye binding method as by the time-consuming Kjeldahl method. The correlation of +0.839 between the percentage of total protein determined by formol titration and the Kjeldahl method indicated that the Orange G dye method has an advantage in accuracy compared to formol titration as a rapid method for determination of protein in milk. This is, in part, due to effects from stage of lactation and month of the year on the formol factors for total protein.

Protein, the most important of the two major constituents of solids-not-fat, is receiving more attention from both the consumer and dairyman. This is due in part to the high nutritional value of milk protein, to the changing food habits of consumers, and to the declining importance of milk fat. Also, there is an increasing trend toward including protein, in addition to fat content, in determing the payment for milk (6, 11, 14). From a practical standpoint, the recent development of a rapid test for total protein, comparable in accuracy to the Babcock method for fat determination, is of great value to dairymen.

The objectives of this research were: to compare the Orange G dye and formol titration methods with the Kjeldahl method for testing the protein content of milk.

MATERIALS AND METHODS

Guernsey cows on Cornell's McDonald Farms near Cortland, New York, were used. Samples were taken at monthly intervals. Unweighted samples were taken from the evening and morning milk from each cow.

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Total protein. Total nitrogen was determined by the Kjeldahl method. This was then converted to total protein by using the factor 6.38. The samples were digested for 4 hr, because in preliminary trials this length of time gave better results than did 2 or 3 hr.

Dye method for total protein. Orange G dye was used to determine protein according to the method of Udy (23–25). Certified 92% Orange G dye was used, but it was adjusted to a concentration of 1 g of 100% dye content per liter. A 2-ml milk sample and 20 ml of buffered Orange G dye were placed in a 1-oz-capacity plastic bottle and thoroughly shaken for complete mixing. Treece et al. (22) recommended 10 min of mechanical shaking for best results, but Ashworth (3) found 15 sec to be sufficient when allowed to stand for 30 min before testing. Next, the contents were centrifuged at 820 rpm for 5 min in a Babcock centrifuge. The solutions were then filtered through No. 595 S & S filter paper to get a clear filtrate, free from fatty material. A short-light-path absorption cell was used to read the percentage of transmittance in an Evelyn colorimeter at 490 mμ. The wave length was based on 470 mμ recommended by Udy (24) but adjusted to 490 mμ indicated by the lowest percentage transmittance for the equipment used. Refrigeration was used for holding either the dye or the dye-plus-milk samples.

Preliminary trials were also made with the use of Buffalo Black, as described by Vanderzant and Tennison (26). Readings of percentage transmittance were taken at 580 mμ. Data are not presented, but Buffalo Black gave a clear solution after centrifuging, so that filtering was not necessary.

Formol titration. The modified method of Pyne (19) was used to determine the protein content of milk by formol titration. A saturated potassium oxalate solution was made. To dissolve the crystals, the solution was heated but not boiled. A 37% formaldehyde and 0.1 N sodium hydroxide solution and 0.5% phenolphthalein indicator were used. Acidity of the formaldehyde solution was corrected. A color standard was made by adding 0.1 ml of a 0.01% solution of basic fuchsin to 10 ml of milk and 0.4 ml of potassium oxalate in a test tube. This procedure was dispensed with later, when sufficient skill in determining the end point was acquired. Formol titrations on samples were run in conjunction with the analyses for total protein and casein, to determine the conversion factors for both total protein and casein.

Casein. The method of Rowland (20) was used in the determination for casein. However, after the analyses of 183 samples, the amount of 10% acetic acid was increased from 1 to 1½ ml to conform with the procedure of the A.O.A.C. (4). The former amount was found insufficient to precipitate all casein from 10 ml of milk, because Guernsey milk has a high buffer value. The method of Rowland uses the filtrate and corrects for the volume occupied by the precipitate, whereas that of the A.O.A.C. measures casein directly. There was a close agreement between the two methods.

Whey proteins. This was calculated by difference, substracting casein from total protein.

Errors in analyses. Duplicates were not run for all Kjeldahl analyses, but it was a practice to check on the analyses by running blanks and duplicates on at least six samples taken at random, two in each of the three digestion setups of 12 flasks each. Errors in determining total protein and casein were estimated by the method in which the difference between duplicates is divided by the smallest value and the quotient is multiplied by 100 to get the percentage error. The error for 85 duplicates in total protein determination was 0.9%; for 40 duplicates in casein determination, it was 1.9%. This is considerably less than the per cent error suggested as permissible for the method.

RESULTS AND DISCUSSION

Methods of analyses for total protein and casein. A comparison of Kjeldahl, Orange G dye, formol factor, and linear regression equation based on formol titration is given in Table 1. The results from 61 samples were compared.

TABLE 1

Comparison of Orange G dye, formol factor, linear regression equation based on formol titration, and Kjeldahl method for determination of total protein

Method of estimation	Mean
Kjeldahl	3.65 ± 0.048
Orange G dye	3.61 ± 0.046 [a]
Formol factor (1.77)	3.75 ± 0.048 [a]
Linear regression equation based on formol titration	3.65 ± 0.045

[a] Tukey's test of significance of difference between means was used with D = 0.12. (Snedecor, Statistical Methods.) Differences were significant between the two extremes, but not for comparisons of the different methods with the standard Kjeldahl method.

The means for protein from the Kjeldahl and Orange G dye methods were 3.65 ± 0.048 and 3.61 ± 0.046, respectively. There was a highly significant correlation of +0.975 between the Orange G dye and Kjeldahl methods of protein determination. Thus, it appears that the protein content of milk can be determined as effectively by the use of the rapid Orange G dye binding method as by the long and tedious laboratory procedure required for the Kjeldahl method.

Analysis of variance of the data shows that there was no significant difference between the formol titration and Kjeldahl methods for the determination of total protein content of milk. This is shown in Tables 2 and 3, and confirms results reported in other research (2, 5, 9–12, 14, 15, 17). Standard errors reported were larger for individual cows than for herd milk; however, the deviations for both total protein and casein from the Kjeldahl method were usually of the order ±5% for both.

The average formol factor of 1.77 for total protein was obtained by dividing percentage of total protein by milliliters of N/10 sodium hydroxide, and was based on 274 samples. The factor of 1.35 for casein was based on 360 samples. There was a highly significant correlation

TABLE 2

Comparison of Kjeldahl and formol titration methods in estimating total protein and casein [a]

Method of estimation	Mean, total protein	Mean, casein
Kjeldahl	3.80 ± 0.016	2.93 ± 0.015
Formol titration	3.82 ± 0.015	2.93 ± 0.014

[a] A total of 650 and 536 samples from 142 cows was compared with the Kjeldahl method for protein and casein, respectively.

TABLE 3

Effect of stage of lactation on the ratio of casein to total protein and resulting factor for each

Stage of lactation	No. of cows [a]	Casein/ total protein	Formol factor	
			Total protein	Casein
1	32	0.789	1.73	1.37
2	49	0.780	1.75	1.37
3	46	0.781	1.74	1.37
4	53	0.778	1.76	1.37
5	53	0.772	1.74	1.34
6	49	0.773	1.80	1.39
7	51	0.758	1.78	1.35
8	43	0.756	1.75	1.32
9	44	0.745	1.77	1.35
10	33	0.737	1.84	1.35
			1.77	1.35

[a] A total of 453 samples from 124 cows. The factor for total protein and casein was based on 274 cows and 360 tests, respectively.

of ±0.839 between percentage of total protein and milliliters of N/10 sodium hydroxide, and a correlation of +0.729 between percentage of casein and milliliters of N/10 sodium hydroxide. These are lower than those reported by Bannenberg and van den Hoek (5) for mixed herd milk. Budslawski et al. (7) and Comberg (8) report on the relationship of different milk constituents during lactation and the composition of bulk milk. The lower correlation for casein may be attributed to errors in the separation of casein from whey, especially during the first two months of the experiment. It is evident that the correlation of +0.839 between the percentage of total protein determined by formol titration and the Kjeldahl method indicated that the Orange G dye binding method, with a correlation of 0.975, is more accurate than the formol titration method.

The estimation of total protein by the use of linear regression equation gave the same results as did the Kjeldahl method, thus confirming the observation of Solberg et al. (21). Using the Kjeldahl method as the standard for comparison, none of the different methods gave significantly different results. However, since the correlation between the Orange G dye and the Kjeldahl method was much higher than between the formol factor and the Kjeldahl, it indicates an advantage in accuracy for the Orange G dye method for rapid determination of protein in milk. Amido Black was found equally as good as the Kjeldahl (1, 26) and has the advantage that filtering is not necessary after centrifuging. This has been used in Holland for routine testing of 1,400,000 milk samples from 80,000 individual cows in herd tests, and for pricing and selling milk at 30 dairies.

The use of the formol factor overestimated total protein by 0.10 from the Kjeldahl (Table 1). Gilmore and Price (13) reported a significantly higher value of 0.045 with formol titration than with Kjeldahl, but did not consider it important in practice. Since stage of lactation and month of the year may exert an influence on the results obtained, both of these were tested to determine their effect on the formol factor.

The effects of stage of lactation on the formol factors for total protein and casein are presented in Table 3. A total of 453 samples from 124 cows are represented in the table. Total protein formol factors showed a trend upward as the lactation period advanced. Casein formol factors exhibited a tendency to decrease, but the trend was not as consistent as for total protein. These opposite trends can be attributed to the increase in whey protein as the lactation period advances, which may also contribute largely to the increase in total protein percentage. This is shown in Table 3 by a decreasing ratio of casein to total protein, which is 0.789 and 0.737 for the first and tenth months, respectively.

Results on 536 samples from 124 cows presented in Table 4 indicated that months of the year do have some effect on the formol factors for total protein and casein. However, if an average formol factor is used, based on determinations and calculations of representative months during the different seasons, sizable errors will not be introduced.

TABLE 4

Effect of month of the year on the formol factor for protein and casein [a]

Month	Formol factor	
	Total protein	Casein
August	1.76	1.30
September	1.74	1.31
October	1.81	1.38
November	1.78	1.38
December	1.76	1.38
January	1.78	1.35

[a] A total of 536 samples from 124 cows.

Both the dye binding and formol titration methods have some advantages for routine laboratory analyses. The dye binding method is more accurate, especially for individual cow samples. The formol titration has an advantage from the standpoint of time required and simplicity of apparatus. However, the continuous presence of formaldehyde gas, even with good ventilation, may prove a hardship for the laboratory technician when a large number of samples are analyzed. Kay (16) reviewed recent methods for estimating milk protein, and concluded that formol titration could be very suitable for routine analytical work. Mogensen (18) reviewed published data on formol titration and concluded that the method is not sufficiently accurate to form the basis for payment for milk proteins. The dye method is rapidly gaining acceptance for accurate use on large-scale analyses of milk samples for protein content.

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METABOLISM OF BOVINE SEMEN. XII. GALACTOSE AS AN INDICATOR OF HEXOSE TRANSPORT BY BOVINE SPERMATOZOA[1]

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SUMMARY

Galactose-1-C^{14} has been used to study the transport of hexoses across the cell membrane of washed bovine spermatozoa. Trials with unlabeled glucose and with 2,4-dinitrophenol established an energy requirement for the transport of galactose. The transport system was shown to be sensitive to iodoacetate and to mercuric chloride, and did not respond to insulin. Since galactose readily accumulated in the cell and little $C^{14}O_2$ was produced, it was a good indicator of hexose transport. An active transport system was indicated, but some transfer appeared to be passive and not energy-dependent.

In the preceding paper (3), evidence was presented of the transport of fructose across the sperm cell membrane. It was pointed out that due to rapid metabolism of fructose, a true measurement of transport was difficult.

After considering the possibilities of the techniques which have been used to circumvent the complicating effects of metabolism in measuring transport (5, 7), galactose was selected for use as an indicator of hexose transport. The rationale for the use of galactose in this regard has been discussed by Levine and Goldstein (5).

This report presents the results of a series of experiments in which galactose-1-C^{14} was used to indicate transfer across the sperm cell membrane. A preliminary report of some of these findings has been presented (1).

EXPERIMENTAL PROCEDURE

The semen used in these trials was obtained from Holstein bulls with the artificial vagina. After collection the semen was examined for quality and ejaculates from three or four bulls were pooled for use in each trial. The spermatozoa were washed in Ringer solution to remove seminal plasma and resuspended in Ringer solution.

Transport was measured by incubating washed spermatozoa with galactose-1-C^{14} in 15-ml centrifuge tubes or (when CO_2 was collected) in Warburg flasks (3). After incubation, an aliquot containing 10^8 spermatozoa was removed and vacuum filtered through a 25-mm diameter millipore filter of 1.2-μ porosity. The cells were washed on the filter to remove extraneous radioactivity, care being taken not to disturb the thin layer of cells on the filter. The samples and filter discs were dried and attached with rubber cement to aluminum planchets for radioassay. Aliquots containing 10^8 spermatozoa could be filtered and washed in less than 2 min; with larger aliquots filtration became so slow that this technique had no advantage over the previous procedure of washing in the centrifuge (3).

RESULTS AND DISCUSSION

Fructose vs. galactose. Before galactose could be used as an indicator of hexose transport, it was necessary to establish entry into the cell and to determine what, if any, metabolic decomposition occurred. This was done by incubating equivalent doses of fructose-C^{14} and galactose-1-C^{14}, and comparing the cellular uptake and $C^{14}O_2$ production during 20 min incubation at 37 C. The results of these comparisons are shown in Table 1. It was noted that some 65% as much cellular radioactivity was found in galactose-fed cells as was found in those receiving fructose. In contrast to the large amount of $C^{14}O_2$ from fructose, only traces

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TABLE 1
Comparison of uptake and $C^{14}O_2$ production from fructose-C^{14} and galactose-1-C^{14}

Expt. no.	Cellular uptake		$C^{14}O_2$ production		Total radioactivity recovered	
	Fructose	Galactose	Fructose	Galactose	Fructose	Galactose
	(cpm per 10^8 cells)					
27	2,625	2,320	6,090	100	8,715	2,420
28	3,080	1,520	6,045	170	9,165	1,690
29	3,900	2,980	7,720	470	11,620	3,450
30	3,350	1,400	6,555	180	9,905	1,580
Mean	3,239	2,055	6,602	230	9,851	2,285

of $C^{14}O_2$ were derived from galactose-1-C^{14}. Thus galactose, with a cellular uptake/$C^{14}O_2$ ratio about 20 times that of fructose, was well adapted for use in studying transport, with little complication from metabolism of the tracer compound.

It should be noted that galactose is not metabolically inert, but the shortness of the incubation period (20 min) permitted transport measurements to be made before appreciable metabolism had occurred. If incubation is continued for 3 hr, the carbon from galactose-1-C^{14} appears in a number of metabolic intermediates (2).

Energy requirement. In the next series of experiments, efforts were made to determine if energy was required for movement of galactose into the cell. Obviously, a simple passive diffusion system would have no energy requirement, whereas a transfer system might require energy. Washed spermatozoa were incubated for 20 min at 37 C with a constant amount of galactose-1-C^{14}, whereas the concentration of the energy source, unlabeled glucose, ranged from 0 to 10^{-3} M. As is evident in Figure 1, the lower concentrations of glucose increased the cellular uptake of galactose-1-C^{14}, indicating that energy was required for the transport of galactose into the cell. At the higher concentrations of glucose, glucose competed with galactose for entry and the stimulatory effect observed at low concentrations was masked.

Additional evidence of an energy requirement is presented in Figure 2. Washed spermatozoa were incubated with galactose-1-C^{14}, and after 20 min 2,4-dinitrophenol was added to a final concentration of 10^{-4} M. This addition, indicated in the figure by the arrow, resulted in a loss of accumulated radioactivity from the cells, and although additions of 2,4-dinitrophenol always resulted in a loss of cellular radioactivity, the rate of loss and total amount lost varied from one experiment to another. In contrast to the reported results with bacteria (7), not all of the radioactivity left the cell; in fact, 30% or more of the total was retained. This may indicate that not all of the galactose crosses the cell wall by transport mechanisms and that some galactose movement is not energy-dependent.

Removal of radioactivity from the cell in a manner similar to that produced by 2,4-dinitrophenol also was induced by the addition of unlabeled galactose after an initial incubation with galactose-1-C^{14}.

Transfer against concentration gradient. Washed spermatozoa were incubated with galactose-1-C^{14} to permit cellular accumulation. The C^{14}-loaded cells were washed free of extraneous radioactivity, then incubated anaerobically in fresh buffer with and without 0.1 M unlabeled galactose. Effluent C^{14} into the galactose-containing buffer averaged about 25% greater than that into the galactose-free buffer. This concentration of galactose against an osmotic gradient is much the same as that occurring with fructose (3).

Sensitivity to inhibitors. Cellular uptake of

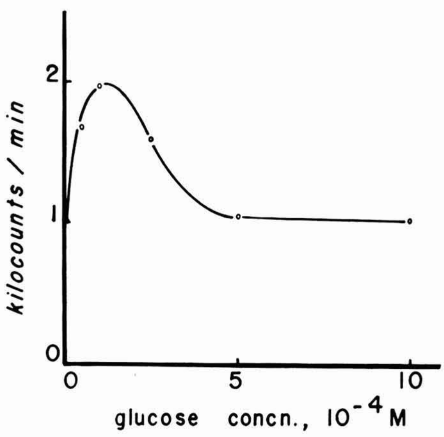

FIG. 1. Effect of external glucose concentration on the cellular uptake of galactose-1-C^{14}.

TABLE 2

Effect of inhibitors on cellular uptake and retention of galactose-1-C^{14}

Experiment	Control	Treated	Inhibition
	(cpm/10^8 cells)		(%)
37-39, Iodoacetate, 10^{-3} M	427	180	58
40-42, Mercuric chloride, added before incubation			
10^{-3} M	550	62	89
10^{-4} M	550	111	80
40-42, Mercuric chloride, added after incubation			
10^{-3} M	550	142	74
10^{-4} M	550	362	35

galactose-1-C^{14} was sensitive to iodoacetate, as shown in Table 2. In these trials washed spermatozoa were exposed to the inhibitor for 20 min before the addition of galactose-1-C^{14}. Mercuric chloride added under similar conditions caused an even greater inhibition of uptake (Table 2, added before incubation).

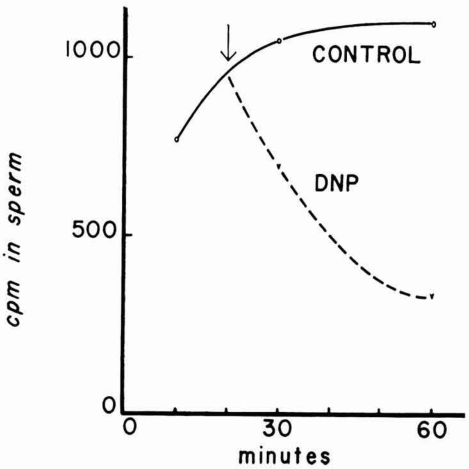

FIG. 2. Displacement of cell-accumulated galactose-1-C^{14} by 2,4-dinitrophenol. Dinitrophenol addition is indicated by the arrow.

With red blood cells, the addition of mercuric chloride after incubation has been used as a means of freezing the transfer of sugar (4). The procedure permitted measures of transport at time intervals of less than 1 min. Furthermore, since movement of sugar stopped upon the addition of the mercuric chloride, the subsequent analysis could be continued at an unhurried pace. This freezing procedure was tested with spermatozoa but, as shown in Table 2, the addition of mercuric chloride after spermatozoa had been incubated with galactose-1-C^{14} resulted in extensive loss of radioactivity from the cell. It is of interest that the extent of release of radioactivity by mercuric chloride was similar to that caused by 2,4-dinitrophenol.

Effect of insulin. Experiments were conducted to determine the effect of insulin on the transfer of galactose in spermatozoa. After preliminary tests, one unit of insulin per milliliter was adopted as approaching the optimum level. Galactose-1-C^{14} was added after spermatozoa had been exposed to insulin for 10 min, and transfer was measured after the usual 20-min incubation period. Results are presented in Table 3; insulin had no effect on the transfer of galactose under the conditions employed. In this respect, spermatozoa fall into the class of tissues, including red blood cells,

TABLE 3

Effect of insulin on the transport of galactose-1-C^{14}

Expt. no.	Cellular uptake		$C^{14}O_2$ production	
	Without insulin	With insulin	Without insulin	With insulin
	(cpm per 10^8 cells)			
43	820	830	160	130
44	2,245	2,180	855	865
45	1,255	1,460	310	300
46	2,860	2,855	655	630
Mean	1,795	1,831	495	481

the gastrointestinal tract, kidney epithelium, and central nervous system, which is not responsive to insulin (5).

General discussion. These investigations with galactose-1-C^{14} have confirmed and extended the previous observations with fructose (3) in measuring transport of hexoses by spermatozoa. Galactose measurements have a decided advantage, in that they permit the use of uninhibited cells for transport studies with little uncertainty introduced by metabolism and removal of products from the cell. On the other hand, galactose enters the cell somewhat more slowly than does fructose, and the possibility exists that the transport mechanism is specific for one sugar and does not necessarily apply to a second sugar. The similarity in behavior of galactose and fructose toward inhibitors and osmotic gradient would seem to indicate the functioning of a nonspecific mechanism in the transport of both sugars.

The data presented are indicative of an active transport mechanism in spermatozoa which probably is similar to that in erythrocytes and yeast (6). This does not appear to be an exclusive process, however, for the results with 2,4-dinitrophenol (Figure 1), mercuric chloride (Table 2), and the effects of temperature (3) lead to the postulation that some transfer occurs which is passive in nature and not energy-dependent.

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REASONS FOR DISPOSAL OF DAIRY COWS FROM NEW YORK HERDS

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SUMMARY

A mail survey was conducted over a six-month period in New York DHIA herds to determine the reasons for disposal of cows from the herds. Responses were received on 7,362 cows. The most important reasons for disposal were low production, 27–32%; sterility, 16–19%; udder trouble or mastitis, 14–20%; and sold for dairy purposes, 14–15%. Brucellosis and tuberculosis reaction are now relatively unimportant, each accounting for about 1% of the reasons for disposal. Culling for undesirable dairy type is also not very intense, since only 2–4% of cows were disposed of for this reason. Distinct differences between age groups for relative reasons for disposal were noted, as were differences between breeds, although the numbers of observations were small for most breeds.

Studies of reasons for disposal of dairy cows have not been frequent. Asdell (1) has probably made the most extensive study. His data included reasons for disposal of 2,792,188 cows in 17 states during the years 1932 to 1949, inclusive. An early comprehensive study was reported by Seath (8) for Iowa and Kansas herds. Florida data were studied by Becker, Arnold, and Spurlock (2) for cows in 14 herds, excluding those sold for dairy reasons. Parker et al. (6) listed reasons for disposal from the Beltsville herd over a 40-yr period. Their results were confounded by a T.B. outbreak early in the study and by the effort made to sell no animals for dairy purposes or for low production.

A critical review of the literature of reasons for disposal may be found in Meek (4), who also conducted a thorough and intensive study of reasons for disposal of 4,768 cows born between 1937 and 1957 in 11 Iowa institutional herds.

There appear to be two main purposes for summary studies of disposal. First, the results serve to guide extension personnel and veterinarians to major problems of management and breeding and of disease on dairy farms. Second, the summaries guide research workers to technical problems which are of practical importance to dairymen.

The object of the present study was to amplify previous studies and to up-date the information needed to serve as guide lines for research and extension workers and for veterinarians.

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METHODS

Under the New York Dairy Records Processing Center procedure, when a cow leaves the herd as reported by the responsible supervisor, a notation is indicated on that cow's record. The reason for disposal is, however, not indicated. Accordingly, for each New York cow marked as disposed of during the period October, 1960, to March, 1961, a mail survey form was sent to its owner. Unfortunately, only a part of a calendar year was included in the survey. The importance of reasons for culling during these months may not be representative of the remainder of the year. The cow's herd number and barn name were provided, along with space to list reasons for disposal. An owner could give as many reasons as he wished, listing the most important first and others in descending order of importance. Two different forms were used during the survey, to provide the evaluator with a numbered list of reasons. The herd manager could also write in any other reasons. The order of reasons on these two forms is shown in Table 1. Based on the other reasons listed, two additional categories were added before the data were punched for summarization—these left the herd because of: 21. Disease or 22. Abortion.

The numbers of responses for each reason for both forms are listed in Table 2. Of the 7,362 total responses, 4,629 were from Form 1 and 2,733 from Form 2. Very few responses listed more than two reasons for disposal.

A question always arises in the analysis of survey data concerning the influence of the

TABLE 1
Order of reasons for disposal on two forms used in a mail survey

Form 1		Form 2	
No. of reason	Reason	No. of reason	Reason
1	Sold—Dairy purposes	1	Sold—Mastitis
2	Sold—Low production	2	Sold—T.B. reactor
3	Sold—Brucellosis	3	Sold—Dairy purposes
4	Sold—Mastitis	4	Sold—Unsound feet or legs
5	Sold—Udder trouble	5	Sold—Hard milker
6	Sold—Unsound feet or legs	6	Sold—Brucellosis
7	Sold—Hard milker	7	Sold—Low production
8	Sold—Physical injury	8	Sold—Physical injury
9	Sold—Sterility	9	Sold—Sterility
10	Sold—Old age	10	Sold—Undesirable dairy type
11	Sold—T.B. reactor	11	Sold—Old age
12	Sold—Undesirable dairy type	12	Sold—Udder trouble
13	Died—Calving trouble	13	Died—Forage poisoning
14	Died—Old age	14	Died—Old age
15	Died—Hardware	15	Died—Hardware
16	Died—Accidental death	16	Died—Calving trouble
17	Died—Milk fever	17	Died—Milk fever
18	Died—Forage poisoning	18	Died—Bloat
19	Died—Bloat	19	Died—Accidental death
20	Other	20	Other

TABLE 2
Summary of responses to a mail survey requesting information on why cows left the herd

Reason	No. listing reason [a]					Sum of 5
	1st	2nd	3rd	4th	5th	
Dairy purposes	1,051	40	3	0	0	1,094
Low production	2,000	304	20	2	1	2,327
Brucellosis	86	9	0	0	0	95
Mastitis	616	170	10	0	0	796
Udder trouble	454	233	26	3	0	716
Unsound feet or legs	211	75	8	0	0	294
Hard milker	187	131	23	1	1	343
Physical injury	313	80	9	1	0	403
Sterility	1,191	208	26	2	0	1,427
Old age	272	209	33	2	0	516
T.B. reactor	60	7	0	0	0	67
Undesirable dairy type	154	131	32	3	0	320
Calving trouble	171	18	2	0	0	191
Old age	21	5	3	0	0	29
Hardware	88	10	3	1	0	102
Accidental death	47	2	0	0	0	49
Milk fever	51	11	3	0	0	65
Forage poisoning	13	1	0	0	0	14
Bloat	34	2	0	0	0	36
Other	250	47	7	0	0	304
Disease	45	4	3	0	0	52
Abortion	47	7	0	0	0	54
Total	7,362	1,704	211	15	2	

[a] A cow could be listed as disposed of for several reasons. The reasons were ordered according to 1st, 2nd, etc. reason for disposal.

survey form used. In this case the only difference in the two forms was the order in which the reasons were listed. A sample chi-square was computed to test whether the difference in response to the two forms was due to chance. A value of $\chi^2 = 216.9$, with 21 degrees of freedom, would indicate at a very high level of probability that the difference in response is not due to chance. This result almost immediately casts doubt on the validity of the survey. Examination of the summary for the two forms shown in Table 3 reveals that although the per cent values vary considerably, the same general pattern prevails in both sets of responses. Therefore, it was decided to report these results, together with a statement warning of the possible dangers inherent in all survey work. Previous reports have used only one survey form or have considered only responses to verbal questions. No one can be sure that the form used, the form of questioning, or the approach of the questioner can provide an unbiased response.

The summary of reasons for disposal by breed from the combined data is shown in Table 4. It must be remembered when examining these values that relatively few observations were available for the breeds other than Holstein. A sample chi-square of $\chi^2 = 242.3$, with 84 degrees of freedom indicates, however, that there are real differences in reasons for disposal among the five breeds.

The reasons for disposal when categorized by year of birth into six classes are summarized for the combined data in Table 5. The numbers in each group are fairly uniform, except for the youngest group with fewer observations and the oldest group with many more observations. The sample chi-square of $\chi^2 = 1247.5$, with 105 degrees of freedom, is much larger than could be expected by chance if the age groups were similar in their disposal ratios.

There may be some confounding of age and breed which could affect the per cent disposal values when summarizing the data separately for age and breed. If the numbers of observations were sufficient, a more complete analysis of an interaction between age and breed would be desirable. The small numbers of observations in the non-Holstein breeds when distributed over six age groups and 22 categories of reason for disposal would not allow suitable estimation of the interaction effect.

TABLE 3

Summary of reasons given for disposal on two mail survey forms

Reason	Form 1		Form 2		Both forms	
	(1)[a]	(2)[b]	(1)	(2)	(1)	(2)
Dairy purposes	.161	.167	.112	.117	.142	.148
Low production	.282	.323	.254	.305	.271	.316
Brucellosis	.013	.014	.010	.011	.011	.012
Mastitis	.077	.108	.095	.109	.083	.108
Udder trouble	.062	.096	.062	.099	.061	.097
Unsound feet or legs	.029	.044	.028	.034	.028	.039
Hard milker	.022	.047	.031	.046	.025	.046
Physical injury	.037	.050	.052	.063	.042	.054
Sterility	.163	.197	.160	.189	.161	.193
Old age	.036	.071	.039	.068	.036	.070
T.B. reactor	.002	.002	.019	.021	.008	.009
Undesirable dairy type	.016	.040	.029	.049	.020	.043
Calving trouble	.021	.022	.028	.032	.023	.025
Old age	.003	.004	.003	.004	.003	.004
Hardware	.011	.012	.014	.017	.012	.013
Accidental death	.007	.007	.005	.005	.006	.006
Milk fever	.006	.008	.008	.010	.006	.008
Forage poisoning	.002	.002	.001	.001	.002	.002
Bloat	.006	.007	.001	.001	.004	.004
Other	.027	.035	.046	.052	.033	.041
Disease	.009	.010	.001	.001	.006	.007
Abortion	.010	.011	.000	.000	.006	.007
Total responses	4,629		2,733		7,362	

[a] Fraction of total number of disposals given as primary reason for disposal.

[b] Fraction of total number of disposals given as either 1st, 2nd, 3rd, 4th, or 5th reason for disposal.

TABLE 4

Summary of reasons given for disposal by breed

	Ayrshire		Guernsey		Holstein		Jersey		Brown Swiss	
No. cows	(273)		(669)		(5,878)		(364)		(159)	
Reason	(1)[a]	(2)[b]	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Dairy purposes	.139	.139	.124	.127	.144	.151	.173	.173	.107	.107
Low production	.300	.341	.354	.399	.255	.299	.357	.398	.302	.371
Brucellosis	.015	.015	.009	.010	.013	.014	.005	.005	.000	.000
Mastitis	.062	.066	.042	.061	.093	.120	.052	.063	.044	.063
Udder trouble	.062	.084	.049	.079	.064	.102	.052	.077	.044	.050
Unsound feet or legs	.029	.037	.024	.039	.030	.042	.011	.014	.031	.038
Hard milker	.018	.040	.018	.036	.027	.050	.011	.019	.038	.057
Physical injury	.029	.033	.027	.039	.046	.059	.030	.036	.038	.038
Sterility	.150	.165	.175	.212	.161	.193	.129	.157	.208	.258
Old age	.018	.048	.045	.079	.036	.070	.049	.082	.044	.069
T.B. reactor	.007	.007	.004	.004	.007	.009	.000	.000	.063	.063
Undesirable dairy type	.018	.033	.025	.057	.021	.043	.019	.027	.013	.057
Calving trouble	.022	.026	.016	.018	.024	.027	.022	.022	.025	.031
Old age	.004	.004	.006	.006	.002	.004	.005	.005	.006	.006
Hardware	.022	.022	.009	.009	.013	.015	.003	.003	.000	.000
Accidental death	.011	.011	.004	.006	.006	.007	.008	.008	.000	.000
Milk fever	.022	.026	.004	.006	.005	.007	.025	.025	.013	.013
Forage poisoning	.000	.000	.000	.000	.002	.002	.000	.000	.000	.000
Bloat	.000	.000	.003	.003	.005	.006	.000	.000	.000	.000
Other	.051	.059	.046	.052	.032	.039	.038	.052	.006	.006
Disease	.011	.011	.004	.004	.006	.007	.005	.005	.019	.019
Abortion	.007	.007	.009	.010	.006	.007	.003	.003	.000	.000

[a] Fraction of total number of reasons for disposal given as primary reason for disposal.
[b] Fraction of total number of reasons for disposal given as either 1st, 2nd, 3rd, 4th, or 5th reason for disposal.

TABLE 5

Summary of reasons given for disposal by approximate age

Approx. age (yr)	2-3		3-4		4-5		5-6		6-7		Older than 7	
Reason	(1)[a]	(2)[b]	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Dairy purposes	.176	.176	.227	.236	.194	.201	.175	.186	.147	.150	.072	.076
Low production	.458	.505	.343	.388	.336	.389	.298	.339	.289	.346	.173	.211
Brucellosis	.011	.011	.015	.015	.017	.020	.012	.013	.013	.015	.008	.009
Mastitis	.032	.043	.033	.046	.060	.085	.086	.108	.110	.140	.111	.141
Udder trouble	.043	.058	.033	.050	.031	.052	.067	.103	.071	.114	.083	.132
Unsound feet or legs	.006	.011	.012	.013	.011	.018	.016	.024	.016	.026	.054	.074
Hard milker	.043	.067	.028	.048	.017	.031	.017	.041	.029	.054	.027	.049
Physical injury	.037	.045	.035	.042	.037	.045	.034	.052	.048	.064	.049	.063
Sterility	.067	.082	.118	.141	.153	.178	.157	.185	.161	.197	.200	.240
Old age	.002	.002	.001	.001	.003	.003	.003	.005	.000	.004	.094	.178
T.B. reactor	.011	.011	.016	.017	.010	.011	.006	.007	.007	.007	.005	.007
Undesirable dairy type	.030	.069	.037	.070	.028	.053	.019	.043	.011	.034	.015	.029
Calving trouble	.019	.019	.018	.020	.031	.034	.024	.027	.025	.025	.022	.026
Old age	.000	.000	.000	.000	.001	.001	.000	.000	.000	.000	.007	.010
Hardware	.006	.011	.014	.017	.011	.012	.020	.022	.013	.017	.009	.010
Accidental death	.013	.013	.009	.009	.004	.005	.005	.005	.008	.008	.005	.006
Milk fever	.000	.000	.001	.001	.002	.003	.008	.010	.008	.009	.012	.015
Forage poisoning	.002	.002	.002	.002	.001	.001	.001	.001	.002	.003	.002	.002
Bloat	.002	.002	.005	.006	.009	.009	.005	.005	.001	.001	.004	.005
Other	.034	.037	.038	.049	.031	.039	.035	.039	.030	.038	.034	.042
Disease	.004	.004	.008	.008	.005	.005	.006	.009	.003	.003	.007	.009
Abortion	.002	.002	.008	.008	.008	.009	.008	.010	.007	.007	.005	.007

[a] Fraction of total number of reasons for disposal given as primary reason for disposal.
[b] Fraction of total number of reasons for disposal given as either 1st, 2nd, 3rd, 4th, or 5th reason for disposal.

DISCUSSION

The most important reasons for disposal over all breeds and age classes are, as expected, low production, sterility, and sold for dairy purposes. These three reasons account for more than 57% of the disposals. All disposals due to death accounted for only about 6% of the animals. About 4% more were sold for old age. Udder difficulties made up 14% of the primary reasons and were listed on 20% of the responses. It is likely that many dairymen classified mastitis trouble as udder trouble.

These results point out two areas for continued extensive research and teaching. Udder difficulties, which make up 14-20% of the reasons for disposal can in part be alleviated by practices known to veterinarians and research and extension personnel but still not practiced by many dairymen. Further research is also required in this area, in addition to more extensive dissemination of knowledge already acquired.

The other problem is well known. Factors affecting sterility have been studied extensively, but still 16-19% of the responses in this survey listed sterility as a reason for disposal. This area even yet evidently contains many problems which, if solved, could markedly affect the dairy operation.

Low production accounted for 27-32% of the disposals and sold for dairy purposes another 14-15%. Undoubtedly, several of the animals sold for dairy purposes could have been culled for low production. This rate of herd culling seems fairly high, but if the importance of sterility and mastitis was reduced the culling intensity could be increased substantially, with the resultant increase in genetic merit of the dairy cow population.

These results are in general agreement with the studies of Asdell (1) and Seath (8). Both reported approximately 34% of cows were disposed of because of low production and 24% for dairy purposes. Their values are a little higher than found in this survey, especially for the category sold for dairy purposes. Their values for udder trouble and sterility are considerably lower than reported here. If, as some dairymen believe, high production leads to a greater incidence of mastitis, this early report does not contradict the present results. Production in 1960 averaged considerably higher than did production in 1950 and 1940.

The more widespread use of artificial insemination in 1960 than earlier might provide a reason for the apparent rise in importance of sterility as a factor for disposal. The Asdell (1) study reported only 8% and Seath (8) only 5% of animals sold for sterility. Dairymen today are more aware of these problems, since they must observe their cows more closely to detect heat so they can call the inseminator.

Results for udder difficulties and for sterility are quite closely in agreement with those of Meek (4), who reported the incidence of disposal for these reasons of about 14-16 and 24%, respectively. The Iowa institution herds, however, had lower disposal rates for low production (20%) and slightly lower for dairy purposes (12%). The study of the Beltsville herd, Parker et al. (6), listed sterility as the reason for disposal in 41% of the cows. This reason is probably confounded with old age, since animals were not culled for low production and would, therefore, be allowed to grow older irrespective of production.

Abortion, brucellosis, and tuberculosis are evidently rather insignificant at this time as reasons for disposal—each accounting for only about 1% of all disposals. The earlier reports of Asdell (1) and Seath (8), and the 40-yr study of Parker et al. (6), showed much higher proportions of disposals for these reasons. The percentages reported by Meek (4) are only slightly higher for these occurrences than in the present survey.

The emphasis on dairy type as a reason for disposal is apparently very low, only 2-4% of cows being sold for this reason, although possibly some of those sold for dairy purposes may also have been sold for undesirable type.

Breed differences. The chi-square test for differences among breeds for reasons of disposal indicated that substantial differences do exist. It should be remembered that the small numbers of observations on the non-Holstein breeds make these estimates less reliable than if more were available. The major reason for disposal in each breed is low production. Among the Jersey and Guernsey breeds, however, about 10% more leave for low production than from among Holsteins. The Brown Swiss and Ayrshire breeds are intermediate between high and low. The current higher emphasis on milk yield rather than fat yield would tend to cause more Guernseys and Jerseys to be culled for low production than the other breeds. The ranking of the breeds in New York DHIA herds according to milk yield is Holstein, Brown Swiss, Ayrshire, Guernsey, and Jersey. This ranking conforms very closely to the inverse ranking for disposal for low production.

There also appear to be differences among the breeds in the rate at which animals are transferred from one herd to another. The largest transfer, making up 17% of the reasons for disposal, occurs among the Jersey herds and the lowest 11% among Brown Swiss herds. The other breeds fall in between.

Sterility problems evidently are more serious in the Brown Swiss breed, where 21% of disposals are for fertility problems. The possible connections between this high rate and the tendency for slower maturity in the Brown Swiss should perhaps be investigated. The Jresey herds had the least relative amount of sterility problems—about 13%. The other breeds were again intermediate between the extremes.

The Holsteins, with nearly 17% of disposals for udder and mastitis difficulty, appear to have much more trouble in this area. This would tend to support the theory of higher production making for more udder trouble. Ordering the other breeds by production and by udder trouble does not, however, further substantiate this hypothesis. In fact, the Brown Swiss are second in production and have the lowest relative disposal rate for udder problems. The difference between breeds in apparent susceptibility to mastitis and udder difficulty indicates a probable difference in genetic makeup among the breeds for susceptibility—either directly or through other indirect physiological processes.

Although the per cent values in the death caused by milk fever category are low, it appears that a difference among breeds exists. The Guernsey and Holstein breeds were low and the Ayrshire and Jersey were high. This result would suggest the existence of genetic differences among breeds for susceptibility to milk fever.

Age differences. A steady decline in the proportion culled for low production occurs with increasing age. Nearly one-half of culled first-lactation animals are culled for low production. Most of the low producers will be eliminated in the first two or three lactations. The relative culling for sterility and udder trouble is low for this younger age group, which naturally allows for more rigid culling for low production. Among older cows, about 17% of those disposed are sold because of low production. This pattern is similar to that found by Meek (4).

The second lactation is apparently favorable for selling animals for dairy purposes (23%), whereas few (7%) older cows are sold into other herds. The economics of selling fairly well dictates this pattern.

Problems of fertility increase relatively after the first lactation (7-8% disposal rate) to plateau in the third to fourth lactation (15-16%) and then increase again among the older cows (20-24%). This same general pattern was found by Meek (4), where he found a steady increase to 7-8 yr of age, followed by a plateau for 2-3 yr, after which an increase was evident.

The incidence of mastitis and udder trouble also appears to increase gradually with age—from 6-10% in the youngest group to 19-27% in the oldest group. There appear to be several explanations as advanced by Meek (4) and Plastidge (7) for this pattern. Either young cows are more free from mastitis or if it does occur it is more likely to be treated. In older animals with a past history of mastitis less leniency would be expected. However, they point out that it is doubtful if this explains more than a small part of the difference among age groups. Some association between age and mastitis infection apparently exists. Younger animals may be less susceptible to infection. The increased exposure to infection with increasing age may also be an important consideration. Perhaps both contribute to the pattern. A pattern of incidence of mastitis which increased with age was reported earlier by Legates and Grinnells (3). Meek (4) concluded that "From these figures it would seem that milking younger animals, with a faster turnover of cows, would be the best way to combat mastitis." Until further research points out better ways, it would seem his solution is the most practical one available.

It would appear from the data that most hard milkers are disposed in the first lactation. Similarly, disposals for undesirable type are likely to occur during the first two or three lactations.

Although the numbers of observations are relatively small, it appears that disposal due to milk fever increases cumulatively with increasing age. Milk fever is almost nonexistent in first-calf heifers which have not been previously subjected to the stresses of high milk production. Apparently, the physiological causes are connected with previous production and thus increased age may bring about increased severity, Meek (5).

CONCLUSIONS

The chief reasons for disposal as reported in this survey were low production, 27%; sterility, 16%; sold for dairy purposes, 14%; and udder difficulties, 14%. The importance to the dairyman of the freedom to cull for low production cannot be overemphasized. The primary importance of decreasing involuntary losses is to increase the culling rate for low production rather than to increase longevity.

The chief areas which need improvement are fertility and udder (mastitis) difficulties. If the incidence of these could be reduced markedly, more attention could be placed on culling for low production. Present knowledge, if applied, possibly could reduce the relative importance of these factors. It would appear, however, that additional research breakthroughs in these areas to find methods of prevention or cure are urgently needed in addition to increased dissemination of known methods of prevention or cure by extension personnel.

Factors which in the past have been serious problems, such as brucellosis and tuberculosis, have apparently been eliminated as significant reasons for disposal. This improvement has been due to thorough and extensive application of testing and slaughter for T.B. and vaccination for brucellosis.

Undesirable dairy type is only a minor reason for disposal, accounting for about 2-4% of total disposals. This indicates that most dairymen do not pay much atention to type characteristics when culling. This low value is in contrast to the much higher importance accorded culling for low production (27-32%).

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EFFECT OF DEOXYRIBONUCLEASE ON THE CALIFORNIA TEST FOR MASTITIS

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SUMMARY

Nucleated but not non-nucleated body cells added to normal milks were found to produce typical California Mastitis Test (CMT) positive reactions. Treatment of mastitic milks with commercial 5 × recrystallized deoxyribonuclease but not ribonuclease or trypsin was shown to prevent the formation of gels characteristic of a positive CMT. Treatment of gels formed by the reaction of mastitic milk with DNAase but not RNAase or trypsin resulted in almost instantaneous dissolution of the gel. A level of 1.65 μg DNAase/ml of markedly mastitic milk (CMT-3+) was found to be sufficient to abolish the CMT reaction completely. These observations suggest that polymerized DNA originating from cells of the inflammatory exudate in mastitic milk is the component responsible for positive California Mastitis Test reactions.

Since the discovery of the California Mastitis Test (CMT) (20), there has been a need for knowledge concerning the factors present in mastitic milk which react with the active principle of the CMT reagent (an anionic detergent) to form gels of varying strengths. With such knowledge, it may then be possible to precisely quantitate the reactive material in mastitic milk by suitable chemical means. From the very beginning, the correlation between total cell counts in milk and the CMT score indicated a very strong probability that the reactive substance was closely allied with body cells, especially those associated with the inflammatory exudate.

Direct observations revealed that the reactive material can be centrifuged or filtered out of the milk. It is present in both the sediment and fat layer but not the skim following centrifugation, indicating the reaction is associated with insoluble particulate material. During centrifugation, cells are both sedimented and are swept up with the cream. Following ether extraction, the reaction was found to be present in the aqueous but not the ether phase. It was found that the increased whey proteins of mastitic milk separated by DEAE cellulose failed to produce the reaction (3). In addition, mastitic milk proteins precipitated by trichloroacetic or perchloric acid followed by neutralization and dialysis failed to produce the CMT reaction. These observations suggested that fat or protein per se was not involved.

More indirect evidence suggested that the reactive material in the milk may be of nuclear origin. For example, it was found that typical CMT reactions were produced in normal milks by the addition of whole mammalian blood or the buffy coat (leukocytes) but not by washed mammalian erythrocytes. Minced tissue (liver), washed nucleated avian erythrocytes, or crude nuclear material separated from avian erythrocytes, on the other hand, all produced typical CMT-positive reactions when added to normal milks. In addition, unpublished observations (O.W.S.) on mastitis-free goat's milk have shown that non-nucleated cytoplasmic cellular material common to goat's milk (15) does not produce a positive CMT reaction.

A review of the literature regarding cell fractionation revealed that gels which appeared to be characteristic of positive CMT reactions were observed during various procedures used in the extraction of DNA, suggesting to us that DNA may be the cellular component responsible for positive CMT reactions.

MATERIALS AND METHODS

Treatment of mastitic milks was carried out with the following enzymes: trypsin (2 × recrystallized, salt-free), ribonuclease (5 × recrystallized), and desoxyribonuclease (5 × recrystallized). The enzymes were the products of Nutritional Biochemicals Corporation. The enzyme stock solutions were made up to a con-

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centration of 50 mg/100 ml. The DNAase was made up in 0.25% gelatin and had a concentration of 35,000 Dornase units/ml. The addition of Mg^{++} was found to be unnecessary. Ribonuclease and trypsin were made up in distilled water.

Varying amounts of the enzymes were added to mastitic milks which were then incubated 3-4 hr at 37 degrees. The CMT was then scored by one of us (OWS) without previous knowledge of the treatment. Suitable amounts of 0.25% gelatin or water were added to control milks to correct for dilution.

RESULTS AND DISCUSSION

If our hypothesis implicating nuclear material (DNA) in the CMT reaction is correct, it is felt that the demonstration that the CMT reaction can be abolished by treatment of mastitic milk with DNAase should be sufficient evidence to show that it is DNA which accounts for the CMT reaction. That such is the case is shown by representative experiments set forth in Table 1.

It can be seen that between 100-200 μg of DNAase/4 ml of CMT-3 milk is sufficient to abolish the CMT reaction completely. We have never observed mastitic milks, regardless of the strength of the CMT reaction, in which the reaction could not be abolished by pretreatment with concentrations of 200 μg of DNAase/5 ml of milk. When this level of enzyme was added to CMT-3 milk (the same as Tube 11, Table 1), a final concentration of DNAase equivalent to 1.65 μg/ml of milk was sufficient to inhibit the CMT reaction completely. Lower concentrations of enzyme reduced the CMT score but did not abolish the CMT reaction. Incubation is not necessary for the demonstration of this effect. DNAase added to fresh milk immediately before the addition of the CMT reagent precludes the development of a positive reaction in mastitic milk.

Kay et al. (12) have shown that strong gels are formed by the addition of sodium dodecyl sulfate to various tissues in the isolation of DNA. Gels are also formed by isolated nuclei in the presence of the detergent. The description of such gels (5) markedly resembles the behavior of gels formed by equal volumes of mastitic milk and the CMT reagent when worked up in a beaker. The exact mechanism of this gel formation is little understood. Dounce feels that gel formation is due to dissociation of DNA from protein followed by hydration and swelling of insoluble DNA salts (5). Bernstein and co-workers (2, 10), on the other hand, feel that the structure of nuclear gels is due to the protein moiety, since trypsin treatment was shown to reduce the viscosity of nuclear gels. However, Cohen (4) showed that trypsin, or chymotrypsin treatment of thymus deoxyribonucleohistone increased the viscosity of the nucleohistone and suggested that the increased viscosity was due to polymerization and aggregation of liberated DNA.

Dounce et al. (6, 7) have also demonstrated that intact DNA is a requirement for the gelability of isolated nuclei, since treatment of gelable nuclei with DNAase, or isolation of nuclei in the presence of disrupted mitochondria, causes a loss of gelability. DNAase is contained in mitochondria (DNAase I) as well as lysozomes (DNAase II) (1). We have found that the addition of DNAase to the gel formed by mastitic milk and the CMT reagent causes an almost instantaneous breakdown of the gel. Trypsin, on the other hand, did not alter the

TABLE 1

Effect of incubating mastitic milk with various levels of DNAase on the CMT score

Tube		Enzyme conc. μg	Dornase units	CMT score
1	4 ml milk A + 1.0 ml 0.25% gelatin (control)	0	0	3
2	4 ml milk A + 0.1 ml DNAase + 0.9 ml 0.25% gelatin	50	3,500	1
3	4 ml milk A + 0.2 ml DNAase + 0.8 ml 0.25% gelatin	100	7,000	Tr.
4	4 ml milk A + 0.4 ml DNAase + 0.6 ml 0.25% gelatin	200	14,000	Neg.
5	4 ml milk B + 1.0 ml 0.25% gelatin (control)	0	0	Neg.
6	4 ml milk B + 1.0 ml DNAase	500	35,000	Neg.
7	4 ml milk C + 0.4 ml 0.25% gelatin (control)	0	0	3+[a]
8	4 ml milk C + 0.07 ml DNAase	35	2,430	2
9	4 ml milk C + 0.08 ml DNAase	42.5	2,965	1
10	4 ml milk C + 0.09 ml DNAase	46.3	3,233	Tr.
11	4 ml milk C + 0.4 ml DNAase	200	14,000	Neg.

[a] Milk C was the strippings from an acutely mastitic quarter and contained large amounts of pus as well as many flakes and clots.

TABLE 2
Effect of the addition of trypsin or RNAase on the CMT reaction of mastitic milk

Tube		Enzyme conc. µg	CMT score
1	4 ml milk A + 1.0 ml water (control)	0	3
2	4 ml milk A + 1.0 ml trypsin	500	3
3	4 ml milk B + 4.0 ml water (control)	0	3
4	4 ml milk B + 4.0 ml trypsin (incubated overnight)	2,000	3
5	4 ml milk B + 1.0 ml RNAase	500	3
6	4 ml milk B + 4.0 ml RNAase (incubated overnight)	2,000	3

preformed gel. In addition, neither trypsin nor RNAase treatment affects the development of a CMT-positive reaction in mastitic milk (Table 2).

Other reagents have been shown to cause gelation or increased viscosity of nuclei or of nuclear material. For example, various concentrations of NaCl have been shown to cause gelation of nuclei (5, 14), fish spermatozoa (19), or to increase the viscosity of ribonucleohistone solutions (4). When the pH of suspensions of gelable nuclei is raised above 8 with NaOH or NH_4OH, gels are also formed (7). We have also produced gels similar to the CMT reaction in mastitic milks by addition of NaCl in high concentration or of NH_4OH or NaOH (Whiteside phenomenon, 21).

Ribonucleic, but not desoxyribonucleic acid, has been reported in milk (11, 16, 18), although it is not unreasonable to assume that DNA from desquamated secretory cells may also be shed into the milk during the milking act. However, the large numbers of leukocytes and other inflammatory cells containing DNA that appear in mastitic milk must perforce elevate the DNA content to measurable levels. Mizen and Peterman (17) calculated that the DNA content/nucleus for normal splenic cells was of the order of 6.6×10^{-6} µg. If leukocytes have levels of the same order of magnitude, it should be possible to start with rather large volumes of milk and determine DNA concentrations. We are presently engaged in exploration of suitable methods for this determination. Preliminary tests have shown that reasonable recoveries of added DNA to normal milk can be achieved.

We have been concerned by the fact that the CMT reaction tends to decline on continued storage of the milks. Leukocytes contain DNAase which would be a convenient explanation for this observation were it not for the fact that leukocytes (human) also have been shown to contain rather potent DNAase inhibitors (9, 13). Catheptic activity of lysed leukocytes in aged milks may also play a role in the decline in strength of the CMT. Greenstein and Jannette (8) found DNAase in normal milks of the rat, mouse, rabbit, and guinea pig, but not in milks from the human, cow, goat, or mare. DNAase activity was also found in lactating mammary tissue. We have added various DNAase inhibitors such as citrate, arsenate, or fluoride to mastitic milk and compared the keeping quality of the CMT reaction with suitable controls. The results of these experiments are inconclusive to date, although this aspect will be pursued further. Of interest is the fact that the addition of very high levels of citrate to dialyzed mastitic milk failed to prevent the loss of the CMT reaction when the milks were treated with DNAase.

CONCLUSIONS

Investigations into the nature of the positive California Mastitis Test reaction strongly indicate that the active principle in mastitic milk is deoxyribonucleic acid, the DNA having its origin mainly in nuclei of cells constituting the inflammatory exudate. These findings add weight to the supposition that the CMT reactions are a qualitative measure of the concentration of cells in milk. While the observations to date with respect to DNA in relation to the CMT phenomenon are preliminary, the results are of sufficient significance to make them known at this stage of the investigation.

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INCREASED LACTATION RESPONSE IN CATTLE WITH THYROXINE 50% ABOVE THYROXINE SECRETION RATE [1]

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SUMMARY

Nine lactating dairy cows were injected with thyroxine daily at a level 50% above their individual winter thyroxine secretion rates during the spring and summer to determine the effect upon milk yield, body temperature, and body weight. The body pool of thyroxine was raised to its ultimate level by one injection of thyroxine at the initiation of the experiment.

One cow reached a new peak of milk yield (weekly average) during the 2nd wk, one the 3rd wk, and the seven other cows the 4th wk. The mean increase in milk yield was 27.6%, with a range from 12.1 to 67.9%.

The effect of thyroxine at this level during the summer appeared to pose no problem in heat dissipation. The elevation in rectal temperature of the experimental cows was very small, with fluctuations in treated and nontreated cows quite comparable.

The mean body weight loss was 9.7%, with a range of 3.7 to 14.2%. This loss was regained within 2 wk after cessation of thyroxine treatment.

On the basis of the observed range in thyroxine secretion rate, and the beneficial effect of thyroxine upon milk yield administered at 50% above their secretion rate, it was suggested that the level of feeding thyroprotein might be reduced from 15 g to about 10 g/1,000 lb body weight/day in the great majority of dairy cows.

The thyroid hormones, thyroprotein, thyroxine (T_4), and triiodothyronine (T_3) have been shown to stimulate variable increases in milk secretion in many dairy cattle (1, 2, 3). In the cows responding, much variation in the percentage of increase has been observed. Many suggestions have been advanced to explain the variations in response observed. Turner et al. (11) suggested that it indicates the degree to which endogenous thyroxine may be a limiting factor in the productive capacity of individual cows. During recent years, methods have been developed using radioactive iodine (I^{131}) for estimation of thyroxine secretion rate and many factors influencing the secretion rate have been determined (8). It has been shown that individual cows show a tenfold variation in thyroxine secretion rate during the winter and during the summer decline to about one-third the winter rate. Cows with thyroxine secretion rates less than optimal but with adequate secretion of other essential hormones would be expected to respond to exogenous thyroxine; whereas, cows with serious hormone deficiencies other than thyroxine would not be expected to respond.

The rate of disappearance of thyroxine-I^{131} from the blood of the dairy cow is rather slow, requiring two and one-half days for one-half of the injected dose to leave the blood (6). From this observation, the concept was developed that the body pool of thyroxine in cows is greater than the daily thyroxine secretion rate, since two and one-half days are required for the disappearance of one-half of the daily secretion.

When exogenous thyroxine in excess of the thyroxine secretion rate is administered daily, a number of days are required for the new elevated body pool to become established (6). During this period, milk secretion increases gradually as the new level is reached. The question was raised, would the milk yield increase more rapidly if body pool of thyroxine was increased by a single high injection of thy-

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roxine, followed by a constant level to maintain it at that level? Further, it was decided to administer the thyroxine to each cow at a level 50% above the determined winter thyroxine secretion rate. In none of the cows did the daily thyroxine injection level equal the highest winter thyroxine secretion rate so far observed (i.e., 10 mg/1,000 lb body weight).

EXPERIMENTAL PROCEDURE

Thyroxine secretion rates of nine cows of several breeds were determined in late winter by a technique described by Pipes et al. (5). Lactation was induced experimentally by the method described by Williams and Turner (12). The present experiment was initiated when the cows had reached their peak and had begun to decline in milk yield (20th to 24th week). Exogenous 1-thyroxine was administered to each animal at a level 50% above its winter thyroxine secretion rate (Table 1). To raise the thyroxine body pool immediately to the level it would eventually reach after a variable period of time, the amount of thyroxine required was calculated by the method described by Pipes et al. (6). The requirement was computed by determining the difference between the original T_4 body pool and the proposed elevated body pool. On Day One of the experiment this amount of thyroxine was administered, followed by the daily subcutaneous injection equal to a 50% increase above the daily secretion rate (Table 1).

The cows were milked twice daily. Rectal temperature was recorded daily and body weight was determined weekly. A high energy ration containing 80% corn was fed and good-quality alfalfa hay was available in the feed lot.

Two cows, no. 38 and 601, were used in a preliminary trial starting March 31, at the 16th and 20th wk of lactation. The seven other cows were started on July 21, at the 24th wk of lactation.

RESULTS

(a) Effect of thyroxine on milk yield. The two cows, 38 and 601, started on March 31 at their 16th and 20th wk of lactation, showed rapid increases in lactation following the injection of thyroxine. No. 38 reached an early peak during the 2nd wk. Her lactation was sustained and during the 8th to 10th wk she equalled or exceeded the early increased production. No. 601 reached her peak during the 3rd wk and continued at a uniform level throughout the experimental period (Table 2).

The seven other cows, started on July 21, showed somewhat more gradual increases in milk yield, all reaching their peaks during the 4th wk, which was then sustained at a rather uniform level. At the end of 10 wk, the mean milk yield of the cows exceeded the mean milk yield before the experiment began. The mean increase in milk yield at the peak was 27.6%, with a range from 12.1 to 67.9%, with all but one animal exceeding a 20% increase.

(b) Effect of thyroxine on body temperature. An inspection of rectal temperatures in thyroxine-treated animals revealed a gradual rise during summer (range 102.1-104.2). When compared with animals receiving no thyroxine (range 101.8-103.6), the temperature elevation was very small. Indeed, two of the nontreated animals exhibited rectal temperatures higher

TABLE 1

Thyroxine secretion rate and estimated body pool of cows injected with thyroxine 50% above secretion rate

Cow no.	Breed	T_4 Secretion rate	Body weight	50% T_4 increase/day	T_4 body pool at 50% increased TSR	Terminal body weight	Weight loss
		(mg/day)	*(lb)*	*(mg)*	*(mg)*		*(%)*
870	H	5.1	1,140	7.6	19.5	1,090	4.3
873	H	5.1	1,030	7.7	19.8	950	7.7
869	H	5.4	1,200	8.0	20.6	1,070	10.8
24	B–S	6.7	1,340	10.0	25.7	1,170	12.6
25	B–S	7.2	1,200	10.8	27.8	1,050	12.5
630	J	2.4	800	3.6	9.3	770	3.7
478	G	4.8	1,200	7.2	18.5	1,050	12.5
38	G	5.2	1,300	7.8	20.0	1,180	9.2
601	Cross J × H	3.6	900	5.4	13.9	772	14.2

TABLE 2
Influence of thyroxine 50% in excess of winter thyroxine secretion rate on milk yield

Animal no. and breed	Average weekly yield before treatment	Average daily milk yield (by weeks) during thyroxine treatment *(lb)*										
		1	2	3	4	5	6	7	8	9	10	Maximum increase in milk yield
	(lb)											*(%)*
870 H	21.6	24.6	25.5	24.8	26.6	22.9	18.1	20.0	19.6	19.2	20.4	23.1
873 H	20.6	23.8	23.3	23.7	25.4	20.2	16.0	19.2	20.1	20.2	19.2	23.3
869 H	17.0	18.0	18.8	21.0	21.8	19.7	18.0	19.2	18.2	18.6	18.6	28.2
24 B.S.	19.7	20.2	23.5	26.0	26.8	22.9	24.3	24.8	23.8	23.5	25.6	36.0
630 J	17.9	18.8	22.4	23.4	24.0	21.5	21.1	22.2	20.6	19.7	18.4	34.1
478 G	13.7	14.5	17.6	21.7	23.0	21.5	19.0	22.0	19.1	19.0	17.8	67.9
25 B.S.	26.6	24.6	26.6	30.3	32.0	29.8	31.1	30.7	27.5	26.8	27.0	20.3
38 G	23.1	26.5	28.1	27.6	26.0	25.8	27.5	27.1	28.0	29.1	28.6	21.6
601 J-H	21.5	23.6	23.6	24.1	22.8	21.7	21.4	21.0	20.6	21.8	22.5	12.1
Mean milk yield *(lb)*	20.2	21.6	23.3	24.7	25.4	22.9	21.8	22.9	21.9	22.0	22.0	27.6

than the majority of the animals treated with thyroxine in summer. The fluctuations in daily body temperatures in summer in treated and nontreated animals were very nearly comparable.

(c) Effect of thyroxine on body weight. The body weight loss ranged from 3.7 to 14.2% in the animals, and on the average it was 9.7% (Table 1). Swanson (9) has suggested that the loss in body weight is not real weight loss; rather, it is due to a reduction in gastrointestinal fill. The apparent loss in body weight was regained in less than 2 wk in all of the animals, on cessation of thyroxine treatment.

DISCUSSION

This is the first study on the effect of mild hyperthyroidism (50% above winter thyroxine secretion rate) upon the rate of milk secretion in cattle where the thyroxine level administered was related to the individual thyroxine secretion rate. The mean increase in milk yield of 27.6% attained during the summer in Missouri indicates that the maintenance of a uniform level of circulating thyroxine 50% above their winter TSR will increase and maintain elevated yields of milk at this time.

The effect of injecting thyroxine at an elevated level to immediately bring the body pool of thyroxine up to its calculated level at the beginning of the experiment showed some promise of effectiveness. One cow reached a peak in 2 wk, another in 3 wk, but the other cows reached their peaks during the 4th wk.

In an experiment by Tucker and Reece (10), where thyroprotein was fed to a group of ten cows at the peak of lactation, an average increase in milk yield of 9.9% (range 3.4 to 18.4%) was observed during 14 days. On Day One of the experiment, a larger amount of thyroprotein was fed to elevate the body pool of thyroxine, as in the present experiment. It is interesting to note that seven cows attained a maximal response before the experiment was half over and the remaining three cows reached their maximum during the second half of the 14-day experiment.

In the present experiment, in cows in more advanced lactation, there appears to be a greater time lag in stimulating increased milk secretion, even when the level of circulating thyroxine was increased at once. Thyroxine may influence milk secretion in various ways. Heart rate and blood circulation should increase rapidly. Increase in cellular metabolism of the mammary gland milk-secreting cells should be rapid also. Moon (4) has shown recently that thyroxine increases the secretion of the lactogenic hormone in the rat. Further, thyroxine stimulates the secretion of the growth hormone as shown by the lack of growth in thyroidectomized animals. The effect of thyroxine on the secretion of the pituitary hormones (lactogen and growth) may require more time and thus increase milk yield more gradually.

To resolve the problem in an unequivocal experiment, it will be necessary to compare the rate of increase of milk yield in groups of lactating cows fed thyroprotein, in one group of which the body pool would be elevated at the onset of the experiment.

The feeding of thyroprotein at the rate of 15 g/1,000 lb body weight to dairy cattle has been recommended for many years. During the past few years, the individual thyroxine secretion rates (TSR) of a number of cows have been determined (8). They show a range in TSR from 1 or 2 mg to 9 or 10 mg/1,000 lb body weight during the winter months.

Since about 10% of the thyroxine in thyroprotein is effective orally (8), the corresponding oral level of thyroprotein to equal the TSR of these animals would be 1 to 10 g/1,000 lb body weight/day. Therefore, the feeding of 15 g/day of thyroprotein to lactating dairy cows would exceed the maximum TSR of 10 mg/day by 50% and the mean TSR of 5.4 mg by about 185%. The excessive level of thyroprotein feeding has been well tolerated due, it is believed, to the increased rate of thyroxine metabolism. It has been shown, recently, that the normal biological half-life ($t\frac{1}{2}$) of thyroxine in dairy cattle was 2.47 days. When the cows in the present experiment were injected with thyroxine 50% above their winter TSR, the $t\frac{1}{2}$ was reduced to 1.05 days (7). From these data, it is clear that the animal body increases the rate of thyroxine metabolism when higher levels of hormone are administered. Thus, thyroxine in excess of necessary requirements is not harmful but is wasteful of the hormone.

On the basis of the observed range in TSR of dairy cattle, and the beneficial effect of thyroxine on milk secretion, when administration of 50% above the individual TSR was followed, it is suggested that the level of thyroprotein feeding could be reduced to about 10 g/1,000 lb body weight/day and still stimulate increased milk production in most animals of a population of cows. This level of thyroprotein would equal the highest TSR so far observed and would provide a 50% or greater increase above the TSR of animals secreting up to about 7 mg/day/1,000 lb body weight.

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THYROTROPIC HORMONE SECRETION IN CATTLE AFTER PROLONGED THYROXINE THERAPY AND AFTER COMPLETE WITHDRAWAL [1]

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SUMMARY

Seven lactating cows of several breeds were injected with thyroxine daily 50% in excess of their experimentally determined thyroxine secretion rate (TSR) for a period of 11–12 wk, and in one Holstein cow for 21 wk after the animals had passed their peak lactation. The Holstein cow also received a supplemental thyroxine treatment of 100% over its TSR for a further period of 8 wk. On cessation of thyroxine administration, milk yield decreased rather precipitously in all the animals for 10–12 days. After this period, there was a small rise in milk yield in some animals for a few days before a plateau was established. I^{131} uptake by the thyroid was determined every other day in all animals for 3 wk. Thyroid I^{131} uptake commenced 12 days after cessation of thyroxine treatment and attained normality by 3 wk. The time at which the thyroid began to show avidity for iodine collection synchronized with the time at which no further decline in milk yield was noticed after thyroxine withdrawal. It is suggested that the precipitous decline in milk yield after thyroxine withdrawal is due to subnormal levels until endogenous thyroxine secretion is re-established.

Several investigators have administered thyroprotein (thyroactive iodinated casein) in lactating cows at various stages of latation, to stimulate more intense milk secretion, and this aspect has been reviewed (1–3, 7). It is a matter of common experience that total withdrawal of thyroprotein from feed results in marked lowering of milk production in cattle. Swanson and Hinton (11) suggested a more gradual withdrawal of thyroprotein to overcome the precipitous drop in milk secretion, while Pipes et al. (6) suggested that the decline may be due to an abrupt lowering of blood and body pool of thyroxine on complete cessation of thyroxine administration. So long as thyroprotein is administered in amounts in excess of endogenous thyroxine secretion of the animal, thyrotropic hormone secretion (TSH) from the anterior pituitary is completely blocked. Upon sudden withdrawal of thyroprotein, it would presumably take some time for the inactive thyrotropic cells to start secreting and discharge of the hormone. The present paper describes observations to show that such a time lag in resumption of TSH discharge does indeed exist, and the magnitude of this lag is described.

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EXPERIMENTAL PROCEDURE

Eight lactating cows of several breeds were maintained in a dry lot under uniform conditions throughout the year, with free access to an iodized salt block. Thyroxine secretion rates (TSR) were determined in individual animals by a technique described by Pipes et al. (5). All the animals were brought into lactation artificially (12). After animals had passed their peak lactation yields, thyroxine was injected 50% above their individual TSR. In one Holstein cow, thyroxine was injected 50% above its TSR for a period of 21 wk and then 100% above its TSR for 8 wk. After the attainment of maximum milk secretion, and when the milk yield began to decline, thyroxine administration was discontinued. Three days before cessation of thyroxine administration, 100 μc of radioactive iodine (I^{131}) was injected into each animal intravenously and 24-hr thyroid uptake determined. Thyriodal I^{131} measurements were made by the method described by Pipes et al. (5). The background radioactivity count was taken in the hip region. If the I^{131} activity in the thyroid was less than the background radioactivity, thyroid blockade was indicated. Twenty-four-hour I^{131} uptake was determined every two days in each animal for a period of 3 wk. Since I^{131} uptake was determined successively every other day, care was taken to account for the residual radioactivity present in the animal at the beginning of each thyroidal uptake measurement (8). All the animals were milked twice daily.

RESULTS

When I^{131} was injected in animals prior to thyroxine withdrawal, there was no thyroidal uptake of I^{131}, as shown by a greater body count than in the thyroid (Table 1). The same situation continued for ten days after cessation of thyroxine administration. After ten days, in some animals, the thyroid began to pick up I^{131} at a rate greater than the body pickup (Table 1). By 12 days, it could be definitely said that in most of the animals the thyroid had begun to function and I^{131} was picked up with avidity (Table 1). However, it was not until 3 wk after cessation of thyroxine treatment that the magnitude of uptake had reached normal average values (Table 1).

Upon total cessation of thyroxine administration, milk yield declined daily for a period of ten days in three animals, and for a period of 12 days in the remaining five animals (Table 2). Individual maximum decline in milk yield over the treatment period (last day of thyroxine administration) ranged from 39.2–68.1%, with a mean of 51.7%. When no further daily decline in milk yield was noticed, some animals showed a slight increase for a few weeks before a plateau at a much lower level was established (Figure 1). It should be mentioned that the animals in this study were moderate milk producers and the lactation period in some animals had approached or exceeded the time at which they would normally be dried off.

DISCUSSION

The technique described for studying the activity of the pituitary and the thyroid is based on the classically described reciprocal relationship that exists between these two glands. During exogenous thyroxine therapy, endogenous TSH is blocked and the body will be dependent upon the exogenous source of supply of the hormone. The present investigation indicates that after cessation of thyroxine administration, about 12 days are required for the thyroid to begin to pick up I^{131}, which is also indicative of secretion and release of TSH. Apparently, by 3 wk after discontinuation of thyroxine treatment in cattle, thyrotropic hormone was being secreted in normal amounts, as shown by the normal thyroid I^{131} uptake. In the Holstein cow (no. 601, Table 1), although the pituitary and the thyroid were blocked continuously for a period of 29 wk, the time lag for resumption of thyrotropic secretion and thyroid activity was the same as in other animals (12–14 days). The latter observation would seem to indicate that in cattle the pituitary does not undergo advanced atrophic changes at least for a period of 29 wk under chronic thyroxine treatment. Evidence for this effect is also provided in studies where thyro-

TABLE 1

Thyroid I^{131} uptake in lactating cows under prolonged thyroxine therapy and after withdrawal

Animal no.	Breed	Treatment	Duration	I^{131} uptake (per cent administered): Two days before cessation of thyroxine	Days after cessation of thyroxine: 2	4	6	8	10	12	21
			(wk)								
24	Brown Swiss	1½ × TSR[a]	12	0	0	0	0	0	0	8	24
25	Brown Swiss	1½ × TSR	11	0	0	0	0	0	1	12	40
478	Guernsey	1½ × TSR	11	0	0	0	0	0	0	6	31
630	Jersey	1½ × TSR	12	0	0	0	0	0	3	12	30
869	Holstein	1½ × TSR	12	0	0	0	0	0	0	8	26
870	Holstein	1½ × TSR	12	0	0	0	0	0	0	10	33
873	Holstein	1½ × TSR	12	0	0	0	0	0	4	11	22
601	Holstein	1½ × TSR 2 × TSR	21 8	0	0	0	0	0	0	0.8	28

[a] TSR = Thyroxine secretion rate.

TABLE 2
Effect of thyroxine withdrawal on daily milk yield in cattle

Animal no.	Day before cessation	Days after cessation of thyroxine 2	4	6	8	10	12	14	16	18	Maximum percentage decline over the treatment period
24	23.3	19.9	22.5	22.9	21.7	14.6	12.0	12.1	12.5	11.5	50.6
25	26.0	25.5	20.0	22.2	20.7	17.0	15.8	15.7	16.7	14.1	39.2
478	16.0	14.5	13.5	11.3	9.5	5.1	5.7	6.3	7.0	8.0	68.1
630	15.3	14.7	14.0	12.7	10.7	7.8	8.5	9.3	7.1	7.1	49.0
869	15.7	14.0	14.7	14.1	13.2	10.8	8.9	9.0	8.3	9.2	43.3
870	17.8	17.0	16.5	16.8	14.2	10.0	9.7	9.0	10.8	11.0	43.8
873	18.2	18.7	16.3	14.5	12.5	9.5	6.1	8.5	7.0	9.5	66.5
601	10.5	10.0	9.0	10.0	7.7	4.9	4.0	2.3	5.2	5.0	53.3
Mean	17.9	16.7	15.8	15.5	13.7	9.9	8.8	9.0	9.3	9.4	51.7

protein has been fed for extended periods of time without any undesirable effects on the pituitary (and the thyroid) or on the animal (4).

The rapid decline in milk yield after thyroxine withdrawal was expected from several previous studies (9, 10). Pipes et al. (6) pointed out that on withdrawal of thyroxine administration the body pool of thyroxine would be diminished at an exponential rate to subnormal levels transiently until the endogenous thyroxine secretion was established. This transient low level of thyroxine may very well account for the sharp decline in milk yield observed in this as well as in other investigations on cessation of thyroxine administration. Some evidence is provided for the latter statement because of the synchronization of cessation of decline in milk yield with the beginning of I^{131} uptake by the thyroid. As mentioned earlier, the avidity of the thyroid to pick up I^{131} is indicative of the return to normality of thyrotropic and thyroid activity. It would appear, therefore, that a certain level of blood and body

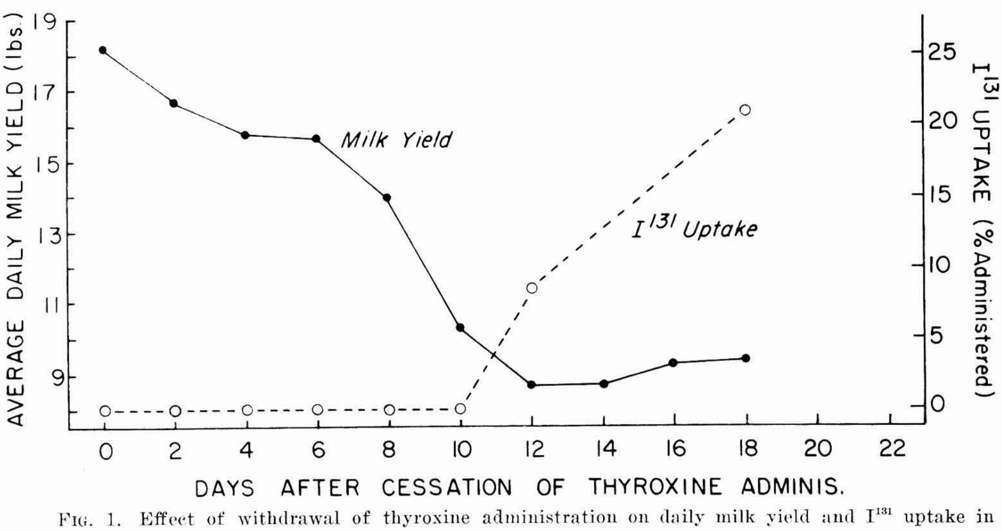

FIG. 1. Effect of withdrawal of thyroxine administration on daily milk yield and I^{131} uptake in cattle.

It will be noted that milk yield declines for a period of about 12 days, at which time endogenous thyroxine secretion is reinitiated, as shown by the increase in I^{131} uptake.

pool of thyroxine is rather critical below which level milk-secreting cells would be functioning subnormally. On the other hand, if thyroxine is withdrawn gradually, blood and body level of thyroxine would be slowly reduced, while at the same time the thyroid gland would begin to function gradually, thereby cushioning the effects of a transient low level of hormone in the body. An inspection of the data in Tables 1 and 2 does not reveal any particular breed difference with regard to time, lag, either in resumption of TSH secretion or for cessation of decline in milk yield after thyroid withdrawal.

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TECHNICAL NOTES

WHEY YEAST RAT-FEEDING STUDY

The conversion of whey waste into a potential food or feedstuff by fermentation with *Saccharomyces fragilis* has been accomplished by Wasserman et al. (2, 3). This raises the question as to whether any undesirable effects would be encountered from the ingestion of such a yeast. Recently, Bender and Doell (1) reported the absence of any harmful effects on the rat when three different food yeasts were fed at dietary levels of 21% for four to six months.

The biological value of the protein of whey yeast has been evaluated by the Wisconsin Alumni Research Foundation (personal communication). During a 4-wk period, the protein efficiency ratio decreased from 2.8 to 1.5 when rats were fed a diet containing 9% protein, contributed entirely by whey yeast in place of casein, and the average weight gain decreased from 100.3 to 50.4 g.

In this note we report the results of feeding whey yeast and brewers' yeast to rats on two different diets for a period of 90 days. The ingredients of the two basal diets are given in Table 1 (Diets 1A and 1B). The Diet B series involved a greater dependence on protein supplied by the two yeasts, which were added on the basis of contributing equal amounts of protein. *S. fragilis,* in common with most yeasts used for food purposes, is low in sulfur-amino acids. For this reason Diet 4B, containing added methionine, was included. Weanling male albino rats (five per diet) were caged together in solid-bottom cages with wood shavings as litter, and allowed free access to food and water.

Body weight gains and efficiency of food utilization data are presented in Table 2. In the Diet A series, growth was slightly, although not significantly, improved when a 20% level of either whey or brewers' yeast was added. The food efficiency ratios were unchanged. However, when most of the dietary protein was provided by the yeast supplements (Diet B series),

TABLE 1

Composition of diets

Dietary ingredients	Diet no.						
	1A	2A	3A	1B	2B	3B	4B
	[*Composition* (%)]						
Corn meal	73.0	58.4	58.4	73.0	63.0	68.5	68.0
Linseed meal	10.0	8.0	8.0	10.0	......	......	......
Crude casein	10.0	8.0	8.0	10.0	......	......	......
Alfalfa meal	2.0	1.6	1.6	2.0	2.0	2.0	2.0
Bone ash	1.5	1.2	1.2	1.5	1.5	1.5	1.5
Sodium chloride	0.5	0.4	0.4	0.5	0.5	0.5	0.5
Cod-liver oil	3.0	2.4	2.4	......	......	......	......
Corn oil	......	......	......	3.0	3.0	3.0	3.0
Vitamins A and D [a]	......	......	......	0.1	0.1	0.1	0.1
Brewers' yeast [b]	......	20.0	......	......	30.0	......	......
Whey yeast [b]	......	......	20.0	......	......	24.5	24.5
DL-Methionine	......	......	......	......	......	......	0.5
% Protein (calculated)	17.1	21.9	23.5	17.1	17.5	17.8	17.8

[a] 2,500 I.U. Vitamin A palmitate and 300 I.U. Vitamin D_3 per 100 g diet.
[b] Protein content of whey yeast $(N \times 6.25) = 49.1\%$; brewers' yeast $= 40.5\%$.

TABLE 2

Growth and food efficiency of rats on whey and brewers' yeast diets for 90 days

Diet no.	Supplement	Mean body weights (g) Start	Mean body weights (g) Gain ± std. error	Food efficiency Wt. gain/food intake
1A	None	38.6	243 ± 14.1	0.23
2A	Brewers' yeast	39.5 [a]	259 ± 11.6	0.23
3A	Whey yeast	38.6	263 ± 9.7	0.23
1B	None	36.6	255 ± 6.0	0.23
2B	Brewers' yeast	38.4	196 ± 6.0*	0.21
3B	Whey yeast	38.2	230 ± 8.2**	0.22
4B	Whey yeast + DL-Methionine	38.6	231 ± 9.7	0.21

[a] One rat died on 25th day.
* $P < 0.01$; ** $P < 0.05$.

growth was significantly reduced, possibly due to an imbalance or inadequate amount of certain amino acids. It was anticipated that methionine would be the most limiting amino acid but, when methionine was added, no response in growth or food efficiency resulted (Diet 4B, Table 2).

All rats were autopsied at the end of the 90-day feeding period, examined grossly, and tissues saved for histopathological study. The only questionable abnormality noted by Dr. W. E. Ribelin, the veterinary pathologist who examined the slides, was the presence of yeast cells in the stomach and gland crypts of three out of five rats ingesting the whey yeast diet (3B). However, the presence of viable yeasts in the gastric glands of control rats was also observed.

There was no evidence of any toxic factor in whey yeast produced by growing *Saccharomyces fragilis* on milk whey. For optimum rat growth, both whey and brewers' yeast proteins require supplementation.

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USE OF DIGESTIBLE DRY MATTER BY DAIRY COWS GROUP-FED SILAGE [1]

Our current feeding standards for dairy cows were gained from research done near the turn of the century with stall-fed cows, under feeding conditions quite different from those practiced by our present dairyman. This is particularly true for dairymen in the southeastern United States, where cows are group-fed hay and silage, with only limited attention being given to the special needs of individual cows. Few efforts have been made in recent years to recalculate feeding standards and these have led to controversy.

Reid (5) presented data indicating that the TDN requirement for producing a pound of 4% FCM increases at higher levels of milk production, but Huffman (3) was unable to find this decrease in efficiency up to 20,000 lb of milk per cow per year. Wallace (6) reported that the TDN requirement for maintenance of 1,000 lb body weight was 12.9 under free grazing conditions in New Zealand, but Corbett (2) was unable to find a similar increase during strip-grazing compared with indoor feeding. In a later study, Wallace (7) stall-fed cows with freshly cut grass and obtained the requirements shown in Table 1. It seems logical that the method of feeding may influence at least the maintenance requirement and, for this reason, data from silage feeding studies conducted at this station were used to measure the relative use of digestible dry matter from group-fed silages for milk production, maintenance, and live weight gains.

EXPERIMENTAL PROCEDURE

Data from feeding trials with 35 direct-cut silages made from a variety of crops and stored with several common silage additives were available for study. The silages were all harvested at the optimum state-of-maturity for this area and were fed as the sole roughage in the ration. Grain was usually fed on a grain-to-milk ratio of 1:4. Feeding trials were 28 days in length and silage was group-fed to four or five cows per treatment. The data were analyzed by multiple regression analysis, using an IBM 1650 computer and routine multiple regression programs.

RESULTS AND DISCUSSION

The resulting requirements for production, maintenance, and weight gains are shown in Table 1, along with similar data from New Zealand and Morrison's standards. The 0.28 lb TDN required per pound of FCM is somewhat lower than that reported by other workers. The lower value may represent the frequently observed increase in efficiency of milk production from silage dry matter due, apparently, to the volatile acids present in silage. The maintenance requirement is similar to Wallace's (7) value for stall-fed, part-time-outdoors animals and somewhat larger than Morrison's standard. The requirement for live weight gain is similar to

[1] Georgia Experiment Station, Journal Series 425.

the New Zealand value. The data suggest that group-feeding increases the maintenance requirement above that of stall-fed cows, but has little influence on the feed required for milk production or changes in body weight. When the data were examined by multiple regression, 41% of the variation in intake was accounted for by maintenance, 21% by milk production, and 11% by changes in body weight.

To determine the usefulness of the data in predicting digestible dry matter intake at various levels of dry matter digestibility, the residuals from calculated minus actual intakes were correlated with per cent digestible dry matter in each of the silages. The resulting regression was $Y = 21.96 - .348\ X$ ($r = .85$), where Y is the residual and X is the per cent digesible dry matter. The equation shows that the values in Table 1 overestimate the consumption of silages below 64 percent digestibility and underestimate the intake of silages above this value. At a dry matter digestibility of 58% the average dry matter intake was overestimated by 1.8 lb per day, whereas at 70% digestibility intake was underestimated by 2.4 lb per day. Wallace (7) found similar trends in his studies of stall-fed forage. This finding is of particular interest, since it is quite similar to the observation of Conrad et al. (1), that intake was significantly influenced by digestibility up to 66%, but, above this level, intake followed a pattern with respect to metabolic size and production.

From these data and results previously published by McCullough (4), a reasonable goal in making silage to insure good intakes by dairy cows would be the production of a silage having at least 65% dry matter digestibility and 24% dry matter. This will not insure high levels of milk production, since animal performance is also influenced by ration balance and other factors, but it should provide optimum conditions for dry matter intake. Future research may provide the necessary information for adding other optimum requirements.

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Georgia Experiment Station
Experiment

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TABLE 1
Comparison of allowances proposed for milk production, maintenance, and live weight gain

Feeding standard	Environmental conditions	TND required for: Production (lb FCM)	Maintenance (1,000 lb cow)	Pound weight gain
		(lb)		
Wallace (6)	Free grazing	0.36	12.9	3.00
Wallace (7)	Stall-fed, part-time-outdoors	0.36	10.1	2.08
Morrison	Stall-fed, indoors	0.32	7.9	......
Georgia	Silage, group-fed	0.28	9.5	2.10
Range of data in Georgia study		19–47 lb/day	900–1,350	−0.7 lb to +3.0

Symposium: Education for Leadership in Dairying in Latin America[1, 2]

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This symposium was organized by the International Relations Committee of the American Dairy Science Association to promote better mutual understanding of educational problems, needs, and opportunities in dairying throughout the Americas. The program was developed on the assumption that the key to a more important and progressive dairy industry in the future in any country is a better supply of well-trained people to provide the leadership needed in all aspects of dairying. There is general agreement that among the developing countries of the world the most underdeveloped science is animal science. Latin America is no exception and if dairying is to become important greater emphasis must be given to education in dairying to provide the leadership needed for this development.

Because dairying covers such a broad and diverse discipline it was decided to restrict this symposium to dairy production; therefore, relatively little time will be devoted to dairy processing and manufacturing.

Our speakers and discussants from Latin America are outstanding leaders in education and research in dairy production; others are well-known dairy leaders from the United States who have lived and worked in Latin America. We have asked them to explore their subjects from every angle based on their wide experiences and observations, including the following:

An analysis of the major problems and what is now being done to meet the education needs for leadership in dairying in Latin America.

What are the most important things that Latin American leaders in education can do to solve their problems? What training is needed to do the job? Are a sufficient number of dairy leaders being trained?

Should more and stronger departments of animal and dairy husbandry be developed in the colleges and universities? Are there qualified people to staff such departments?

Are the Latin American students trained in the United States coming up to expectations in meeting the needs? If they do not measure up, why not?

What should a professor or scientist know concerning the culture, language, traditions, etc., before he goes on an assignment, temporary or otherwise, to Latin America?

Are there career opportunities in Latin America for North American college graduates with majors in dairy production—considering students from Latin America and the United States?

We hope that our speakers can enlighten us on these questions, and many others, and thus contribute to our common understanding of problems and how they may be solved to insure an adequate supply of leaders needed for agricultural sciences in the years ahead.

[1] The American Dairy Science Association acknowledges the generous support of the Rockefeller Foundation, 111 West 50th St., New York 20, New York, in providing travel grants for some of the Latin American participants in this symposium.

[2] Presented at the 57th Annual Meeting, American Dairy Science Association, University of Maryland, College Park, June 17–21, 1962.

EDUCATION PROBLEMS IN DAIRYING IN LATIN AMERICA

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In a broad sense, universities in Latin American countries have not played roles similar to those of United States universities in the technological development of the country. Integrated development plans should start with universities to ensure a consistent source of well-trained technicians, who in turn will be responsible for carrying out the different phases of the development program. Furthermore, the basic problems inherent in the natural development should be investigated at the university level where scientific attitudes and technical abilities prevail.

Traditionally, Latin American universities have devoted their main interest to Humanities. It is difficult to establish whether this has been the result of a keener interest of students in this field or whether it actually was the determining factor in keeping most of the students away from the undeveloped technological sciences. The fact is that in Latin America, with very few countries as an exception, only small groups of students have been engaged in agricultural studies.

Thus, the relatively small demand from Latin American students, the little recognition received from government agencies, together with the absence of rapid national growth, have been responsible in the past for the lack of develop-

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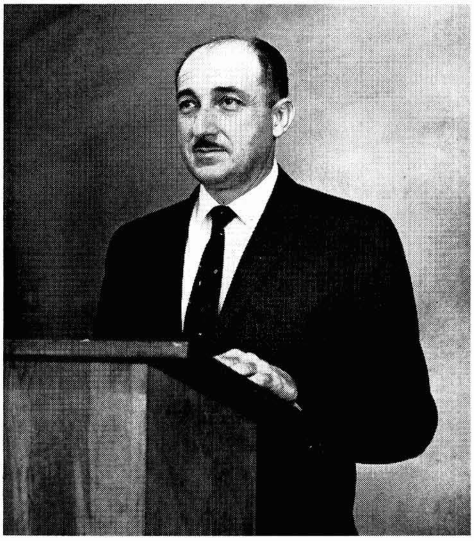

Ferruccio Accame

ment of agricultural colleges.

Dairying has been no exception in this respect. It has faced and is still facing an urgent need for improvement in college teaching and research.

To discuss comprehensively the problems encountered, it is necessary to review briefly the conditions under which dairying takes place in the other republics of the Continent.

Let it be pointed out, in the first place, that it is not fair to refer to the 20 Latin American republics as being one large unit or group. Their geographical distribution is so extensive that there are extreme differences in environment. Tropical or arctic weather, jungle or desert, grazing areas located at sea level or at 13,000 feet of altitude, flat plains or gigantic mountainous chains, regular jet plane schedules or mule's back transportation, modern city dwellers or stone-age uncivilized tribesmen, all are actually existing contrasts. Differences are obviously too great! However, there are still important points in common among them.

Conditions under which dairying is developed. The training of leaders in dairying should cover all conditons under which this activity will take place. The lack of development in most countries and the socio-economical structures to be found in them result in a very low purchasing capacity of the people. Potential markets are small and their growth is further impaired through difficulties in processing, storage, and transportation of dairy products. In addition to this, poor labor efficiency and the absence of adequate production techniques result in an extremely high relative value for milk: about 1/4 to 1/5 of an average labor day-wage per quart throughout Latin America.

College conditions as a background for teaching for leadership. Because local governments have given so little recognition to the importance of universities and colleges, a vicious circle has developed: inadequate financial support meant that many professors could teach only on a part-time basis and in turn had no time for either research or extension work. Curricula were designed to provide only one professional degree, and covered a wide area of training that was very shallow in depth of specialization. With this kind of background, it is not surprising to find veterinarians engaged in a continuing dispute with agricultural graduates on the question of which group should work in animal production.

Basis for teaching leadership in dairying. With fast development taking place in the Western Hemisphere, Latin American countries are living today the same experiences that the United States had many years ago. It is obvious now that universities must receive more attention from the governments of their countries, in view of the role they have to play. Fortunately, Latin American colleges have kept alive the seed of renewal and development in spite of their shortcomings. Now that the environment has become more favorable, the will for improvement has become activated and most of them are progressing.

The most important changes to be introduced are related to staff and teaching facilities. Others could be considered as a natural consequence of the former and refer to curricula, condition and activities of the staff, scholastic requirements for students, and development of national conditions connected with dairying.

Considering that 15 yr ago the Universidad Agraria at La Molina was fairly representative of many other agricultural colleges in Latin America, I should like to describe its attempt to develop a stronger course in dairying and related fields.

A. *Staff.* In 1947, the Agrarian University at La Molina, which was called at that time the National Agricultural College, had only three professors engaged in teaching animal husbandry. All of them were on a part-time basis and taught production courses, fundamentals of livestock diseases, and the main animal product processes. None of them had any graduate training.

It was believed then that the starting point in a development program to improve teaching in animal husbandry (dairying included) was to increase the number of staff members on a full-time basis and to increase the number of those with higher academic training in specialized fields. During the past 15 yr the Agrarian University has been able to achieve these goals in the animal science fields. It has at present a total staff of 30, 25 of whom are on a full-time basis; three have a Ph.D. degree, eight have a Master's degree, five have received specialized graduate training abroad but have no academic degrees, and one is about to receive his M.S. in the United States. In addition, two professors are ready to begin work leading towards the M.S. degree, and one is about to start working towards his Ph.D.

This considerable change has been possible only because of the increase in the number of full-time professors. They were eligible to receive fellowships supported by the different foreign governments or foundations sponsoring programs of this nature.

Several major problems have been encountered in reaching this goal. Age was a limiting factor. Experience shows that once they reach a certain age, many well-qualified men find it nearly impossible to undertake graduate studies leading towards a degree. Economic and family situations are largely responsible. Whenever this circumstance was met, the procedure followed was to appoint promising young members to the staff, who eventually had the opportunity to receive the graduate training desired. In some instances, vacancies created by professors who left La Molina for graduate work elsewhere were not filled, because it was difficult to replace these men during their absence. When no other regular staff member is in a position to absorb this additional work, the possibility of obtaining a foreign specialist through appropriate channels should be explored. I realize that language might be a serious problem in using this solution.

Actually, the most important setback met in developing this training program was the language barrier. Before being accepted at any foreign graduate school, fellows-to-be are expected to have a minimum proficiency in the language of the country where they are to study. Most of our professors were able to overcome this difficulty through hard work for several months before they left. However, some others, for one reason or another, have not been able to acquire this minimum knowledge of the foreign language in spite of obvious ability in their particular fields. La Molina is sponsoring an in-service period of language training that should be very helpful to those preparing for study in foreign countries.

The training program has also involved yearly appointments of a few new young members to the staff to act as assistants while they obtain experience and training. It has been extremely successful, since it has enabled us to create a group of specialized men in almost every field.

The employment of full-time professors, and the additional training acquired by many of them, made it possible to initiate several years ago a strong research and extension activity in various fields of the animal sciences. At present, the La Molina group is the strongest research unit in Peru, and probably in Latin America. This is particularly true in the field of animal nutrition. The activities initiated in animal breeding (artificial insemination, cow-testing program, herd books, dairy cattle expositions, etc.) have changed the physiognomy of dairy herds in the country and have introduced the breeding of purebred cattle. Nutrition and feeding projects for dairy cattle have permitted a higher, more efficient, and more economical milk production in the main dairy sheds, as well as the development of a vigorous feed-lot industry using dairy cattle as the basic source of livestock. Finally, research in dairy technology has facilitated the establishment of cheese manufacturing plants and the setting up of milk regulations.

B. *Teaching facilities.* Staff has been thought to be the most important need in developing academic activities at the Universidad Agraria. However, staff by itself cannot achieve miracles without a minimum of facilities to carry out a good teaching program.

The library has been a major problem and one that has not yet been fully solved. Books, journals, and other publications printed in Spanish are very scarce, even more so in the field of dairying. Books originally written in Spanish are almost nonexistent and most are not up-to-date. Those books that have been translated into Spanish usually have new editions in their original language before they become available to us. The use of libraries is, therefore, actually restricted to bilingual professors and cannot be used effectively to develop interest and initiative among students.

Many of us have asked ourselves why is it that a center for translating books and journals has not been established. It would render an important service to all of Latin America. This organization might also find some publishing channels that could offer publications at a price low enough to make them available to the large majority of students. At present it would be impractical to ask students to purchase a textbook for every course, because of financial limitations.

The Universidad Agraria has recently set up an agreement with the Government Experiment Station through which the university and the station libraries will be merged under a single direction. The unified library will serve both institutions simultaneously. It is hoped that through this scheme a better service to everyone will be available.

Other very important academic requirements are laboratories and demonstration farms. Laboratories are lacking not only for the study of dairying but also in supporting fields such as chemistry, physics, biology, and physiology. La Molina has been fortunate enough to attract interest from foreign institutions during the past several years. Through grants from foundations and from government agencies, we are in the process of enlarging considerably our laboratory facilities, in both the basic and applied fields. A good general laboratory for milk analysis has been equipped, thanks to a Rockefeller Foundation grant. Some butter and cheese processing equipment has been obtained through local gifts and direct purchases. A 50-head dairy herd has been built up through the past 10 yr with the assistance of the Peruvian government agencies and with funds established by U. S. Public Law 480. This herd had the largest and second-largest herd production average within the cow-testing program in the country in 1959 and 1960, respectively. Our dairy farm has modern hand- and machine-milking facilities and a very good feed room in which we can prepare any experimental rations. All of its other installations were designed especially for the Peruvian coast environment. Calving pens, calf nursery, corrals, bull pens, milk room, etc. have been used extensively by farmers as models.

The operation and development of this farm have been established on a commercial basis, so that sales of cattle and other products provide all funds necessary for its operation and improvement, at no extra cost for the University. This same method is being used to acquire dairy processing equipment to support teaching and research, in addition to grants that are being sought from other agencies.

Here again, cooperation with the Peruvian government agency responsible for agricultural research will provide financial support for the same purpose. Perhaps it should be pointed out that in most instances grants from foreign foundations and other sources are given only for equipment, with the understanding that the institution will provide the building to house it. This is too much to ask from any Latin American university, because they are now engaged in a general development program similar to the one at La Molina. This means that they are fully absorbed in many problems and are in no position to afford investments of this nature. Assistance is needed that is subject to little or no restriction, at least to those institutions that have shown a definite wish to develop and progress.

C. *Academic aspects.* The Agrarian University has made it a point to stress research by the staff. This is something new for many Latin American countries, but it is essential if improvement in teaching is desired.

The increase in staff members with advanced academic degrees, together with the development of research, has made it possible to attempt the local establishment of a graduate school. Foreign philanthropic foundations have encouraged this project because it will play a major role in turning out selected groups of better-qualified technicians who can be called upon for future staff expansions or to man other teaching and research institutions in the country. At the same time, this school will strengthen the teaching of basic sciences within the college.

Special attention has been given by La Molina to establishing a production curriculum which includes dairying, and possibly also the processing of animal products. It was felt that those graduates who were designated as agronomists were no longer properly trained to cope with the specialized problems met in Peru. In addition, the field of veterinary medicine is so wide and important in its medical implications that veterinarians should not be expected to do production work. The work of both the agronomist and the veterinarian should complement that of the animal husbandryman as a new profession in Peru and in Latin America. The expansion to come in the country during the near future calls for all of them and there are ample opportunities for animal husbandrymen, agronomists, veterinarians, and food technologists.

I believe that a solid basis in general sciences should be given for all animal production studies. With the limited resources available now, it is only natural to concentrate in a general basic strengthening of sciences and to include dairying in the curriculum of animal husbandry. This is in accord with current trends in the United States. In our plan more emphasis has been given to applied aspects than is common in the United States. The reason lies in the fact that Latin American graduates will not find the same possibilities as in the United States to pick up the application of principles at well-organized and modern equipped establishments. On the other hand, they are expected by industry to master this kind of activity upon graduation. Fortunately, the 5-yr curriculum provides the opportunity to strengthen the basic sciences, to devote special attention to applied courses, and still leave time to inspire in all graduates a healthy interest in Humanities and social problems frequent in this part of America.

La Molina has also been successful in developing a close and strong interdepartmental coordination, so that each department or faculty is concerned only with the teaching of courses in its own field of activities. It is rather a unique situation in Latin America, where every faculty or department usually offers all of its courses contemplated within their curriculum. This creates duplication of activities between faculties and a very poor use of the limited funds available.

I believe that the program outlined above has been successful in up-grading the instructional program at the Universidad Agraria and in improving the quality of our graduates in dairying and in other animal and plant sciences. Further improvement at La Molina will depend upon continued increase in the graduate training of its present and future staff, the application to teaching of research and extension work, and the improvement of laboratories and demonstration facilites through cooperation with other Peruvian official agencies.

I feel that this program can be easily adapted to conditions in other countries of Latin America. The experience gained by the faculties of universites will enable them to understand, solve, and apply to teaching the nature of local conditions under which dairying takes place.

DISCUSSION

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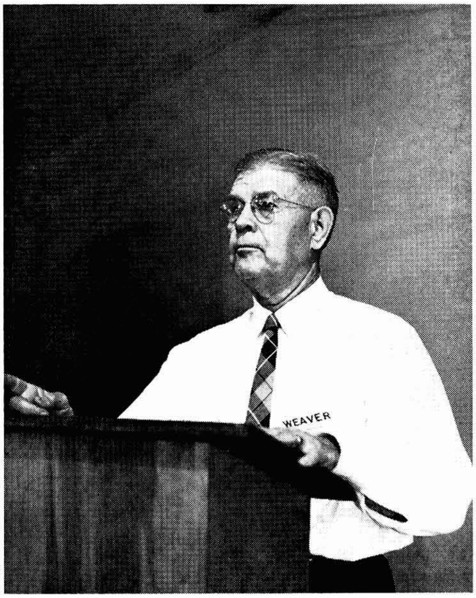

Earl Weaver

All of us, I am sure, recognize that this paper by Dean Accame is an excellent one; we congratulate him. His paper has reminded me of major educational problems, which I know from experience, exist in Colombia. I shall comment on these.

Dean Accame indicates, as his first problem, that ". . . in Latin America, with very few countries as an exception, only small groups of students have been engaged in agricultural studies."

I can testify to the fact that Colombia conforms to this generalization. In 1956, the second year of our assignment in Colombia, results were reported on a survey to ascertain the choices by high school graduates for their desired university majors. The survey involved a questionnaire to each of 3,891 high school graduates; replies from 70% of them were received and tabulated. The following indicates the percentages of the responding students who intended to elect the various majors: medicine, 21%; engineering, 16; law, 10; army, 8; architecture, 7; agriculture, 3; chemistry, 2; economics, 2; veterinary medicine, 1%.

[1] Professor Weaver is a past president of the American Dairy Science Association. He spent several years in Colombia as leader of the Michigan State University ICA contract team working with the Colleges of Agriculture at Medellin and Palmira.

Of course, I am not sure whether a comparable survey in the United States might reveal a higher or lower percentage who intend to study agriculture. I am sure the figure of 3% is not adequate to provide the agricultural or dairy leadership that Colombia needs.

Here I intend to make four observations on this question of agriculture enrollment as we observed it in Colombia. Vast numbers of influential men bemoan the low enrollment in agriculture and then proceed to do little, if anything, about it. Seldom are effective programs of student recruitment planned and completed.

My second observation relates to an almost unbelievable tendency toward some organized effort to forestall recruitment of new students in agriculture. Many university students resist such recruitment; evidently, they intend to avoid too much competition for available jobs. The Asociacion de Ingeniero Agronomos—the presumed agricultural leaders—has on occasion implied or expressed its official opposition to an increase in agricultural students, who on graduation could compete for their jobs. Even some university teachers are not sympathetic to student recruitment. In too many cases the teachers have no duties except to meet classes; additional students would increase the teaching load.

My third observation is that student recruitment in agriculture can be successful. From Dean Accame's paper it is evident this has been accomplished at La Molina. It was done in Colombia. Between 1955 and 1959 the number of students was more than doubled at the two colleges of agriculture at Palmira and Medellin.

A fourth observation will appear somewhat discordant here. Some of you will not agree with my belief and observation that short-course training can provide considerable effective leadership in most fields of dairying. Most of us seem to think that training for leadership has to come only at the university level. I urge that we forsake some of our traditional academic image and admit that short-course can provide some elements in leadership that otherwise could never be developed nor utilized.

This thought encroaches somewhat on topics assigned for other papers for this symposium; for that I apologize. On the other hand, this tendency among educators—in the States as well as in Latin America—to discount short-course training constitutes a problem; and our immediate topic here relates to educational problems.

Then I wish to comment on another education problem which exists throughout Latin America. It's the dictatorial powers which university students have usurped in the conduct of the universities. Because of the menace of student demonstration and strikes, university administrators often surrender their authority in curricular and personnel matters and in all policy actions. They fear to take disciplinary action against the few offenders who rejoice in leading others against authority. Fortunately, students in agriculture are less prone to the escapades than are those students with other majors. But the entire situation is a problem and handicap.

In my second annual report in 1957, I incorporated the following:

"University education in Colombia will be handicapped as long as the University and the Facultades are run by ill-advised, rabble-rousing young men who aspire to a crusader's role."

There is another situation in Latin America which I feel constitutes a problem. All of us endorse graduate training for university teachers whether they may serve in Latin America or in the States. But it is regrettable that a teacher in Latin America usually has to contemplate his graduate study in some foreign country. As Dean Accame has stated so effectively, the foreign study usually entails serious personal problems in respect to finances, the language, and family situations. The problems exclude too many potentially good teachers. It is conceded that foreign study is broadening and usually valuable; I'm sure it is not always worthwhile.

Latin American countries must develop their graduate programs as La Molina has done. Colombia is progressing effectively in this direction at the present time. Other countries are at work, too.

My last comment is not related to students nor to matters of training. It's on the organization of the universities. In Colombia we were assigned to the two Colleges of Agriculture of the National University. The University is at Bogota, the national capital. One of the colleges is at Palmira, in the state known as the Valle; the other at Medellin, in Antioquia. The longer I worked in Colombia the more I was convinced the colleges would have fared better if each had been a part of its state university rather than a part of the huge university of Bogota. From Bogota the distant Colleges of Agriculture receive too little recognition and support and too much jealous opposition. If these colleges might be identified as parts of their state universities, through state pride they could enjoy more local support, both financial and otherwise.

DISCUSSION

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1. *Some major factors affecting agricultural production in Latin America.* In dairying, as well as in the other animal sciences, our goal is increasing production both in quantity and quality. The proper solution to the formal educational problems affecting these disciplines is mandatory. However, we must realize that to obtain a real and substantial improvement it will be necessary to consider other major factors.

The development of agricultural progress in Latin America has been inhibited by many complications that have to be overcome to achieve higher production. Among these we can mention the following most important factors:

Technological factors

a) Lack of modern technology, at both farm and industry levels.
b) Failure to make full use of available arable land.
c) Poor transportation, processing, and marketing facilities.
d) Lack of technical assistance to farmers through a well-organized and efficient extension service.

Economic factors

a) Poor credit facilities.
b) Land-holding systems which restrict improvements in production.
c) Price control systems which discriminate against agriculture.
d) Uncontrolled importation of dairy and other agricultural products.
e) Lack of capital for agricultural development.
f) Low wages earned by some farm laborers.
g) Lack of support and means for research and education in agriculture.

The measures adopted toward the solution of these problems will greatly benefit the agricultural education and the food production in Latin America.

2. *Professional, technical, and general education in agriculture in Latin America.* In the 20 republics of Latin America, agriculture is the predominant activity despite the development of industry and mining. Nevertheless, the number of professional men and technicians in agriculture is extremely limited, considering the requirements of the region.

This paradoxical situation has two main causes: In the first place, the colleges of agri-

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Hernan Caballero D.

culture have been left behind in their human and financial resources, and secondly, the students have not always been provided with adequate opportunities for performing effective work after graduation from these colleges. This is apparent from the fact that the prospective university students have shown little interest in agriculture and related fields.

Our universities, and especially our colleges of agriculture, need more funds and more well-trained, full-time professors to be more effective in teaching, research, and the development of the animal sciences. In some of these colleges it will be necessary to carry out substantial changes in their traditional systems of organization and teaching. Agricultural education should be conducted through more efficient, scientific, modern, and practical channels, thus providing the student with a solid knowledge of the basic sciences and with a better and deeper understanding of the professional courses, among which we may point out dairying.

In this line it is considered advisable to separate the dairying and the other animal sciences from both agronomy and veterinary training. This will lead to the solution of many problems that are actually interfering with a proper education in dairying and the rest of the animal sciences. In Latin America these disciplines are lost professionally between the schools of agronomy and veterinary medicine.

We must insist on improving the level of education in basic sciences in the colleges of agriculture. The professional man trained in animal science will not perform a satisfactory job in research and animal production unless he has been properly trained in chemistry, physics, mathematics, biology, and physiology. In this respect, we must remember that in Latin America there is an urgent need for research in dairying and the other animal sciences.

It may be of interest to relate that to raise the level of education of the basic sciences, the University of Concepcion, in Chile, has recently created four central institutes of chemistry, physics, mathematics, and biology. These institutes perform basic scientific research, and impart education and training to all university students who need these basic sciences. Many advantages have been obtained from the use of these facilities, among which are the following: (1) improvement of teaching in the basic sciences, (2) promotion of scientific research, (3) economy and more efficient utilization of laboratories and equipment, and (4) better and more specialized libraries.

Considering now the urgent need in Latin America for well-trained personnel in dairying and animal science, it will be advisable to establish a few well-equipped centers for research and for advanced training. In these centers a high level of technical and scientific instruction could be offered in the different fields of animal science. Since in Latin America many of the problems affecting animal production are common to all countries, these centers will not only benefit the country in which they are located but will also spread their benefits throughout Latin America. They could be organized and developed as in the North American land-grant college system.

In Latin America, it may be noticed that the few experts actually working in dairying and animal sciences do not have enough communication among themselves. In this respect, the formation of a Latin American Society of Animal Science will be highly beneficial. This might lead also to the establishment of a publishing center where the research workers could make public their findings.

The improvement of education in dairying and the other animal sciences at the university level does not represent the complete solution to the problem, however. It is necessary to consider the education and training of the personnel at other levels. This will require more special training centers that could supply the necessary instruction and training to professionals, farmers, farm operators, foremen, and farm workers. We must consider also the improvement of agricultural teaching and instruction at various school levels. Moreover, the consumer must be educated to appreciate and demand a good product. In many Latin American countries the consumption of dairy products is rather low. This is due, sometimes, to insufficient or low-quality production, but in other cases to consumers' habits. Through educational programs and well-organized campaigns it will be possible to raise the demand for good-quality dairy products. This, in turn, will encourage production.

3. *Final considerations.* When we speak of the problems facing Latin American education in the agricultural field, it is difficult and sometimes impossible to generalize, because of the diversity of conditions which exist in different countries. It must be emphasized that there are exceptions to the observations presented here, but, in general, they portray the situation in Latin American agricultural education, and especially that concerning dairying.

Today most of the Latin American countries are awakening to the urgent need for greater development in the various fields of production, especially agriculture and industry.

During recent years some progress has been made; however, this growth has not always been sufficient and harmonious. In this respect, agriculture has been in almost every case relegated to a very slow process of development.

The existing situation has not furnished a favorable environment for the development and progress of education in agriculture. I believe that very little progress will be achieved in this respect if we do not have the understanding and cooperation of the governments, the farmers, and the communities to place agriculture on an equal footing with the other production activities of Latin America. Only in this manner will Latin America overcome the acute problems arising from our insufficient food production.

TRAINING NEEDED FOR LEADERSHIP IN DAIRYING IN LATIN AMERICA

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Jorge de Alba

The views expressed in this paper are the product of the author's long-standing preoccupation with the problems of training Latin Americans in the field of animal production.

[1] Professor de Alba is a native of Mexico and is a graduate of the University of Maryland. He obtained the M.S. and Ph.D. in animal physiology at Cornell University. Before assuming his present position he managed cattle ranches in Mexico.

As far as possible, these ideas are based on objectively observed facts.

In essence, these views express two main lines of thought: First, training for leadership in animal production can be accomplished in Latin America more effectively and forcefully than by the colleges doing it. The situation can be much improved if outstanding teachers are given the essentials of stability, continuity, and opportunity for research. Thus, they can maintain an understanding of the ever-changing scientific field.

A second problem is that although many outstanding young men are needed by colleges and experiment stations in Latin America, few of them are able, because of financial, or administrative difficulties, to prove the worth of the new trainees. Despite the excellence of their background, the new trainees must fit themselves into situations where progress is often impeded by traditions or financial limitations. They must be pioneers not only in their technical fields but in human qualities as well.

However desperate may be our efforts to bring about a change, it will be slow and painful. Despite the ample field and the multiple theoretical opportunities for work, many of our best trainees are going to find it very difficult to locate suitable jobs where they can develop to their expected potentials.

The pattern as it exists now. Even though each Latin American country has its own peculiarities, there is a general pattern of development that applies everywhere almost equally. Most of them have facilities for teaching in agriculture. Some of the institutions were founded almost a century ago; many are more than 50 yr old. A study made by FAO and the Inter-American Institute of Agricultural Sciences revealed there were 46 colleges of agriculture in Latin America in 1957 and more than 60 today.

Many of the early colleges were founded under French and Belgian influence, and were usually government-sponsored, but only recently have become a part of university systems where some leadership in dairying is now being provided. But a cursory examination reveals that, as far as dairying is concerned, the training offered is deficient. Of the 60 agricultural colleges the author is acquainted with 21, only two of which have facilities for dairy manufacturing work. Among the others, facilities and budgets for dairy research are almost nonexistent. Only two have published specific papers on research findings in dairy production in the last 5 yr and no publications on dairy manufacturing have appeared in the last 10 yr. The pattern is similar if we include publications from schools of veterinary sciences.

Specialization is not offered in the Latin American agricultural colleges. Typical is the Ingeniero Agrónomo degree, which is granted on completion of a single type of general curriculum followed by all students for 5 yr. The present tendency is toward a slight amount of specialization. For example, in a questionnaire about specialization, used in Chaparro's study and answered by professors, students, and alumni, animal production was recognized as one of the most desirable agricultural majors. However, only nine of the 148 people who filled out the questionnaire mentioned dairying as a separate major from animal production. Animal husbandry occupied 11.1% of the time of students enrolled in agricultural colleges in 1955. Of 21 colleges that gave details about their animal husbandry courses, only six were giving courses in dairying. Dairy manufacturing courses were not listed separately by any of the colleges. [Chaparro, (2).]

From this brief look at the situation, it is obvious that the educational system is doing little to provide leadership in dairying in Latin America. It might not be so serious if the state of economic development were such that there were no demands for changes in the dairy industry. But such is not the case, for industrial development and rapid increases in the population of Latin American cities are creating a strong demand for quality dairy products. Many Latin Americans are investng in equipment for dairy manufacturing. The author knows of at least ten attempts to establish modern dairy processing plants in cities of Honduras, Mexico, and Colombia that failed completely for lack of technical knowledge on the part of the operators. Frequently, the dairies have survived and are operated either by European-trained plant managers or by local people who have learned the essentials through trial and error.

In one of the richest countries in South America, the largest dairy manufacturing and distributing firm, which owns many pasteurizing plants and a huge collection and distributing system, employs not one man trained specifically in dairy manufacturing. Some of the huge losses that have been incurred from time to time by this company are compensated for by the large price differential paid by the consumer. It might not be amiss to mention that this large company is North American–owned. In all cases where manufacturing establishes itself on a purely commercial trial and error basis, frequently protected by laws that prohibit the sale of unpasteurized milk, the relations between producers and manufacturers are strained. Wherever state regulations for the sale of milk are enforced by people with no knowledge of dairy production, the friction that ensues is especially evident, and cooperation from the producers is highly jeopardized.

Obviously, a new type of leadership is urgently needed for the dairy industry in Latin America. Some tentative solutions have been put into operation that are worthy of close examination. Outstanding among the solutions tried are the attempts at technical assistance and the training of Latin American students in countries with more advanced dairying systems.

Technical assistance in dairying. Several types of technical assistance in dairying have been attemped in Latin America. These can be subdivided into assistance rendered by international organizations, such as UNESCO, FAO, or the Inter-American Institute, to which the author belongs; assistance rendered through agreements between local governments and the U.S. Department of State; and assistance rendered through the foundations. Another type is the assistance rendered to regional or national projects by United States college contracts. This is also handled financially by the State Department, but few dairying projects have taken place under these agreements. [Adams and Cumberland, (1).]

In relation to the amounts of money invested, the results obtained have been rather disappointing. However, this is not the occasion to make a detailed analysis of the causes responsible for such meager success. Moreover, we are concerned with only a single aspect of agricultural technical assistance, that of dairying. One assistance plan that concerns dairying specifically has been the UNICEF-FAO scheme to provide facilities for producing, dehydrating, and distributing dried skimmilk for schools. Large sums of money have been spent in this project in equipment, buildings, and personnel. The failures have been more outstanding where huge plants were constructed in areas that had no experience in dairying. Better results are likely to be obtained where the dehydrating plants were organized as part of cooperative enterprises made up of dairy producers.

Frequently, when foreign technical assistance is given to Latin Americans, one finds the native technician or even the public at large highly critical of the capabilities of the men sent by the more advanced countries. The barriers of language, social customs, and traditions are slow and difficult to overcome. When the foreign technicians set up a separate shop from the local institutions and are personally protected by diplomatic privileges, assimilation into the local scene is more difficult. Constant routine transfers of personnel, not only within Latin America but to and from other totally dissimilar areas, have aggravated the problem of assimilation into the local environment.

Sending foreign technicians to solve dairying problems in Latin America is a sort of substitute system in lieu of national leadership. From an altruistic point of view the idea is commendable, but from a practical point of view it may be unsound. At best, it provides only a substitute for the permanent leadership required. Presumably, local leaders would come later. But when the foreign technician is not located in teaching institutions, and does not participate in the local life, the possibility of his influencing future generations is slim indeed. Perhaps all technical assistance schemes should be constructed with the awareness that no country has a surplus of brain power; also, it should be recognized that because brain power operates satisfactorily under one set of circumstances, there is no guarantee that it will function equally efficiently under another.

Training of future Latin American leaders in the United States or Europe. The undergraduate level. The North American college is an institution designed to give the most useful and practical training in the shortest time to the man who is going to work in the United States. Herein lies its greatest quality, its practical, down-to-earth approach and its ability to direct research findings toward the solution of practical problems. But the very practical nature of college training in the United States, so useful to the man who will apply the principles in the vicinity of the college, may turn out to be a liability for the man who tries to apply a set of solutions in totally different situations. Since the local situation may need a complete readaptation of principles, it takes a deeper knowledge of these principles before the adaptation can be made. Too often I have seen United States- and European-trained Latin American technicians become totally discouraged and despondent when they fail to make a success at their first efforts to improve production under primitive or difficult conditions. While many personal qualities (or the lack of them) may contribute to this failure, I would also blame the lack of depth in scientific principles as one of the underlying causes. Obviously, agricultural science has a greater share of these unadapted foreign trainees than the exact sciences, such as engineering and mathematics or even medicine. The solutions to many of the latter's problems obey universal rules, they are not modified by levels of soil fertility and the interactions of soil fertility with history, tradition, and social structure.

The postgraduate level. If I am making an appeal for depth in scientific principles as a means of overcoming the problems of adapting research findings to new situations, postgraduate training should provide the answer to my plea. Many of you will immediately protest that postgraduate training is for the few, and that too many leaders are needed in Latin America to make the Ph.D. degree a requirement. But since I am convinced that quick, improvised solutions will not help us, I would aim for a slower but more certain action—one in which we would prepare the men who will train the leaders in their own countries.

To be able to do this, the man with an advanced degree must be given a chance to prove the worth of his scientific knowledge in the local situation. Before we turn him loose we must give him a period of protection, so that he may produce results of local significance.

I see no better place for our well-trained man to prove his ability and influence future leaders than in the Latin American colleges themselves. These are the colleges that we find so inept and poorly organized now. But they are the ones we must work with. Only progress from within can be long-lasting and important. Our leader, once trained and back on a job of importance, must make his own fight to obtain a budget for research in his institution, and for modernizing the teaching responsibilities given him.

This means that, for postgraduate training, preference should be given to the young men who have the contacts with and acceptance of their local colleges. It may also require some support and loan of personnel to enable his college to grant him time to study. I would even recommend that the thesis problem be developed locally by the Ph.D. candidate so that a local difficulty can be attacked along with his training. This is a deviation from American practice but, with the speed of present-day travel, the supervision of work done thousands of miles away is not difficult, though somewhat costly.

I also recommend that the Latin American candidates for higher degrees be rigorously selected. Only the very best should be given the time and attention that good personal training requires. I would ask you to be completely dispassionate in this selection and, if anything, apply more rigid standards than usual because, as foreigners, they will have to develop and prove their worth under more trying circumstances than your own countrymen. The time spent in obtaining a Master's degree is an appropriate measure for selecting those best suited for further training. In fact, since postgraduate training at the Master's level is being offered now by some Latin American institutions, I would recommend that the American graduate school consult these institutions and heed their word in the selection of candidates.

Since our local colleges are so poor financially, the new leaders, or the institution itself, might need assistance to effect the changes that are so urgently required. I would say that money is well spent when it develops the sort of leadership that is self-perpetuating. I would certainly favor this kind of support over providing elaborate, expensive, superficial foreign leadership for the Latin American countries.

(1) ADAMS, R. N., AND CUMBERLAND, C. C. United States University Cooperation in Latin America. Michigan State Univ. 264 pp. 1960.

(2) CHAPARRO, A. Un estudio de la Educación Agrícola Universitaria en América Latina. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Estudios Agropecuarios No. 48. Roma. 1,207 pp. 1959.

DISCUSSION

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Joao Soares Veiga

There are no special courses for dairy husbandry in Brazil. Animal husbandry occupies a small part of the veterinary and agronomy curricula, and only a few hours a year are assigned to their teaching and training. Students in veterinary and agronomy colleges have no opportunity to work on farms or in dairy plants to gain first-hand knowledge of the problems of dairy farming. Theoretical schooling rather than practical training is more frequently provided. Technical high schools that give better training than colleges operate in some states, but their level is still too low to provide adequate leadership in dairy husbandry. In Latin American countries both veterinarians and agronomists are often in dispute about their relative positions but, in truth, neither is sufficiently prepared to perform the job satisfactorily.

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Brazil is an unusual country, with peculiar problems and conditions that differ in several aspects from those of other countries in the temperate zone. Dairy husbandmen in this country, which is both tropical and subtropical as are many other large areas of Latin America, must be prepared to face a number of outstanding problems, some of which are: climate, malnutrition, poor management, and diseases. To deal with these adverse environmental conditions, the dairy husbandman must understand animal reactions to high temperatures and humidity, animal physiology, and animal acclimatization. He must know how to raise animals resistant to the hazards of these environs, as well as ways to compensate for the effects of the environment. Furthermore, he must be well acquainted with cattle nutrition procedures, pasture grazing, and pasture melioration. He must be accomplished in the skills of hygienics and sanitation. As a rule, he should understand the economy of his area and be prepared to deal with inexperienced people.

In Latin America there are no specialized courses such as dairy husbandry, animal breeding, nutrition, or dairy industry. Few of these matters are dealt with in veterinary or agronomy courses; thus, veterinarians and agronomists have to invest much additional time to be able to execute their duties effectively in these fields. Obviously, the country is in great need of well-prepared experts in animal husbandry, nutrition, and dairy industry. These subjects should be taught in the schools of Brazil, and intensive research carried out; new curricula should be designed.

Technical schools and colleges need to change both the systems and methods of teaching, and veterinary and agronomy colleges should put more emphasis on animal husbandry. In my opinion, it would be much better to create separate courses for animal husbandry in Latin American countries. But before opening or improving schools and colleges, skilled teachers and researchers must be available, and unfortunately there are too few of them in Latin America. I believe that animal husbandry personnel trained in the United States can really be helpful in Latin American countries, provided they are first acquainted with the problems of the region where they are to teach or work.

Latin American students can also be trained in the United States, but they should first be familiar with their own agricultural problems before entering an American college. Thousands of skilled husbandmen, personnel for management and operation of dairy plants, are urgently needed not only to improve but also to develop the production of milk and its by-products in Brazil. Farmers must be taught and trained in the skills and procedures of animal breeding, animal husbandry, pasture grazing, animal feeding, and care and management.

An extension service should be created to assist the dairy farmers. To meet this demand, again, large numbers of accomplished, skilled experts are immediately required. To increase the number of trained experts in animal husbandry in our country, it would be necessary to:

1. Restore and enlarge the curricula of veterinary and agronomy colleges, with more emphasis on animal husbandry;
2. Create specialized courses in animal husbandry;
3. Intensify training of students of animal husbandry in colleges and high schools;
4. Intensify research on such problems as cattle breeding, cattle acclimatization, pasture grazing, nutrition, diseases, housing systems for cattle, and many others;
5. Award teachers and technicians scholarships to train abroad;
6. Welcome foreign teachers and technicians as experts to aid our organizations, colleges, and research centers dealing with animal husbandry.

Millions of young men and women are awaiting up-to-date education in our country, especially in technical subjects, and it is our duty to lead them into agricultural and animal husbandry courses, thus offering them better opportunities to participate in the struggle for improved food production. All American countries should be unsparing in their efforts to help one another. The intercommunication between teachers and technicians is an invaluable aid to education and training in Latin America. Students in veterinary and agronomy colleges must be given a sounder basic training; for the time being, this could be accomplished by making more extensive use of the seminar system. To fufill our country's urgent need for highly skilled experts, therefore, Brazil must revise its animal husbandry teaching.

DISCUSSION

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Throughout recorded history one of man's greatest concerns has been how to influence his fellow man. My assignment is to help point out some of the training needed to exert an influence over those whose goal is the improvement of the dairy industry in Latin America. Many of the needs have already been stated by Dr. de Alba and I should like to discuss some of them in more detail and mention some others.

Dairying in the Latin American nations is developing at a rapid rate, considering the many grave obstacles to progress not completely understood by people in the United States. One must recognize that, taken as a whole, the present state of the dairy industry in Latin America does not compare favorably with that in the technologically developed countries, although there are isolated herds and processing plants comparable to the best available in the more advanced countries. As might be expected, development is most rapid near large population centers with access to transportation and markets.

The dairy industry of Latin America appears to be in about the same state of development as that of the United States at the turn of the century. Dairying, as it is practiced in the United States today, did not develop overnight but was the result of a sequence of events, each of which served as a building block, or foundation, for the next. At the turn of the century, the United States had few leaders in dairy and very little specialization.

Much of the basic technical information needed to improve the dairy industry in Latin America is already available in the more advanced countries, but trained leaders are needed to disseminate and adapt it to existing conditions. Leaders must be found who have adequate technical training and who possess those personal qualities that command the respect and confidence

[1] Professor Noller spent 2 yr as a member of the Purdue University ICA team in Brazil.

Carl H. Noller

of the group. It is this confidence, based in part on ability, which permits a leader to direct and organize the activities of a group toward achievement of their goal.

A leader is a person who directs the activities of a specific group. Leaders can be found on the national, state, and community level, and in various organizations or groups which may have overlapping interests, due to different objectives. Each group, from the total population to the smallest organization, has a leader to whom it looks for direction. A leader, then, is in a position to have tremendous influence upon a segment of a population.

Dairy leaders must have certain desired leadership qualities plus adequate technical training and dairy experience to maintain the confidence of the group. Dairying will not develop rapidly until sufficient stress is placed on training leaders qualified to take the responsibility for developing and intensifying technical progress in dairy production and processing. Emphasis should be placed on overcoming the shortage of basic technical and administrative skills in the areas of dairy education, research, and extension.

Since a high proportion of the future dairy leaders will come from the agricultural universities, it is important to be cognizant of the background of the students. Many of the students have little or no agricultural background and, as has been indicated by Dr. de Alba, only limited dairy training is provided in the undergraduate curriculum. Too often the students graduate without having heard about, or even seen, modern facilities, equipment, practices, and programs that we take for granted. As a result, they have considerable difficulty in promoting and obtaining acceptance of improved dairy practices.

To provide opportunity for some degree of specialization and more training in the basic subjects, a number of agricultural universities are presently extending the undergraduate program to 5 yr; but extending the program will not solve the problem if the sole emphasis is on course work. Stress must be placed upon practical experience with animals and farm operations and access to improved facilities, equipment, and techniques. Existing facilities and practices must be improved to teach adapted modern concepts of feeding, breeding, management, and milking procedures. There is not enough emphasis on practical work, which is particularly necessary for students without an adequate dairy background. Students need experience with milking parlors, milking practices, and milk-handling procedures as well as a better understanding of basic principles and their application to dairying.

As Dr. de Alba has pointed out, there is a similar lack of facilities, equipment, and experience in dairy manufacturing. Poor or nonexistent facilities provide little opportunity for the student to see or gain experience in dairy plants. Consequently, they have no concept of the problems or how to solve them. Modern milk plants can be found near high population centers and these might agree to cooperate in a training program.

Training for leadership in dairying in Latin America requires more than knowledge of improved techniques in dairying and their application; it must also provide a working knowledge of related fields such as agronomy, soils, processing, marketing, credit, etc. In view of the shortage of trained personnel, a leader cannot depend on others for assistance in solving related problems, nor should he be expected to be an authority over the whole range of problems. A degree of specialization is needed but not the high degree of specialization now found in advanced countries.

Training for dairy leadership in Latin America must be built on a broad base of practical and technical knowledge, to aid in understanding and solving problems. New practices may not be accepted because previous ones failed for lack of specific recommendations on procedures to follow. In one case, a silage-making program failed for lack of specific instructions, and today only a few of these dairymen are making silage. This is in an area where silage-making should be encouraged.

Training is also needed in effective communication, since there is little use in promoting improved practices unless dairymen can be induced to accept advice and to adopt the reccommended practices. Persuading dairymen to accept and apply knowledge is an immense task. However, one should not be too critical of a lack of acceptance of new practices. In many instances this is not due to a lack of initiative or desire but rather to a lack of financial means to make the change.

A common error often made by both foreign and native technicians is the attempt to transfer a practice without modification to another country with different physical, biological, and social environments. Direct transfer of good practices is often questionable, but the basic principles can be applied to develop new systems within new environments. Obviously, anyone not capable of applying basic principles and the scientific method can fail utterly in an undeveloped country. Few people realize the vast amount of scientific information accumulated within the more scientifically advanced countries that serves as a foundation for present agricultural practices. In Latin America few basic data are available. Therefore, scientific leaders interested in practical application of knowledge must analyze the problem and develop new systems in terms of basic principles. For a dairy program to succeed, a concentrated attack must be mounted simultaneously on all major bottlenecks limiting increased production.

Basic to the improvement of dairying is a program of effective teaching, research, and extension. Such a program requires a large number of technically and practically trained persons. The training needed goes beyond that now given by the superior schools of agriculture and must provide opportunity for major fields of specialization. A program of this type has been initiated in Brazil by Purdue University, in cooperation with a Brazilian university, with the establishment of a graduate program in agriculture leading to a Master of Science degree.

The program will provide training in technical subjects and research under the conditions of the country. Advanced training within the country provides training pertinent to their needs, and the research, which is a required part of the program, provides needed information.

The present practice of sending students to foreign countries for advanced training leaves much to be desired. In the first place, the students often have difficulty with English, which handicaps them in the early months. Secondly, as has already been pointed out, graduate programs in the United States are not necessarily designed to provide the training needed by students from underdeveloped countries. More emphasis is needed on program planning and implementation, with training in basic principles and their application in solving problems. Thirdly, many foreign students show a preference for impractical courses and esoteric dissertation subjects. The limited sojourn permitted often prevents their conducting research so that they follow a non-thesis option or may analyze data of their own or obtained from others in their own country. This does not provide badly needed training in research methods and advanced techniques. Others may be assigned a segment of a total research problem without an understanding of its contribution to solving the overall problem. Upon their return home, these students may continue research begun in the United States, which may have little bearing on solving urgent problems in their own countries.

I feel also that more programs of specialization should be initiated in Latin America which lead to a Master of Science degree. Where needed, qualified professors from other countries should be invited to assist in the organization and development of the program. Such a program would provide specialized training under conditions of the country, train more students for the same expenditure of time and money, give stimulus to a research program, and provide opportunity to assist the country even during the learning period. Upon completion of the Master of Science degree only the most qualified students would be sent to other countries for further training, while the others go to work. This would provide for a more rigorous selection of students for foreign training, as was suggested by Dr. de Alba.

Another alternative which might be considered is a program whereby qualified students are sent to the United States for course work and training in research methods and advanced techniques. Then, with the assistance of the major professor, a research program would be planned, to be conducted in the home country. The research could be conducted alone or with the assistance of designated individuals within the country. Upon completion of the research, the student would return to the United States to prepare and defend the thesis. Another remote possibility is that, with the large number of North American university and other technical assistance personnel available in Latin America, a group of qualified examiners might be available to give the final examination. It is doubtful that many universities would approve the latter suggestion.

In addition to graduate training for education and research, there is a need for training in extension techniques and technology. Greater emphasis must be placed on the training of a staff to promote better understanding and preparation for the job. Higher priority should be given to field work in the initial phases if dairymen are to be served effectively. An extension man must have enough general knowledge and detailed experience to enable him to offer worthwhile guidance to a dairyman. The confidence of dairymen and processors cannot be sustained without adequate practical results. Extension men must have a practical grasp of the dairymen's problems and avoid an abstract, textbook approach. To discharge his responsibilities effectively, the extension man needs a working knowledge of the subject matter in dairy and related fields, an understanding of rural sociology and psychology, agricultural credit, and farm management, as well as other aspects of agricultural economics, such as cooperative organizations and marketing.

The training needed for leaders in dairying will vary with the type and level of their future or expected activity. Technical and practical knowledge are important, as well as sufficient understanding of related areas. Since leaders function at different levels and in different areas of activity, their training by necessity must be different. Key factors which need emphasis are organization, development, and conduct of programs in a logical sequence, and cooperation between education, research, and extension. In addition to technical knowledge, a leader must have a deep-rooted faith in people and confidence in the potentialities of dairying in the area in which he is trying to work.

MEETING THE NEEDS FOR LEADERSHIP IN DAIRYING IN LATIN AMERICA

R. K. WAUGH [1]
The Rockefeller Foundation, Bogota, Colombia

R. K. Waugh

My assignment is to discuss the following from a United States scientist's viewpoint:

a) An analysis of the basic problems in dairying, and the major needs in teaching, research, and extension for helping to solve them.
b) Tailoring curricula in the United States to the needs of Latin American students—what these needs are and how they should be met.
c) What a professor or scientist should know concerning the culture, language, and customs before going on a foreign assignment, temporary or otherwise, to Latin America.
d) Career opportunities in Latin America for North American college graduates with majors in dairy production for both United States and Latin American students.

This is a large and difficult task and for the purpose of this symposium these topics must be treated in very general terms, at the risk of leaving much unsaid and of making statements to which there are many exceptions.

Application of new methods. Dairying in Latin America has many problems. The major ones are disease, nutrition, management, and lack of cattle adapted to the hot areas. But the most general problem is the slowness with which technical and productive practices are adopted or, in other words, the manner in which these specific problems are attacked. While much of the data collected in other countries must undergo adaptation before being applied in Latin America, and the amount of data collected from within countries is limited, there is still much information that is not being put to use very rapidly.

What are the reasons?

a) There is a shortage of technicians. The most important basic problem is education at all levels—primary, high school, and university. There are not enough schools nor are there enough teachers. And many of those who are now teaching are not well prepared. It is estimated that, in Colombia alone, 30,000 children each year have no educational facilities, are lost as potential leaders, and never will produce much for the economy of the country. Furthermore, according to a recently published report on education in Colombia, 81% of the rural schools offered programs of 2 yr or less, and 91%, of 3 yr or less. Thus, the rural people, with a first-hand knowledge of the land, have very limited opportunities to obtain a high school education. With such an educational system a country cannot effectively utilize its human element.

[1] Formerly was a member of the staff in dairy husbandry at Purdue University and North Carolina State College. Before assuming his present position he spent 3 yr in Peru as a member of the North Carolina State College ICA team.

High school and university facilities are likewise limited, and those who have the opportunity to attend a university come from a very small segment of the population.

As would be expected under these conditions, the facilities for graduate studies in any phase of agriculture are very limited, and for a good understanding of the application of modern research results it is important to have technicians trained at the graduate level.

b) As a result, many college professors do not have a good understanding of modern agricultural methods and thus their students who may become extension workers do not have the correct information to pass on to the farmer.

c) Often the organization in which the educator or extension worker faithfully tries to carry out his duties is cumbersome, and he is further handicapped by problems of communication and transportation.

d) In addition, social and economic conditions influence the effectiveness of an educational institution or extension service. A hired farm manager who earns a low salary seldom has had enough training and orientation to grasp new techniques where attention to details are of utmost importance for the success of the method. Furthermore, the landowner may not give much supervision. The farm manager is hesitant to introduce new methods without first checking with the owner, and the owner may not be readily accessible because he usually has other business matters to which he must attend. Thus, not all of the problems of introducing new methods is due to lack of technicians or to poorly trained technicians. In part, it is lack of a favorable environment for the application of scientific procedures.

In general, education, extension, and research are not coordinated, and standing alone they all fall short of expectations. Most of you at this meeting do not fully realize the mutual benefit which results from the close association of these three phases of agricultural education, although most of you have accepted a combination of duties as a desirable arrangement.

But to leave the impression that all is unfavorable would be erroneous and unjust. Many ministers of education and of agriculture are aware of these staggering problems. There are a few good schools at all levels, enough to show that the people appreciate the value of good education. There are some really bright spots in university education and in research in Latin America. Peru has made some important moves to combine research with education. I understand that in Argentina, where progress was slow with a previous system of separated extension, research, and teaching, a new organization has been formed within the research organization to give additional training to technicians of the organization.

In Colombia a strong start has been made to create what is essentially a land-grant college of agriculture with emphasis on a graduate school to start at the Master's level.

Improved practices are being put to use. One can observe excellent, well-managed herds in many areas. Again using Colombia as an example because the data were close at hand, 95% of the barley grown in the country is of a new improved variety which combines quality with good yields. In this case, farmer education was conducted by a commercial organization, using extension workers trained largely within the research program which developed the new variety. And in the fertile Cauca Valley, 90% of the corn grown is of improved varieties. These are concrete results from research and extension, but much remains to be done. There are enough isolated cases such as these to indicate that the demand for technical information will increase rapidly, and to meet increased demand the shortage of technicians will be even more critical. In addition, land reforms will further increase demands for technicians.

Where to start to meet these problems is a big question, but education in all its phases, including extension, is so handicapped by lack of leadership that first emphasis probably should be given to the universities, at both the undergraduate and graduate levels, to develop the needed personnel. And it is at these levels that the members of the A.D.S.A. are best prepared to help. I have said nothing about dairying, but the over-all situation must be improved before modern practices can be put into use on a large scale. The problems in dairying should be attacked, but the push for dairying should be combined with efforts in other technical fields, and I believe that what has been mentioned up to this point applies equally to all technical fields of agriculture.

United States curricula. Many Latin Americans have graduated from North American universities. Most of them are proud of their education and their contacts in the United States; many have accepted responsibilities within their own countries and have become internationally well-known.

However, I believe that North American universities can make greater and more valuable contributions in the field of education than they have in the past. At the undergraduate level it is difficult to develop methods or to make changes in curriculum for a small percentage of the students, and the basic curriculum at this level of training probably has not been too faulty. Nor should North American universities be most concerned with this level. Even with their shortcomings, Latin American countries have universities which should be attended by the majority of students who seeek an undergraduate degree. As far as teaching in agriculture is concerned, within the continental United States, the graduate level is the more important.

The North American graduate schools have good basic courses that are appropriate for Latin American students, keeping in mind that some background courses will have to be taken. These courses serve as the nucleus for the student's program of study. However, graduate training consists of more than course work, and it is here that improvement can be made by a better understanding of the Latin American student and the conditions under which he will work when he returns home.

The following comments are about the Latin American student's background; they may help in improving the usefulness of his education if the professor is aware of them.

a) The Latin American student attending a North American university usually is from a very narrow segment of the population. Remember that the farm boy seldom gets the opportunity to study at the university level and it is very unlikely that a student in any phase of animal industry will have had much, if any, experience in animal management. A North American student taking a course in the physiology of lactation will immediately understand the importance of the physiology of milk let-down, because he has had experience with the idiosyncrasies of cows. Probably the Latin American student will have milked a few cows, but not enough to give him practical experience. The teachers in North American universities have been too quick to attribute the lack of experience to the assumption that the Latin American student does not want to get his hands dirty. While this may sometimes be true, it does not excuse the instructor for assuming it applies to all Latin Americans. The Latin American student who seems averse to dirty work is more likely afraid of appearing foolish in the eyes of other students because he is not skilled in manual labor. The instructor should realize that these students have not had the background experiences which are valuable as an aid to learning and understanding. The manual dexterity developed and the experience gained by young North Americans while tinkering on an old car, changing the oil in a tractor, or just fixing a fence are invaluable.

b) Many Latin American students have not found an environment really conducive to academic study and true understanding to scientific principles. They have language difficulties, and often do not feel that they are a part of the community. Some are socially shy; others, too socially inclined.

The orientation courses in agriculture which have been developed for foreign graduate students by Cornell University and by Southern Illinois University are a step in the right direction. Such courses as these, coupled with a greater awareness by the professor of the points mentioned above, should go far toward improving the training of Latin American students in the United States.

c) Latin American students have not grasped the over-all meaning of production efficiency nor of the role of our farm organization and management in North American agricultural production. Much of the agriculture in Latin America is carried out on an extensive scale. Especially, animal agriculture has been historically extensive in nature, where more attention has been given to the number of animals rather than to the individual production. Their background has not prepared them to easily understand the principles of intensification for which North American agricultural universities have striven so diligently and with much success.

United States technicians abroad. When a North American technician travels to a foreign country on assignment, temporary or otherwise, he accepts considerable responsibility. He has a responsibility to his employer, to the country to which he travels, to himself, to his country, to his family, and to his profession. These foreign technical assignments are wonderful opportunities to learn how other people live and to become acquainted with technical problems in other parts of the world. These assignments should not be taken lightly. Universities that lend their personnel should send their best technicians, keeping in mind that the best one at home is not always the best one abroad. There is no substitute for technical competence and in the field of agriculture the universities have the bulk of the know-how in the United States. Several years ago the United States government embarked upon a program of technical aid to foreign countries, and the program is being continued. They have had both success and disappointment, as might be expected, but for over-all success it is vital that there be a much larger percentage of successful projects than failures. The only way to be successful is put the good men on the job and most of them are to be found in the universities. To use these men efficiently, the university must become a planned part of such programs. There are not enough high-calibre technicians outside of our campuses to get the needed job done.

In addition to professional competence there are other prerequisites for success of a man on technical assignment abroad. He should be able to adapt himself to a wide range of living conditions. If he can do so, it will be reflected in his work. The same applies to his family.

He must have an attitude of wanting to help and a desire to get the job done. He must remember that he is a guest and a foreigner, and that the United States does not have the best of everything.

Customs vary from country to country and it is important to learn the main ones as quickly as possible and for this it is largely a question of being alert. Books and counseling will help, but just as it is difficult to learn a foreign language with only a textbook, so it is also difficult to learn new customs without practicing them, and learn them sufficiently well so that one is comfortable when applying them.

Language is a part of a country. While a translator can usually be found, and there are many good ones, the use of a translator results in second-hand information. The lack of knowledge of the language is a deterrent to good communications, and poor communication is a handicap to working with the people. The North American people have been slow in learning languages and it seems that many of us have a mental block against it, with the excuse that English is universally understood. It has been relatively recent that more attention has been given to modern languages, but we still have not faced up to the problem, and are undoubtedly the most ignorant people in the world about languages. We are improving, but we must do much more. The fact that English is commonly spoken abroad is not a good excuse to refuse to study the language if one is going to reside in a country for more than six months. Young people learn to speak languages with more facility than older people, but most people of nearly any age can learn a language with the opportunity, effort, desire, and a good mental attitude. One is in a better position speaking with an accent than not speaking at all. Latin Americans would like to have us speak their language, and they are extremely tolerant of abuse of their language, especially where one is a beginner. A common error is to believe that one will just absorb a language. Children will, but adults probably will not, at least not to the extent that it cannot be considerably improved by some serious study.

Career opportunities. There are always career opportunities for the well-trained, capable person. However, there are not many opportunities for the North American graduate trained in dairy production with a B.S. degree in Latin America unless he has the capital to go into business for himself. And, in this case he should know the language, business procedures, and customs which usually, for North Americans, means spending some time in the country before investing. Some opportunities do exist, but most of these are with North American companies or with foreign aid programs. Most commercial positions, for which dairy production majors with a B.S. degree are qualified, are taken by local technicians. North American technicians usually make their contacts in their home country. There are career opportunities for the Latin American with a B.S. degree from a North American university and they are essentially the same kinds of positions that their United States counterparts would qualify for in their own country; that is, with commercial companies such as feed companies, private dairy farming, extension work, or the universities but, in this latter case, as in North American universities, he would not be in a good competitive position without some advanced training.

There is a great need for technicians with advanced training and the number of Latin American universities which offer graduate training are very limited. Such people are needed in the fields of research, teaching, and extension. It is in this level of training that North American universities can make a real contribution.

DISCUSSION

LUIS RIVERA-BRENES [1]
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My assignment is to comment of Dr. Waugh's talk from the viewpoint of a Latin American scientist, but my comments will also be from the viewpoint of an American citizen located at the crossroads of the Americas.

It is easy to point out all the various aspects of the dairy industry which offer a wide margin for improvement in Latin America, but Dr. Waugh is right when he points out that it will take considerable time to discuss everything in detail.

Of course, the demand is urgent, but I believe that before we start bringing out basic changes in production we ought to prepare a comprehensive program that will emphasize the raising of the educational and standards of living levels of the people concerned. This is of fundamental importance.

All Latin American countries should benefit from this kind of educational approach to their particular problems. The acquired know-how should enable them to raise their standard of living when they conscientiously exploit their vast natural resources.

Interest in improving and increasing leadership in any kind of industry, especially agriculture, happens to be slow when a bright future is hard to foresee; that is why an educational program will help the people to understand the problems and to visualize what may result from their efforts to solve them.

The growth and improvement of the dairy industry in Latin America may, in part, depend on how fast people learn about the nutritive value of milk and milk products and to what

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Luis Rivera-Brenes

extent they are able to increase their purchasing power per capita. Leadership along these lines must be worked out parallel to both aspects —general education and living standards.

The United States is in a privileged position to help Latin America to develop this kind of leadership through the different programs already in progress.

Latin American countries must have also a sincere attitude toward educating their people. This is the cornerstone on which to build progress and democracy. After these objectives are achieved, others will follow.

In the meantime, as pointed out by Dr. Waugh, we can help by providing part of the technicians needed and also by training a considerable number of students from all those countries. In regard to this aspect, I want to add the following: technicians assigned for work in Latin America must be able to speak fluently the language of the country, if rapid results are expected. Most Latin Americans do not speak English; therefore, the language barrier defeats efforts toward mutual comprehension, and should be eliminated.

Our government may help by providing the means to teach Spanish to American technicians assigned to missions in Latin America. In that respect, the Commonwealth of Puerto Rico, I am sure, will do its best to cope with this situation if asked to do so.

I have been told that all technical personnel sent to Cuba by the Soviet Union speak Spanish fluently. Why could we not do the same in regard to our technicians going to South American countries?

Another thing, any personal attitude toward Latin Americans should be at such a level that they never feel any social differences between co-workers while performing common daily routines. It will result in mutual benefit if North Americans know how to mix socially with Latin Americans. That is why thorough knowledge of national customs and of language is so important for smoothing out nationalistic disparities when they arise.

As to the curricula for graduate studies in our universities, I agree with Dr. Waugh, in that the fundamental background courses must be taken. My suggestion is that thesis work should concern problems of the country of origin of the student. Arrangements could be made with experiment stations and universities of those countries to provide adequate supervision. In that way students may rapidly put into practice in their own countries the basic scientific knowledge recently acquired.

Arrangements should be made to bring more of the outstanding students of Latin America for undergraduate studies in agriculture. Proper orientation could be offered during these 4 yr of training. Many may proceed into graduate work with a more thorough academic background than those released directly from Latin American universities.

Latin America is full of opportunities for career men from the United States with majors in dairy production. But these men must decide to stay at least until their efforts become a real asset to the countries in which they work; it is obvious that it will take time for them to become acquainted with the people and their problems before actual contributions can be made.

DISCUSSION

J. B. Frye, Jr.[1]
Department of Dairy Science, Louisiana State University, Baton Rouge

As indicated by the previous speakers on this subject, this assignment is a difficult one, which must not be treated lightly by the educators in American universities and colleges if we are to be successful in this program. Although my experience in Latin American countries has been limited, I have had enough in

[1] Professor Frye has much experience in teaching students from Latin America and has been on several assignments there.

J. B. Frye, Jr.

some of them, and enough contact with representatives of many of them, to fully appreciate the important points emphasized by Dr. Waugh. I concur with what he has said. During the short time that I have on this program, I should like to offer a few comments on the following:

1. The role of the department head.
2. The attitude of the American teacher and research worker.
3. The language barrier.
4. The importance of a practical training program for the Latin American student.

The role of the department head. Under this topic, I should like to discuss the general role of the department head as related to the student's program of work. As a general rule, the department head is the key individual in establishing the first contact between the Latin American student and the American university. Whether by letter or personal interview, this first contact should be one of welcome and friendly warmth; it should give the student a feeling of being wanted. In fact, this is the sort of relationship that should be established with all students. The foreign student needs more individual attention because in most instances he is a total stranger to the new community in which he is about to make his home. Help should be given on such matters as a place to live, a place to worship, and schools for the children. A satisfactory solution to these matters is extremely important if the student is to do his best work. From the standpoint of the student's academic program, a counselor or major professor should be assigned to the student immediately. Usually, it is the counselor or major professor who assumes the responsibility for seeing that the student is properly administered to in all of his basic needs. It should be the role of the department head to see that the stage is properly set for a productive learning experience for the student.

The attitude of the American teacher and research worker. Once the student has been properly introduced into his field of study by the department head, the success of the educational program for the student will be closely related to the proficiency and attitude of the counselor or major professor. He should show a deep interest in the student's background and needs, and should learn the future plans of the student, so that an effective program can be planned.

It has been my experience that most of the Latin American students display a considerable degree of timidity and reluctance to discuss problems frankly with the American professor. Apparently, this is the result of the social patterns developed in their homeland. This obstacle can be easily overcome by the professor who is sincerely interested in his student, so that he makes a special effort to get to the bottom of a problem. It is most unfortunate if the professor resents having to spend time with a Latin American student and has no understanding at all of the student's needs. When this situation develops, the department head should assume the responsibility for taking corrective action. An American professor finds it almost impossible to understand the social and religious customs, the educational background, and the deep needs of the Latin American student if he has never been in the country. Hence, some type of continuing orientation program should be developed, whereby more of the American teachers and research workers will have an opportunity to visit some of these countries and learn more about the environment from which the Latin American student comes. At least the head of every department that offers undergraduate and graduate training to these students should have this experience. It is impossible for a department head to do the most effective job of administering a good educational program for the student if he is not sold on it. Without the department head's full understanding, the program will have little opportunity to succeed.

The language barrier. It is my feeling, and that of those with whom I have discussed this matter, that the language barrier is a far more important problem for Latin American students than many people realize. It is one thing to have a reading knowledge of a foreign language, and still another thing to be able to follow the same language well when it is being spoken. Not all of the learning of the student is through reading, since much of the material in our American colleges and universities is given by lecture, discussion, and laboratory demonstrations. These students should be encouraged to room with American students, to improve their proficiency of the English language. Consequently, Latin American students should live in dormitories with North American students and be encouraged to talk English as much as possible.

The importance of a practical training program for the Latin American student. It was pointed out by Dr. Waugh that the lack of practical training in the field of dairying is often observed in the Latin American student. This has been our experience at Louisiana State University. However, most students are ready and willing to learn when given the proper opportunity. Latin American students, like Americans, have considerable pride and do not like to be embarrassed; neither do they like to do any more than is required of them. The time to settle this problem is when the student reports for work the first day. If he understands that practical training is a requirement of the department for proficiency in his field, and that all students must be evaluated on this basis, the Latin American student will accept the program without question. The word soon gets around from the graduate students who have already had the training. Once the Latin American student realizes that the jobs of feeding, milking, cleaning the barns, breeding cows, and cleaning the laboratory are part of the total educational program, he forgets about pride and goes about his work with interest and enthusiasm. Although he may never do these things again when he returns to his home, these experiences will enable him to do a better job in his profession. It will give him a deeper appreciation of the educational program and the ability to evaluate programs and situations that he would never develop otherwise. The American professor must be careful not to downgrade the student because of his inadequacies. It is usually better that such discussions be confidential between the professor and the student. This practice will soon teach the student that he can confide in the teacher and receive advice without other people knowing about it. As a result, any reluctance to participate in the entire educational experience because of his pride will be minimized.

One of our students made the following comment about this matter: "Although the native home of the student may not have the modern and up-to-date facilities for training and for a highly productive agriculture, the student should be motivated to take advantage of these opportunities while in America. The knowledge and practical experience he gains may not have immediate application when he returns to his country, but are wonderful assets for the near future. Students must fully realize that there is no substitute for practical experience."

Dr. Waugh indicated that the North American universities should be mostly concerned with the graduate program. This may be true, but it is the feeling of my colleagues that more emphasis should be given to the undergraduate program than is the case in many instances. The undergraduate program is like the foundation of a building. Builders do not think of erecting a tall building without a good foundation. Likewise, I do not believe that one can build a strong graduate program without a strong undergraduate background. Thus, department heads, major professors, and graduate schools in the United States need to do better jobs of evaluating the undergraduate courses taken by Latin American students and their practical experiences in their countries, and of tailoring their graduate programs according to the needs in each case. Most of us are too inclined to want every graduate student to fit into the same mold, regardless of the background, desires, and needs of the student.

In closing, I would like to offer the following recommendations for improving the education for leadership in dairying in Latin America:

1. It is recommended that the American Dairy Science Association consider the possibility of organizing affiliate units of the Association in Latin American countries. Such an organization would speed up the educational processes now in effect.
2. It is recommended that the American Dairy Science Association investigate the success of the orientation courses for foreign agriculture students at universities where they are given and, if they are successful, take the necessary action to encourage more of the colleges and universities to offer such courses.
3. It is recommended that the Association spearhead a move through FAO, other government agencies, and private foundations to sponsor a program whereby department heads, other key administrators, and professors would have the opportunity to spend some time in Latin American countries for the purpose of learning more about the background of their students.

SUMMARY REMARKS

K. L. Turk
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These analyses and observations of the educational problems are of great significance to all of us as we think about the food needs of rapidly increasing populations throughout Latin America. Food needs will increase, especially for high-quality proteins, and dairy products can play an increasingly important role in meeting them if the right kind of leadership is given to the development of the dairy industry.

All of our speakers have referred to the fact that education, or lack of it, is the real bottleneck in the future development of Latin America. While greatest emphasis has been given to higher education, it is well to remember that the critical problem really begins at the elementary and secondary educational levels. Greater opportunities must be provided to fill this educational pipeline all of the way up to the college and university level. Greater efforts must be made to provide education for more people at all levels.

Our speakers agree that Latin American colleges and universities urgently need more well-trained, full-time professors, more adequate research facilities, better libraries, increased financial support and stability, and freedom from political insecurity—all of which are essential for good education in any discipline. These educational institutions need to be prepared and equipped to disseminate knowledge that will contribute to the improvement of the living standards of all the people. To accomplish this will require larger numbers of more highly trained personnel, especially in the agricultural sciences, including dairying.

Reference has been made to the desirability of Latin American students obtaining their training for leadership in dairying and other technological fields at universities in the area rather than in the United States and in other countries abroad. This has many advantages where universities have developed to a point where adequate staff and facilities are available. Regional graduate education and research centers are developing in some countries which will provide opportunities for advanced training for students under an environment more nearly like those in their own countries. This is a commendable development. Until such time as adequate educational institutions for work in dairying and related fields are developed in more countries in Latin America, however, many students will find it to their advantage to go to the United States or Europe for advanced training.

As more people become trained in the various agricultural disciplines, better ways and means of transmitting knowledge to the people for translation into action need to be developed in the local countries and institutions. This is highly essential if nutritional and living standards are to be up-graded.

The definite shortage of well-trained people in dairy and animal science has been emphasized; also, the fact that there is a place for the animal scientist just as there is for the agronomist, dairy technologist, or veterinarian. Well-trained people in each of these professions have important roles to play in the further development of dairying in Latin America.

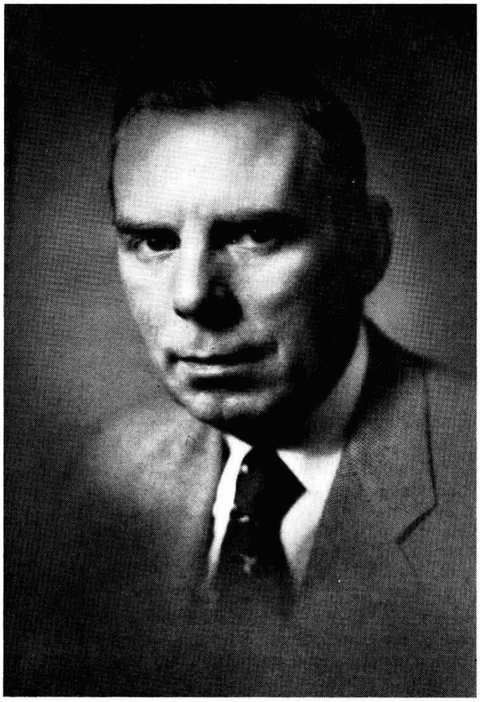
Even though most of our participants have described unfavorable elements affecting education in agriculture in Latin America, I should like to summarize by saying that dairying is developing at a rapid rate in many areas. There are bright spots among the universities and colleges, some of which are the oldest in the Americas, and several are making remarkable strides. I should like to emphasize again that the key to a more important and progressive dairy industry in the future in any country is a better supply of well-trained people to provide leadership needed in all aspects of dairying.

The situation in Latin American universities is quite similar to that in the United States about 100 yr ago, when the Land-Grant Act was passed. It is hoped these universities among our neighboring countries in Latin America can play a similar role in molding the future of their countries, as have our Land-Grant universities in the United States during the past century. Education and research can provide a sound basis for agricultural and human development.

ASSOCIATION AFFAIRS

SURMOUNTING LOCAL, STATE, INTER-STATE AND REGIONAL PROBLEMS IN UP-DATING, REVISING, REORGANIZING, CONSOLIDATING DAIRY SCIENCE DEPARTMENTS [1]

G. M. WORRILOW [2]
School of Agriculture, University of Delaware, Newark



G. M. Worrilow

You have honored me by asking me to present an invitational paper to this 57th Annual Meeting of the American Dairy Science Association. I am happy to be here.

Your Committee has confused me by assigning me the topic, Surmounting Local, State, Inter-State, and Regional Problems in Up-dating, Revising, Reorganizing, and Consolidating Dairy Science Departments. This might well be considered the reading of the paper—a real Mother Hubbard.

Perhaps by now you have joined me in my confusion. If not, perhaps later. The topic did seem understandable when I discussed it with the members of the Education Committee of this Association. They explained that a part of last year's annual meeting had been given over to a symposium during which the discussants covered the general area of Changes Forced Upon Us by Trends in Enrollments in Agricultural Colleges, from the particular point of view of university administrators and the undergraduate curricula in dairy manufacturing and dairy production.

This academic exercise of last year, according to one college of agriculture administrator in one land-grant college was successful in throwing out some ideas for the membership to think about, but certainly there needs to be considerable follow-up on some of the ideas given if any action is to be forthcoming.

This quote is probably the understatement of the year, with my feeble efforts here this morning as the fingered follow-up man no doubt ranking well under the just-quoted understatement.

In the light of last year's discussion, perhaps we can agree that re-examination, re-evaluation, and resultant change is bound to come. So, the key word in my topic as I see it is—Surmounting. Webster's New Collegiate Dictionary, in part, defines it thusly: to mount or rise above; to surpass; to lie at the top, get over or across barriers, obstacles, etc; lit. or fig: as It was impossible for cowards to surmount the barriers of unknown seas and hostile Barbarians.

In short, last year you talked about Why. Now you expect me to talk about the What and the How, so that most of you can build up your Why and How Not defenses.

As we are this year celebrating the Centennials of the Land-Grant Colleges and the United States Department of Agriculture, a bit of history at this point may serve to remind us that Senator Morrill was also uncertain as to the wise course to follow a century ago, upon the passage of the Land-Grant College Act.

And now I am quoting history, implying that by so doing we will tie down our perspective a bit:

"Above all, the Land-Grant Act completed the breakaway of American higher education from the European tradition of education for an aristocracy based on heredity, occupation, or money. It was not intended that we be 'Ivy League'." (One possible exception in the Northeast.) Even so, I detect that there is an increasing tendency to emulate Harvard, rather than a determination for each of us to develop new meanings in our time for the Land-Grant philosophy and to meet the indigenous needs of the States which support us.

[1] Presented at the Fifty-Seventh Annual Meeting of the American Dairy Science Association, University of Maryland, June 1962.

[2] Vice-President for University Relations and Dean and Director of the School of Agriculture.

For nearly 100 years, or ever since President Abraham Lincoln on July 2, 1862, signed the Morrill Act, it seems to me that most land-grant colleges have been continually in the process of defining and redefining our purposes—of sorting out that which is distinctive from that which is commonplace. This is not inconsistent with the Act, as many educators and historians agree that "Morrill himself was quite indefinite about the educational purposes of his legislation until he was well along in years and had had time to organize his memory."

The main reason I dwell at all on history, parentage, and experience is for emphasis. As in these times of great stress on nonagricultural education and research, and the tendency to seek status by being in fashion, it is heartening to review the distinguished history and steady growth of this unique educational enterprise.

Today, more than in any other era of the last century, the over-riding reason for stark realism in thinking about the future role of land-grant colleges, their colleges of agriculture, and their dairy science departments, is that the stakes in this nuclear age are too high for any milder treatment.

On the other hand, what were the human, social, and economic conditions that prevailed at the time President Lincoln signed the Land-Grant Act on July 2, 1862? On July first, Union forces had lost a major battle in a war which made uncertain the very existence of this nation. This country, North and South, had a population of 32 million at the time. Out of this population more lives were lost as a result of war between 1861 and1865 than in any other war in which this country has been engaged. Inflation was rampant, and printing-press money was a fact. Yet in this darkest period of our history the Congress of the United States and the President of the United States had no hesitancy in investing a major portion of our national resources in the higher education of future generations of America's young people.

Again, the world is confronted with a continuing crisis; yet, even so, I contend that if sputnik did nothing else for this country, it multiplied manyfold our production of experts on higher education. Everybody knows what's wrong with our universities, our colleges of agriculture, and dairy science departments and their respective students, particularly our neighboring departments, their faculties and students. Of course, it is true that many of these experts who know all the answers do not know all the questions, but this is an advantage, as it makes for a mettlesome exchange of biases and prejudices.

But, as far as I am aware, there are no seers among us, certainly not at the podium at this time. At the rate our world is moving, particularly in science, one who conjectures about matters one hundred years hence is more likely to be ahead of his time, if at all, by only a decade. Moreover, it is even truer now than when Ralph Waldo Emerson made the statement, "Things are in the saddle and ride mankind."

I'd dwell for a moment upon Emerson's key word, things. The big thing is that we have known what was in the minds of the Russians for 40 years past and only in the last decade brought ourselves to recognize it. For a long time we are going to have to live with Soviet aggression, if live we shall. Our preoccupation with lesser things—incidentally, our universities have beeen as culpable as society—getting two chickens in every pot, two cars in every garage, has dulled a higher sense of purpose and obscured the fact that we are facing national, if not world, survival.

To prove that critical re-examination is not new, may I remind you that thirty years ago, at the 45th meeting of the Land-Grant Association in Chicago, the president of what then was Oregon State Agricultural College—now Oregon State University—defined the spirit of the land-grant institutions in words which I do not think I or anyone else could improve upon today. As President W. J. Kerr put it, this spirit is quadripartite. In his own words:

"First, the spirit of initiative—pioneering

"Second, the spirit of growth—progress

"Third, the spirit of equal opportunity for all—democracy

"Fourth, the spirit of helpfulness—service."

Although President Kerr would scarcely recognize the problems we are facing if he were alive today (he died in 1940), the spirit he delineated—and each part of it—is as valid today as when he spoke, two years before we recognized Soviet Russia, eight years before World War II, 14 years before Hiroshima and Nagasaki, 25 years before monkeys explored outer space, 27 years before sputnik, 30 years before John Glenn and Scott Carpenter orbited, and at a time when the parents of many of our post-war babies were still babies themselves.

I expect the understatement of our times could well be that our colleges of agriculture have assumed their full burden of critical re-examination, evaluation, or just plain biased criticism.

The Centennial Convocation of the State and Land-Grant Universities Association was devoted in a large part to the evaluation of our traditional programs at the undergraduate and graduate levels.

Let's briefly review the reports on agriculture. First, an outside evaluator, J. Earl Coke, Vice-President of Bank of America, and formerly Assistant Secretary of Agriculture:

"As our agriculture has developed into today's pattern, it has become increasingly interrelated with other segments of our economy. Political, social, and economic developments throughout the world affect our commercial farmers. Consequently, the successful operator of a commercial farm must have some understanding of these forces.

"Change lies ahead of us as well as behind in this age of innovation. Effective education must look ahead to work that does not exist today."

Of course, he said more, but time limits further quotations.

The inside evaluatior, Dr. Paul Miller, ex-sociologist, ex-Extension Director, ex-Provost and President-elect of the University of West Virginia, commented under the topic, The Intellectual Perspective:

"The colleges are in no small way disconcerted and off-balance because the entire agricultural establishment is contorted by interlocking webs of organized special interests, somehow less effective than they once were, and caught up in divergent grounds for agreement. The result is indecision, occasional self-defacement, confusion, modest discouragement, and contest. No given part of the establishment seems to be speaking for and leading the whole."

And the final outside evaluator, Dr. Theodore W. Schultz of the University of Chicago, made his usual biting but well-taken comments, and I quote briefly from his topic, "My test of the agricultural colleges is in terms of higher education in the United States.

"Here, too, important changes are taking place affecting instruction and research. Basic forces are influencing all sectors of higher education. The adjustments that must be made are neither trivial nor easy. How are the agricultural colleges meeting this test?

"Some of your activities are complementary and some are competitive with those of other educational sectors. It is a mistake, one that many, however, make, to evaluate the functions of the agricultural colleges as if they were off by themselves in splendid isolation."

So much for the ideas and collective wisdom of those inside-outside experts and scholars involved in this evaluation.

Now to my first specific clue concerning what the nonisolated dairy science faculty member can do at home to up-date, revise, or reorganize and make more effective his efforts as a teacher.

The technological explosion makes it mandatory that each individual faculty member of every college of agriculture consider himself as a member of a large team, and that, while doing as an intensive job as he possibly can within his special disciplines, he must recognize that his own efforts must strengthen and complement those of our colleagues.

A quick review of the 150-odd papers to be presented at this annual meeting reveals that you are aware of the importance of interschool and departmental teamwork. Progress is evident, but much more must be done.

Yes, even on a university-wide basis your influence must be felt and your worth appreciated. To illustrate this point of worth, I am reluctantly going to use the dollar sign to establish the comparative pattern of fiscal growth of the agricultural programs and a composite of all other university budgets and programs. These data were supplied by the presidents of 20 land-grant state universities to President D. W. Colvard of Mississippi State University and used by him in a recent seminar presentation at the University of Wisconsin. The comparison is made between the budget years, 1940–41 and 1960–61.

For the Cooperative Extension Service, the budget increase for the 20 states was 354% during that period. The range was from 260% for the lowest state to 610% for the highest state. Total budgets for the 20 states increased from $14,270,627 in 1940–41 to $64,847,148 in 1960–61.

The Agricultural Experiment Station (19 states) increased at a much faster rate from $8,786,665 to $68,563,684, or 680%. Also, the range of the increase from the lowest to the highest state was much wider. The lowest increase was 392%, which is higher than the average for the 20 Extension Services. The highest increase for the Experiment Stations was 1,226%.

For all other parts of the universities in these 20 states total budgets increased during this 20-yr period from $49,647,076 to $385,965,487, or 677%. The range here was even wider, from 305 to 1,767%.

These figures for the three divisions of the 20 institutions include funds from all sources. A substantial part of the increase for experiment stations and other parts of the universities has been provided by student fees, contractual, or other nonpublic funds. The fact remains, however, that in 1940–41 agricultural budgets (not including the budgets for resident instruction in agriculture) accounted for 46.4% of the total budgets for these 20 institutions, and by 1960–61 this figure had dropped to 34.0%.

I am not attempting to justify or explain these university gains or agricultural losses. This may be a profitable exercise for the dairy science faculties represented here today.

I should explain that the budgets for resident instruction are included in the other parts total, and although teaching costs in agriculture are quite often considered to be unduly costly by many top college administrators, teaching budgets usually do not constitute more than 25% and sometimes as little as 10% of the total budget of the school of agriculture alone.

I should in all fairness add that during the past two decades society and/or the public has placed great store in research (agriculture included, but not emphatically so) and that student enrollment both in on-campus and off-campus programs have grown at an unusual rate. The past is but prologue in this respect. New and additional needs, new frontiers of service, adult education, and urban services have tended to compete for available funds. I suspect the college presidents have been engrossed in financing for the future rather than the past.

Even so, the traditional agricultural programs are still important and deserve and must have the understanding of top administration.

This suggests the prime importance of effective communication between presidents, deans of agriculture, and their department chairmen, and every faculty member if the objectives and procedures of our schools of agriculture and dairy science departments are to be in harmony with the over-all goals and objectives of the university. Mutual respect and understanding of the individuals involved is a must.

Even if the optimum administrative climate prevails, I have found that a legally constituted agricultural committee of the university's board of trustees or governing body can be of invaluable help in interpreting a modern school of agriculture, both to administrators and other trustees. Then, too, over-all agri-industry and commodity advisory committees often can contribute the great common sense and wisdom needed to meet the criticisms and challenge of our time.

Now to the most important ingredient in today's schools of agriculture—The Student. Is he ready for us and are we ready for him? I can quickly cover this question and meet my purposes by quoting from an article entitled, The New Student in the Old College, by E. D. Eddy, Jr., President of Chatham College:

"In the past two to three years, the students have changed faster than the colleges. Vested interests on every campus prevent recognition of the obvious. Established customs, long-standing departmental and administrative structure, and sentimentalized traditions protected by alumni keep the colleges from responding with vigor and enthusiasm to the vigor and enthusiasm of the new students. The interest of the youngster who is ready for something new in the way of learning is quickly dampened by the self-oriented faculty member who sees a threat in change and resists it out of apprehension."

The number of students. Are agriculture and dairy science majors keeping pace with the other colleges and departments of the university? Unfortunately, the answer is No. The facts are that undergraduate enrollment, although it increased from 32,006 in 1960 to 32,861 last fall—2.8% representing 6.5% of the total enrollment in all land-grant universities, it dropped from 8.0% 5-yr ago. Graduate enrollment in dairy manufacturing up to 319 from the 204 the year before, +56% increase; dairy production, down to 323 from 387 the year before, −16.5%. The enrollment in terminal programs increased 24.3% in 1961 over 1960. Graduate degrees at the master's level increased 40.3%, and at the Ph.D. level, 75.3% over the previous year.

So much for those we will have to teach. Now for a quick look at which is taught—the curriculum—course of study—the broad field of agriculture.

Does it not also seem futile that after nearly 100 yr since the granting of the first college degree in agriculture, there could be any question regarding the curriculum for the undergraduate in agriculture and what it should contain, or what should be valid measurements for evaluating the undergraduate program in agriculture? We have a yardstick for evaluating the improvement of the dairy cow—a minimum production of 500 lb of milk fat and an average selling price of $500. Surely, during this time, we should have these basic problems settled if we have anything settled in the field of education in agriculture.

But, I suspect that in any group of professional dairy scientists such as are represented here this morning, there are many different viewpoints as to what should be the criteria by which we should evaluate the character and effectiveness of the curricula to be set up in their particular specialties of education in agriculture.

The three criteria for testing a curriculum which I can most strongly defend are:

1. What is the purpose of a college training in dairy science and does our program serve this purpose?
2. Does it produce a truly well-educated college graduate, equal to the best in any other field of human service, or does it give us only a craftsman or technician?
3. Are our programs too specialized and rigid in requirements and designed only for the present, or will they also equip the dairy science major for his part in the next quarter-century of dairy development?

We take it for granted that everyone feels that our undergraduate programs could and should be upgraded—not to achieve status, but to more adequately meet the needs of modern dairy science as well as the modern-day student.

But, how many of you here this morning talk with students concerning curricula content? Or how often has a student raised the question with you? May I suggest that they are silent because you have set them too good an example. And what we need are some professors who are both inspiring and disturbing, as well as some undergraduate students who regularly voice their intelligent dissatisfaction with our course offerings. How fortunate we would be if we could only discover a Conant who would rediscover agriculture.

Recruitment. An acceptable word in dairy science circles? I also raise, in passing, the question concerning your efforts to recruit top students for the dairy science curricula. High school principals and guidance counsellors just don't understand modern dairy science, but county agents and the 4-H staff do. Have you ever discussed with them their unique opportunity to recruit for you, or do you feel that inasmuch as they are scattered over your statewide campus that the probable returns just might not be worth your effort?

Where to look for potential students—in the town or in the country? The per cent of the population between the ages of 18 and 24 enrolled in school is about a fourth larger for urban than for farm youth. The percentage of urban high school seniors who plan to attend college (among those who were seniors during October, 1959) ran 59% higher than for farm high school seniors (32 and 51 out of a hundred). The reasons are many and they are complex.

In reading last year's symposium papers, I failed to find student or job placement mentioned, although I suspect many of you are quite active in this field. If not, I strongly urge you to consider this phase of your program as important. Placement competitionwise is difficult due mainly to the fact that at the baccalaureate level you generally have only the average student available for on-the-job placement. (Even then, you are in competition with his military obligation.) The highly qualified student, having decided freely or by coercion to go on for graduate study. And all too often you arrange to have him take his work under you after all you have taught him, he must be good; so, why let him go to a strange university and get any new or different ideas?

Then too, I often wonder if many of our graduates aren't heeding Bob Hope's advice on going out into the world today, Don't. Certainly, graduate work is necessary and essential to meet the increasingly high demands of the scientific and professional world. Yet, I sometimes question the balance of modern education in that over a third of today's high school graduates don't go to college, and about one-third of our most able college graduates won't leave college until they are too old to consider anything but the academic life.

James Reston recently wrote that "A generation ago we deplored the athletic bum who put sports ahead of everything else. Now we have substituted the academic bum who puts books ahead of everything else." Money produced both of them.

This cult of graduate degrees encouraged by parents, teachers, foundation and government grants is not all bad, but it does mean that we are getting a relatively few of our best minds into the lifestream of our business, industry, and public service today.

This causes justifiable concern, as evidenced by the fact that the manufacturing representative on this Association's educational committee commented thusly in a letter to your committee chairman:

"If the industry demands a high caliber of training and accomplishment of dairy school graduates and gets what it demands, I feel certain that it will pay for what it gets. The universities that can train their graduates to meet the high standards will find a ready market for their product. Those that cannot will soon be required to raise their academic standards or drop the courses altogether. I feel that the success of the program will lie in courageously setting the standards sufficiently high. When we do that we will attract a caliber of student commensurate with the program.

"Two other thoughts I'll briefly mention concern the universities, also. The first is that the colleges might take a greater part in assisting their graduates in locating suitable positions. This would need to be done on an individual basis whereby the training the student has had and his personal response to the complete academic program would be evaluated. This might help create a demand for the highly trained, well-balanced student and thus effect a more favorable salary range. In back of such a program would be the effective screening of students prior to their second or third year in college."

Simply stated, the desirable goal is better-trained and qualified men in better-paying jobs, but at work in industry.

Let me explain that I am in full sympathy with the current emphasis on producing Ph.D's, but I also favor at an earlier age real production by Bachelors as well as Ph.D's.

Let's get back to my multifarious topic and have a quick look at the aspects of reorganizing and consolidating dairy departments. Ideas freely discussed but difficult of achievement, you will agree, even though it is a device which is currently the height of fashion.

A basic assumption we have to make if we follow this road is that in union there is not only strength but quality. And that in order to compete, colleges of agriculture and dairy science departments, like the corner grocer, must join together to fight the supermarkets.

Professor- and facility-sharing is in vogue, and to the extent that we profit by either or both in producing a quailty product at a lesser cost, the technique of consolidation should be further explored and implemented. We must realize, however, that it is most difficult to convince faculty, parents, students, and even state legislators that this is the wise or politic road to pursue, particularly across state lines, although federation has been more successful in a limited number of private colleges.

The New England Study of Agriculture in that area's land-grant colleges is still in the formative stage and its objectives have not yet been clearly defined. The director of the study, Dr. H. A. Brinser says, "We may have to come to a system of in-and-out education, in which a student comes in for some education, out for experience, back for more education, etc., until the proper level of education for the individual has been determined." Not a new idea, we must admit, but an interesting one. This thought may lead one to conclude that there is merit in further considering the twelve-month college, four terms, refresher courses in technology, and a working-learning partnership with industry. We are moving in this direction at a faster rate than most faculty or students realize.

Some regional and interstate educational plans do work; witness the Southern Regional Education Board's arrangement in veterinary medicine and other professional programs now operating. It should be pointed out, however, that the financial advantage is mostly in favor of the paying state. For example, Maryland gets a graduate veterinarian for an out-of-pocket outlay of $6,000, whereas it actually costs Georgia $7,500 to $8,000 to educate this same individual. Admittedly, Georgia gains some fringe benefits, such as research findings resulting from graduate thesis work and perhaps greater budget flexibility.

Now, what about the yields from intrauniversity reorganization and consolidation? Such local arrangements appear to me to have considerable potential from the point of view of both intellectual stimulation and the reduction of credit-hour costs.

Faculty must respond to the needs of our changed students. (I am hopeful that better students will bring this response, as better salaries have not.)

All too few faculty members make an honest effort to change course content and teaching methods to challenge these new students. Few and far between are the professors who take a hard look at the total curricular offerings reinforcing his major field. Instead, when he hears from the president or director of admission "that this fall's class is the best ever to enter the university," he immediately decides to hand out longer assignments, while maintaining the same curve in the grade scale.

We must, indeed, revise and up-date the technology taught and we must teach it better and do it now. We must have curricular flexibility without laxity. Courses must have depth, and proliferation must be resisted at all costs. Therefore, upon you falls the responsibility for determining the objectives of education in dairy science, and not allow the courses to fall together willy-nilly, unduly influenced by the urge to be in fashion, the new professor with a new specialty who must have new research assistants to assist in building his new empire. Department heads must resist the temptation to be everything to everybody, particularly commodity organization, and small businesses who want ready-made employees.

At this point, I should warn you against the inherent weakness in practicing Parkinson law as I know from experience that our presidents and provosts are quite adept and positively insistent on the size of staff being status quo or even reducing the numbers of staff. (You know the gimmick, replacing two mediocre staff members with a top-quality man and saving 100% of the salary.)

But why should they not follow these tactics as long as you continue to try to fill vacant slots with the same kind of man, with very little if any thought given to why and what will stand your department in good stead 10 yr hence.

On the organization at the department or division level, there is quite often a distinct opportunity to add depth to staff, scope to your offerings, reduce duplication of equipment, and add competence to your graduates. In short, it is high time we replaced our box stalls with a functional dairy barn with a milking parlor.

Let's educate for all the segments of today's agri-business–industry complex. To do this, we may well have to consider the wisdom of introducing a 5-yr curriculum in agriculture with the broadly educated student having earned both a baccalaureate and a master's degree. If this innovation were made, a technical or practical training program would be a logical complement, terminal with an associate degree. (The trend in this direction is a 24.3% increase in enrollment in the last year.) Taught by the same faculty (different course content) with a credit-hour penalty involved for those students deemed capable of transferring at a given point to the degree program.

In conclusion again, may I warn you of the folly of reorganizing or consolidating just to be in style or to evade a looked-for administrative or board of regents edict. The current paper reorganization rash in colleges of agriculture of new divisions, bureaus, and institutes all too often adds to the problems of administration and lessens the productivity of those individuals unwilling to be reorganized or consolidated. I say this in spite of the fact that when your vote was counted, you were in favor, but by the time you had re-established your place in a new pecking order, you were in a cold war, or didn't give a damn, at best. Of course, there are exceptions where changes are not the result of expediency and have been wisely made and widely accepted.

As a starter, or even a finisher, why not consider the organization pattern we would design were we to have the opportunity and challenge of establishing a brand new land-grant college system today to meet the needs of our dynamic agriculture of the next century?

Oh, yes! Agriculture will be with us in the 2062 and a look at today may provide some clues as to its importance tomorrow.

We have today 3,700,000 farms in the United States producing the food and fiber for 186,000,000 Americans and for millions of others throughout the world. Estimates from the Census Bureau indicate that the number of people to be fed and clothed in this country by 1970 could reach 220,000,000. Africa and other underdeveloped countries will probably have their populations doubled before the year 2000. These countries will not be able to produce sufficient food to supply their needs until about the year 2040. If the United States population makes such growth, and if we are to feed and clothe the people in 1975 as well as they are fed and clothed today, the farmers must produce half again as much as they are producing now. It appears highly likely that our agriculture can meet this challenge, not in spite of, but because of our land-grant colleges and the Department of Agriculture. In fact, if productivity continues to increase at the present rate, surplus problems will be even more acute than now. So, the dairy scientist and his counterpart allies in the department might well consider not only the natural and physical sciences, but allow for enough curriculum flexibility to include the social and political sciences, also, if and when you decide to surmount local, state, interstate and regional problems by up-dating, revising, reorganizing, and consolidating the dairy departments of the 21st century.

Thank you.

CALL FOR PAPERS FOR THE 1963 ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

S. D. Musgrave, Chairman, Program Committee, A.D.S.A.
Department of Dairying, Oklahoma State University, Stillwater

The 58th Annual Meeting of this Association will be held June 16-19, 1963, in the Memorial Center of Purdue University, Lafayette, Indiana.

All members of the Association, including graduate student affiliates, are entitled and encouraged to submit papers for consideration for presentation. Participation by members of industry and by senior members of the Association is especially encouraged. The Program Committee favors the general policy that an individual present only one paper and that his name should appear as author on no more than two. This committee, with the Association officers and membership, wishes to stimulate excellence in research and in presentation and realizes that these restrictions may penalize certain members engaged in full-time research. Therefore, a member may exceed these limits if he or his department ranks the affected abstracts in order of preference for oral presentation.

Papers submitted for the Annual Meeting must be confined to research that has not been reported elsewhere. Abstracts of papers accepted for publication by a scientific journal before the annual meeting are not acceptable for presentation at this meeting. If the total number of acceptable papers submitted by the membership for presentation in a section program is too great to include in the program, the committee will assign some papers to be read by title. In this event, consideration will be given to evident quality of research to be reported and number of abstracts per author and per department. Abstracts arriving late may be read by title or rejected.

Attention is called to the Dairy Manufacturing Extension Section program, and interested members are urged to participate. This is a subsection of the Manufacturing Section.

Mimeographed copies of pertinent details and data are desirable for distribution at the time of presentation. At least 300 copies should be made available. They should be numbered with the assigned program number in the upper right corner of the first page. This can be supplemented with slides for projection, provided the author can adhere to the assigned time of 12 to 14 min for presentation of each paper. For papers presented in joint sessions or in a symposium, it is suggested that 500 copies of the mimeographed material be made available.

ABSTRACT PREPARATION

The Program Committee continues to encourage improvement in quality of material to be presented and in the method of presentation. Good experimental design and interpretation are essential. Exact compliance with these instructions for preparation of abstracts will simplify the task of the Program Committee, improve the program, and ease your own work load. Careful editing of abstracts before submission is essential! Each year a number of abstracts must be returned for correction or clarification.

1. Submitted titles and abstracts must be in the hands of appropriate section officers by March 1. This deadline must be met to permit publication of titles with the complete program in the April Journal and abstracts in the May or June issue.
2. Four copies of each abstract must be typed double-spaced on 8½- by 11-inch paper. The original (on bond paper) and the first carbon should be mailed to the chairman, the second carbon to the vice-chairman, and the third carbon to the secretary of the Section where the paper

is to be presented. The original copy will be used for publication in the JOURNAL.

Student affiliates entering the Graduate Student Presentation Contest should check below for additional instructions on submitting abstracts.

3. Abstracts must not exceed 200 words by actual count. Those exceeding 200 words must be returned to the author for revision.
4. The style and abbreviations of the JOURNAL OF DAIRY SCIENCE must be used. Please refer to abstracts in the May, 1962 JOURNAL for guidance.
5. Only initials of authors should be used, except in unusual cases, where it may be necessary to use the complete name.
6. When more than one author is listed, indicate who will present the paper by an asterisk after his name.
7. The title should indicate clearly the nature of the research. It should not be repeated in the text. The abstract should indicate, insofar as possible, the design and major results of the investigation. Only completed research should be reported. Brief, essential statistics will make the abstract more meaningful.
8. The following form with no caps for the title is correct: Utilization of carbohydrates posterior to the rumen-reticulum of the bovine. J. T. Huber and N. L. Jacobson, Iowa State University.
9. If the author lists an address for an experiment station other than the university, such as a USDA research branch or a commercial company, the complete address should be provided, as in the following example: A study of dye reduction methods as platform tests for the detection of antibiotics. Burdet Heinemann, Producers Creamery Co., Springfield, Missouri.
10. All symposium papers should be typed double-spaced and organized according to the acceptable style of the JOURNAL OF DAIRY SCIENCE. The author should send the first copy directly to the JOURNAL editor, E. O. Herreid, before the annual meeting.

GRADUATE STUDENT PRESENTATION CONTEST

This contest will be conducted in both the Production and Manufacturing Sections. A cash award will be given to the winner in each section. Each institution is entitled to enter one participant in each contest. Participants must be student affiliate members. Complete rules for the contest will be sent to department heads. Those wishing to enter the contest must submit copies of their abstracts to the section officers as outlined above. In addition they must include a letter indicating their desire to enter the contest. This letter must be signed by the major professor and the department head. A carbon copy of this letter and four additional copies of the abstract should be mailed to the contest representative so as to be received by March 1.

For Production Section Graduate Student Competition: Dr. J. L. Albright, Department of Dairy Science, University of Illinois, Urbana.

For Manufacturing Section Graduate Student Competition: Dr. A. V. Moore, Department of Dairy Science, The Agricultural and Mechanical College of Texas, College Station.

Names and addresses of officers of sections to whom titles and abstracts should be sent are:

EXTENSION SECTION

Chairman: C. D. McGrew, Department of Dairy Science, Ohio State University, Columbus 10.

Vice-Chairman: D. E. Voelker, Department of Animal Husbandry, Iowa State University, Ames.

Secretary: C. H. Parsons, Department of Dairy and Animal Science, University of Massachusetts, Amherst.

PRODUCTION SECTION

Chairman: L. H. Schultz, Department of Dairy Husbandry, University of Wisconsin, Madison.

Vice-Chairman: V. R. Smith, Department of Dairy Science, University of Arizona, Tucson.

Secretary: P. M. Reaves, Department of Dairy Science, Virginia Polytechnic Institute, Blacksburg.

MANUFACTURING SECTION

Chairman: D. M. Graham, Pet Milk Co., Research and Development Center, Greenville, Illinois.

Vice-Chairman: E. L. Thomas, Department of Dairy Industries, University of Minnesota, St. Paul.

Secretary: M. E. Ellertson, Carnation Research Laboratory, 8015 Van Nuys Boulevard, Van Nuys, California.

(The Dairy Manufacturing Extension Section is a subsection of the Manufacturing Section. A. L. Rippen, Department of Food Science, Michigan State University, East Lansing, is chairman, and J. C. White, Professor of Dairy and Food Science, Cornell University, Ithaca, New York, is secretary of this subsection. All abstracts for papers in this subsection should be submitted through the regular channels of the Manufacturing Section, and should be identified for presentation at the Manufacturing Extension Section meeting and a courtesy copy sent to A. L. Rippen, Chairman.)

PRICE SCHEDULE FOR REPRINTS OF PAPERS THAT APPEAR IN THE JOURNAL OF DAIRY SCIENCE

H. F. JUDKINS, Secretary-Treasurer
32 Ridgeway Circle, White Plains, New York

The Executive Board, at the time of the Annual Meeting of the American Dairy Science Association at the University of Wisconsin, increased the price of reprints 25%, effective July 1, 1961. The new reprint schedule follows:

No. of reprints	Number of pages								
	2	4	8	12	16	20	24	28	32
	(Cost in dollars)								
50	17.50	20.00	36.25	51.25	67.50	78.75	97.50	115.00	125.00
100	20.00	22.50	41.25	61.25	77.50	92.50	112.50	132.50	145.00
200	22.50	28.75	51.25	76.25	97.50	117.50	143.75	162.75	185.00
300	28.00	33.75	62.50	91.25	117.50	143.75	173.75	205.00	226.25
400	30.00	40.00	72.50	107.50	137.50	170.00	205.00	241.25	266.25
500	33.75	45.00	83.75	122.50	157.50	195.00	236.25	277.25	306.25
600	37.50	51.25	93.75	137.50	177.50	221.25	266.25	313.75	346.25
700	41.25	56.25	105.00	153.75	197.50	246.25	297.50	350.00	387.50
800	45.00	62.50	115.00	168.75	218.75	272.50	328.75	386.25	427.50
900	48.75	67.50	126.25	185.00	238.75	298.75	358.75	422.50	467.50
1,000	57.25	73.75	136.25	200.00	258.75	323.75	390.00	458.75	507.50

If covers for reprints are desired, the cost of 50 covers will be $21.18, and for each additional 100 covers, the cost will be $8.75. Back copies of the JOURNAL will cost $2 each.

The reprints are made from standing type within 30 days after the papers appear in the JOURNAL. Requests for a few reprints of a paper should be sent to the authors, whose names and addresses appear with the title. The Secretary and the Editor's office do not keep supplies of the various reprints. Orders for large numbers of reprints should be sent to The Garrard Press, 510 North Hickory Street, Champaign, Illinois. These orders must be received within 30 days after the papers are published in the JOURNAL; otherwise, the type will have been destroyed.

In case the original type has been destroyed, it is possible to supply reprints by a special photographic process, and their cost will be 50% more than the regular ones. For example, 100 reprints of 32 pages will cost $217.50.

It is hoped that the publication of this reprint schedule will make it easier for interested people to obtain reprints in any number desired and, at the same time, aid in disseminating useful information to the dairy and related industries.

FIFTY-SEVENTH ANNUAL MEETING, AMERICAN DAIRY SCIENCE ASSOCIATION, UNIVERSITY OF MARYLAND, JUNE 17-21, 1962

E. L. JACK, President and Presiding
Department of Food Science and Technology, University of California, Davis

Inadvertently, the following material was omitted from the August JOURNAL. The reader is referred to page 1028 of that issue for the beginning of this article covering the 57th Annual Meeting of the American Dairy Science Association.
—ED.

PRESIDENTIAL ADDRESS

Honored Guests, Members of the American Dairy Science Association, Ladies and Gentlemen:

The president of a society such as ours has two obligations in addressing the membership at the Annual Meeting: to give an accounting of his stewardship in relation to the affairs of the society, and to point out some of the problems likely to be encountered. The affairs of the Association may be discussed under three headings: the physical aspects such as finances, membership, and JOURNAL circulation; the scientific climate within the Association; and the Association activities of the members.

E. L. Jack

I shall direct my remarks first to the physical aspects of our Association. I am pleased to be able to report that the financial condition at the present time is sound. Last year, because of some loss of advertising revenue and of increased costs of publication, we encountered a deficit. At first it appeared that this deficit might be as much as $15,000, but later audits showed it to be only about $7,000. Even though we had ample reserves to carry this without embarrassment for one year, steps had to be taken to bring us back to a stable basis. Your Executive Board a year ago initiated several measures designed to achieve fiscal soundness. The dues and subscription rate to the JOURNAL were increased along with the price of reprints. Also, this year the Journal Management Committee instituted some savings in newsprint by adopting a two-column page with a different size type face for the JOURNAL. In addition, the A.D.S.A. Review was discontinued because it did not seem to be serving a purpose sufficient to justify its cost of about $3,000 per year.

Another source of increased revenue adopted by the Executive Board was the creation of a Sustaining Membership classification for industrial supporters of the Association. While one of the results of Sustaining Membership is increased revenue, in my opinion it should not be regarded primarily as a revenue-producing action. Actually, what it does is give industrial organizations a recognized way of supporting the American Dairy Science Association in its scientific endeavors by corporate action rather than solely by individuals. I am pleased to report to you that a substantial number of organizations this year have taken sustaining memberships, and I am sure they will benefit from this action. Also, we are very appreciative.

Membership is the life blood of any organization and there was some apprehension that perhaps the increase in dues, together with a tendency toward a decrease in the number of university scientists solely in dairy science, would make it difficult to maintain our membership. However, I am pleased to report to you that, thanks to the strong efforts of our membership solicitors, the national, regional, and state committees with yeoman assistance from our Secretary, the membership total is about 2,500, where it has remained relatively stable for several years. Also, the number of affiliate members, which is vital to the future of our Association, is holding about where it has been. And the circulation of the JOURNAL to subscribers other than members has not diminished. I think we can be pleased that we have been able to maintain our membership and circulation levels. Growth is usually desirable, but maintaining a strong stable position in the face of obstacles is not to be disdained.

A proper scientific climate is another element of strength in a scientific society. There are several criteria that can be used to judge the climate of our society. First is the quality of scientific achievements to which our Association contributes. I refer mainly to the papers published in the JOURNAL and presented at our national and divisional meetings. The scientific merit of these papers is, indeed, impressive. It is apparent to those of us who have watched the changing character of the educational and research activities over the years that dairy science has kept pace with the general development and has given its share of leadership. Our Association has had a big part in this change through offering a critical but receptive forum where ideas can be presented and debated.

Another way in which the scientific stature of our Association may be measured is in its relationship to other groups. As evidences of leadership we appoint each year representatives to numerous organizations, both within and without the dairy industry. These take the form of formal advisory committees and of individuals of liaison and advisory purposes. A new committee of this sort was appointed this year to the Dairy Society International at its request, and one has been authorized as advisory jointly to the Food and Agricultural Organization of United Nations and the federal Food and Drug Administration.

Additional international leadership is exhibited in many other ways. We represent the largest community of dairy science scholars in the world and we would be sadly remiss if we did not extend our assistance wherever it can benefit. The Symposium on Education for Leadership in Dairying in Latin America on our program this year is an example of one of the areas in which we can serve. Among other ways is the technical assistance rendered by many of our members on an individual basis. But whether on an individual or an Association basis, the background of A.D.S.A. activity is always a helpful factor. This leadership may well be expanded and extended. The opportunities are many and the need is great. The Atlantic Community will soon be a reality and dairy science must carry its full share of responsibility in this great movement. Powerful forces are moving to achieve economic integration and increased unity of political action in the free world. The realization of these aims can have a greater influence on the future of mankind than all the threats of nuclear destruction. These are the ideologies that defeat those who would overthrow our systems. Our Association should continue to strengthen its position of leadership to assist in this development.

Another source of strength in our Association is the widespread and active participation in Association affairs by the members. Last year there were 35 committees and representatives comprising 165 persons serving the parent body. Add to this number the officers and committees of the Extension, Manufacturing, and Production Sections and the total is increased by 85 or 90 more. Also, there are those serving the Eastern, Southern, and Western Divisions. A conservative estimate is that there are about 350 members participating in the affairs of the Association under formal election or appointment. This is nearly 15% of the total membership and is a substantial factor in maintaining the cohesiveness necessary for a vigorous Association.

The students in dairy science to whom we must look for future leadership have been active. The student branch of the American Dairy Science Association is a lusty infant with its own constitution, officers, and program. This is a movement to which we must give encouragement and sound guidance. Mention must also be made of the student competitions, including the presentation of research papers and the club activities reports. It is evident that our young people are picking up the torch.

Review of member activities would not be complete without mentioning some of the internal-association cooperative activities. These usually take the form of joint committees among the sections. We long have had joint committees between the Extension and Production sections because of their closely allied interests. Recently, however, all the sections have joined in committees to provide technical knowledge from their own individual fields on problems that extend across all areas of dairy science. This is most commendable and is to be encouraged wherever it can be effected.

Thus, it appears to me that our Association today is in a strong and vigorous condition; the financial affairs are in balance, the JOURNAL circulation is good, the scientific climate of the Association is healthy and conducive to maintaining a position of leadership in dairy science, and the participation by the members in Association affairs is widespread and effective.

For this healthy state of affairs the Association is indebted to many people: those who established the firm base on which we operate, the many persons who formally or informally serve in many ways, your Editor-in-Chief who has done so much to elevate the standards of the JOURNAL, the Secretary-Treasurer who looks after the affairs of the Association so vigorously, and the Executive Board which has deliberated the problems and resolved them wisely.

So much for the present state of affairs. What of the future? In order to appraise the future with some degree of intelligence, it is necessary to examine briefly the broad background of the Association and those matters relating to it.

A quick look at the development of science in agriculture and its relation to dairy science will perhaps help us to see where we are today with respect to agriculture and our contemporary sciences. Originally, curricula in agriculture were composed largely of basic sciences—botany, chemistry, geology, and a few others—with only scant reference to applications to agriculture. Soon it became apparent, however, that there were special applications of these sciences to many areas of agriculture. Thus, departments were formed to exploit and expand specialized knowledge in nearly every segment of agriculture. This departmentalization and specialization resulted in tremendous advances in all agricultural practices and particularly in the dairy industry. It was within the framework of these developments that many scientific agricultural societies, including the American Dairy Science Association, came into existence. They were essential parts of this great advancement, in that they promoted scientific interchange through the publication of suitable journals and through the presentation of results of research at formal meetings. These societies have continued to thrive because they provided leadership for the development and application of science.

What is the situation today? It seems that we have come nearly full-circle in our educational and research activities. Once again the emphasis is on basic sciences, with the applications to practical uses subordinated. Our dairy scientists are no longer husbandmen and technologists; they are geneticists, physiologists, nutritionists, chemists, bacteriologists, and engineers. Their allegiance is torn between their basic science field and the applied field on which their activities bear. One of the tasks of the American Dairy Science Association is to maintain a scientific climate that will retain the allegiance of these and future basic scientists to our Association.

Sweeping changes have taken place in industry, also. I need not dwell on the revolution that has occurred in milk production, processing, and marketing. The development of large-scale operations, the adoption of science-based practices, the advent of automation, and unionization have greatly changed both the technology and the manpower situation in industry. The need is for relatively fewer technically trained men, but those that are needed must have a much broader and stronger education than in the past. This situation poses problems for A.D.S.A. in educational policies and in membership potential.

In our universities and research institutions there is an increasing tendency for dairy science to lose its identity. This stems, in part, from the increased emphasis on basic science which cuts across commodity and departmental lines, but is also accounted for by consolidation necessitated by low student enrollment and by the emergence of broader areas of interest having a common scientific base. The same trend prevails in industry; our large dairy companies no longer are concerned solely with milk and milk products but are in the general food business. These are changes that may seem at first glance to bode ill for the American Dairy Science Association. But they need not if the Association is alert to the opportunities offered for leadership. Changing conditions and new challenges are the most constant of all things in life. They continually offer opportunities for progress. They are detrimental only when ignored by trying to maintain the status quo. These, then, are the conditions that confront our Association, and decisions will have to be made as to how to meet them effectively.

It would be presumptuous of me to attempt to lay out a blueprint for the future as to how this can be done. There are certain basic principles, however, that I think are self-evident and, if adhered to, will assure an increasingly influential future for our Association. In the first place, I believe that there is now, because of the changing conditions I have noted, more than ever a need for the American Dairy Science Association as a unifying force in dairy science research and education. With the great dispersion of dairy science it is of utmost importance to have a journal and meeting forums where ideas can be brought together for study and debate. A central agency for dairy science affairs is a necessity if dairy science is to prosper. The American Dairy Science Association is such an agency. Secondly, I am firmly convinced that A.D.S.A. must maintain a favorable scientific climate and must strengthen it at every opportunity. Only in this way can good scientists be attracted to our Association, and without a strong nucleus of the best scientists in the field we are doomed to wither and die.

A strong and vigorous Association has many opportunities for effective leadership. In particular, one area where our Association might profitably direct special attention is in connection with the problems of dairy science education. I have mentioned earlier some of the changes that have taken place in this field. These changes have posed difficult problems for our universities and the solution of them is not yet clear. Various means have been adopted by different institutions in adjusting to changed conditions and many of these measures have not been favorable for dairy science. Our Education Committee, through a series of symposia during the last few years, has called these problems to the attention of the membership. Another such symposium is scheduled for this year. The problem has been stated adequately. The solution remains to be determined. This would seem to be an area in which the Association could direct major effort to working with university administrators and departments in developing a solution to this problem so that the teaching of dairy science would not suffer. A sound plan or plans developed in conjunction with the other interested parties and officially endorsed by the American Dairy Science Association should have substantial influence in shaping the future of dairy science education.

Regardless of how the future may develop, the challenges will be great and meeting them will give much pleasure and satisfaction to those who will have that privilege. I have utmost confidence in their success and my best wishes go to them.

Now in conclusion, I have enjoyed this past year as your President and I am grateful to you for allowing me that privilege. My thanks also to the entire membership for giving so unstintingly, some formally and some informally, to the affairs of the Association. There was not a single person who did not perform any task requested of him if able to do so. That sort of loyalty is characteristic of our Association and therein lies its inner strength.

Long may it continue!

E. L. JACK

Delivered at
University of Maryland
June 18, 1962

Citation by Dr. K. L. Turk for the Recipient of the American Dairy Science Association's Award of Honor for 1962

The highest recognition that the American Dairy Science Association can extend to any of its members is its Award of Honor. Again this year it is our privilege to honor a distinguished teacher and scientist, a man who is concluding an outstanding 42-yr. career in dairy cattle education and research.

The recipient of our Award of Honor was born and raised at Clermont, Iowa. After finishing high school, he entered Iowa State College

R. B. Becker

(now Iowa State University) and completed the B.S. degree in 1916. After serving in the 91st Infantry Division of the United States Army in World War I, he returned to Iowa State College for graduate work and earned the M.S. degree in 1920.

At that time he accepted a position as Instructor of Dairy Dairy Husbandry at Kansas State College (now Kansas State University), where he remained 3 yr. He later served as Instructor at the University of Minnesota, where he completed the requirements for the Ph.D. in 1925.

After completing his grauate work our recipient was appointed Associate Professor of Dairy Husbandry at Oklahoma A & M College (now Oklahoma State University), a position he held 3 yr. In 1929, he transferred to the University of Florida, serving as Associate Dairy Husbandman until 1935 and as Professor of Dairying and Dairy Husbandman continuously since that time.

His long and distinguished service to three universities, especially to the University of Florida, and to the dairy industry, is widely known and appreciated. While his interests in research have been many, our recipient probably is best known for his contributions and stimulating leadership in mineral studies with cattle. His name is intimately associated with cobalt studies and the establishment of cobalt as a necessary nutrient, with research on copper, and with classical investigations on the role of calcium and phosphorus in the nutrition of dairy cattle.

President E. L. Jack congratulating Dr. R. B. Becker (center) after presenting him with the American Dairy Science Association Award of Honor. Dr. K. L. Turk (left) read the citation.

He is also well known and respected because of his investigations into the factors which make for a productive dairy herd, studies on the useful life span of dairy bulls, and the management and breeding patterns which result in the development of a profitable dairy operation.

This man has been particularly appreciated by the dairymen of the country because of his intimate knowledge of dairy production problems and because he has been interested in conducting extensive and continuous studies with various feedstuffs. He is a careful and meticulous worker and his insistence upon careful evaluation of new feed materials has paid tremendous dividends to dairy farmers and the entire dairy industry. The results of his research have been recorded in more than 90 scientific articles and bulletins. In addition, he has published over 100 articles in trade and breed journals. He has recently completed the manuscript for a new book entitled, Dairy Cattle Breeds — Origin and Development.

It may surprise you to know that our recipient has been active all of his life in paleontology and anthropology. Many of his specimens collected are now housed in some of the most famous museums in this and other countries. He has been an active stamp collector for many years, and has spent some of his other spare time in nature study, particularly in the field of ornithology. Also, he has been active in his church and in Rotary International.

This man has served our Association extensively and ably since his first appointment to the 4-H Club Committee in 1922. His service on many of our important committees has been almost continuous since that time. On two different occasions he served as Secretary, Vice-President, and President of the Southern Division, A.D.S.A., and he served as Vice-President of this Association in 1951 and President in 1952.

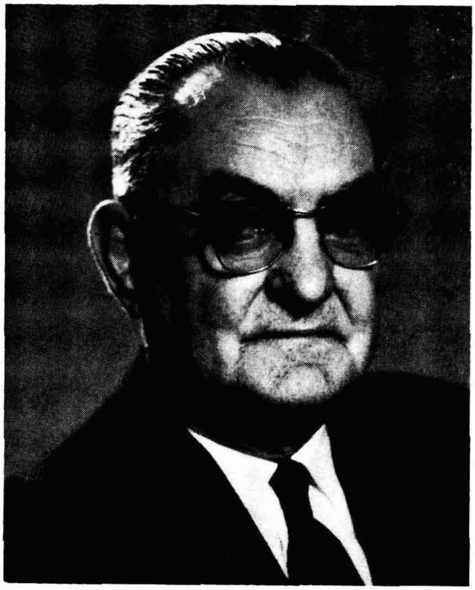
Many honors have come to our recipient. He received the Honors Award for distinguished service to the dairy industry of the South presented by the Southern Division, A.D.S.A. in 1952. He received the Borden Award in dairy production in 1953. His University presented him with the first Gamma Sigma Delta Senior Faculty Award in 1955, the outstanding teacher award presented by Alpha Zeta in 1959, and the Blue Key Certificate of Appreciation in 1959, in recognition of significant contributions to his profession and to academic life at the University of Florida.

Tonight the members of the American Dairy Science Association are pleased to bestow further honor upon this distinguished fellow member. Our Award of Honor does not carry money value, as do most of the other awards, but it does include best wishes from more than 2,500 members of this Association, in recognition of his many contributions to the dairy industry.

The American Dairy Science Association bestows its highest recognition, the Award of Honor, on Dr. Raymond B. Becker of the University of Florida.

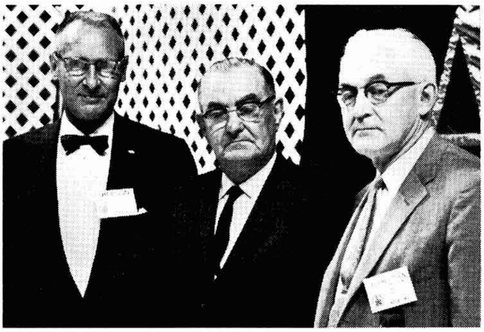
Citation by Professor Raymond Albrechtsen for the Recipient of the DeLaval Extension Award for 1962

The recipient of the 1962 DeLaval Award in Extension was born in Indiana. His early experience in dairy farming came from living on a Jersey farm and his experience as a 4-H Club boy. At this early age, he showed qualities of leadership by becoming a leader of the 4-H Club work in his community. This leadership trait was further developed at Purdue University where, while earning his B.S. degree in Dairy Husbandry, he also was managing director of the student daily newspaper, a chairman of the Senior Gala Week and many other campus functions. He was a member of several honorary journalism and public relations fraternities.



C. G. Cushman

He entered dairy extension work in 1921 in a state rather distantly removed from his native state. His ability to organize people was quickly brought into play in his new work. He recognized the disastrous consequences of using scrub dairy sires, so he proceeded to organize Scrub Sire Eradication Programs. His interest in dairy cattle and other types of livestock led to the organization of 16 county agricultural programs which eventually resulted in the establishment of 11 milk fat manufacturing plants. These programs gave significant impetus to dairying in this state.



Dr. G. H. Hopson (left) of the DeLaval Separator Company presented the DeLaval Extension Award to Professor C. G. Cushman of Clemson College, with Professor Raymond Albrectsen (right), who read the citation.

He devoted a great deal of time to the development of a forage production and harvesting program supplemented with extensive annual and permanent pasture demonstrations. These works are basic to the present practices throughout the state.

His versatility in the field of dairy husbandry is exemplified by his organization of 4-H dairy clubs, his leadership in brucellosis eradication, the organization of four state dairy cattle organizations, and the organization of artificial breeding associations.

He has served as chairman of such activities as June Dairy Month, a committee studying the dairy industry in the state with recommendations for long-range program development. More recently, he has been chairman of a public relations committee involving television, radio, and press programs in the public relations effort in keeping the dairy industry of his state in a favorable position in the eyes of the general public.

In the field of dairy herd improvement association work, he is credited with devising a system of recognizing the percentages of various dairy cattle feed nutrients that need to be considered in evaluating feeding programs on dairy farms. He has found time to write more than 20 extension circulars and bulletins.

He has been recognized by dairymen in his state, by the agricultural press, and by his associates in the southern division of the American Dairy Science Association for his outstanding contribution to the dairy industry of his adopted home state. The designation of C. G. Cushman of Clemson College to receive the DeLaval Award in Extension is a fitting climax to 39.5 yr of dedicated service to the people and to the dairy industry of the state of South Carolina.

Citation by Dr. Bruce Poulton for the Recipient of the Milk Industry Teaching Award in Dairy Production for 1962

In his book The Education of Henry Adams, the author, Henry Brook Adams, made this observation: "A teacher affects all eternity. He can never tell where his influence stops." Tonight, our Association recognizes a man whose influence as a teacher has been felt by nearly 5,000 students during his 34 yr of active teaching. Certainly, our recipient's influence as a teacher is destined to continue for many, many years. It is particularly appropriate that this

P. M. Reaves

year's recipient be a member of the great State of Virginia's teaching faculty, for certainly our country's agricultural beginnings are in Virginia. Our recipient's career began in Greene County, Tennessee, where he was farm-reared and directed national attention to his exploits particularly as a State Champion Corn-Club boy. He received his B.S. degree in dairy production from the University of Tennessee. He did his graduate work there, receiving his M.S. degree, then continued graduate work at Iowa State College. Since 1928, he has been a member of the teaching faculty at Virginia Polytechnic Institute. His teaching ability has been recognized by his colleagues, who granted him the College's Outstanding Teaching Award in 1957.

Mr. L. S. Robinson (left), General Manager, Sealtest Foods Division, Washington, D. C., presented the American Dairy Science Association Teaching Award in Dairy Production, sponsored by the National Dairy Products Corporation, to Professor P. M. Reaves of Virginia Polytechnic Institute, with Dr. Bruce Poulton (right), who read the citation.

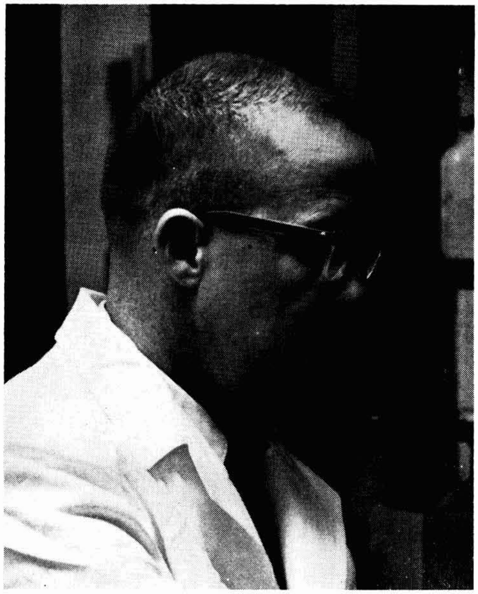
Through the years, he has not only taught but has found time to publish a number of scientific articles and to collaborate as an author on several widely used textbooks in our field. His contributions to our American Dairy Science Association are too numerous to list—suffice it to say that at the present time he is very active in our Organization's Membership Committee and Student Affiliate Committee. He is Past-President of the Southern Section of the American Dairy Science Association.

Perhaps the best way to bring to life his devotion to undergraduate students in dairy science is to quote from the dedication section of the P.I. Dairy Year Book of 1955: "In recognition of his sterling character, unselfish service, wise counsel, and enduring faith in students of dairy husbandry we dedicate the 1955 issue of the Milk Way to—."

At this time it gives me great pleasure to call to the stage for our recognition Professor Paul Marvin Reaves, to receive this year's A.D.S.A. Award for Distinguished Teaching.

Citation by Dr. C. L. Norton for the Recipient of the Borden Award in Dairy Production for 1962

The recipient of the Borden Award in Dairy Production for 1962 was born in Elmhurst, Long Island, in 1916. He attended Johns Hopkins University and Stanford University before enrolling at Iowa State University, where he graduated in 1939. He received his M.S. degree at Rutgers University in 1941. Military service in the African and European theaters of operation



H. D. Eaton

from 1942–1946 interrupted his Ph.D. studies at Ithaca, but he completed his work and was awarded this degree by Cornell University in 1947.

The recipient's research has involved nutritional studies on forage evaluation, methods of calf rearing, antibiotics in calf rations, the role of antioxidants in vitamin A utilization, and prevention of oxidized flavor in milk. However, his research for over 10 yr has dealt primarily with numerous studies of fat-soluble vitamins and their interrelationships and the mechanisms responsible for the biochemical, physiological, anatomical, and histopathological effects of de-

The citation for the Borden Award in Dairy Production was read by Dr. C. L. Norton (left) and presented to Dr. H. D. Eaton of Connecticut State University by Mr. J. H. McCain, Vice-President of the Borden Foundation.

ficiencies of vitamin A. These and others studies are the subject of 62 scientific publications by him and his co-workers.

The recipient is a meticulous researcher who emphasizes precision in all phases of his work. He has always possessed a keen interest in experimental design and the statistical analysis of results. His graduate students have benefited from his unselfish and unrelenting encouragement to develop and his outstanding example of zealous and dedicated research effort.

Aside from a six-month sabbatical leave at North Carolina State College in 1954, and a year's sabbatical leave in 1961–62 at the Philadelphia General Hospital, where he worked on biochemical interrelationships between protein and vitamin A, the recipient has been a staff member at the University of Connecticut since 1947. He received the A.D.S.A. American Feed Manufacturers Award in Dairy Cattle Nutrition in 1952 and the New York Farmers, Inc., Agricultural Award in 1955.

On behalf of the selection committee, it is my happy privilege to ask Dr. Hamilton D. Eaton, Professor of Animal Nutrition, to come forward to receive the 1962 Borden Award in Dairy Production.

L. A. Rogers

Citation by Dr. W. M. Roberts for the Recipient of the American Dairy Science Association Distinguished Service Award for 1962

Our candidate to receive the 1962 Distinguished Service Award is a native of Maine. He earned his bachelor's degree at the University of Maine, and did graduate work in bacteriology and botany at the same institution.

Before the turn of the century he was engaged in research at the New York Agricultural Experiment Station. He joined the U.S. Department of Agriculture as a bacteriologist in 1902. From 1906 until his retirement in 1942, he was chief of the Dairy Products Research Laboratories, U.S. Department of Agriculture.

As scientist, inventor, and author, he has contributed much to the dairy industry. He showed conclusively that butter made from pasteurized sweet cream had better and more uniform initial flavor, and much better keeping quality than butter made from raw, ripened cream. This discovery, made almost 60 yr ago, revolutionized the theory and practice of butter making, and resulted in a tremendous increase in monetary return to the industry.

He initiated, conducted, and through associates directed and influenced both fundamental and applied research for 45 yr over a wide area of dairy science. He was an unselfish leader and developer of scientists. He was admired, esteemed, and loved by them. The discoveries of this man and his associates have contributed profoundly to the knowledge of milk and milk products, and to the development of improved methods for manufacturing or processing milk products.

In all his activities he exhibited a high degree of creativity which led him and his associates to new approaches to old problems. He was endowed with a rare mechanical sense and a love for fashioning new equipment and apparatus. This was a tremendous asset in research a half-century ago before apparatus manufacturers were able to cater to every whim of the experimental scientist.

Alone or jointly he authored almost 100 scientific publications, exclusive of the many published abstracts of papers presented at national and area meetings.

His accomplishments are many, and the honors have not been lacking. In 1937 he was the first to receive the Borden Award. He holds honorary degrees from the University of Maryland and the University of Maine. The building which houses the University of Maine's dairy instructions and research was named and dedicated in recognition of his many outstanding scientific contributions to the dairy industry. The classic reference book, Fundamentals of Dairy Science, was written in 1927 and revised in 1934 by his associates. The book was dedicated to him as follows:

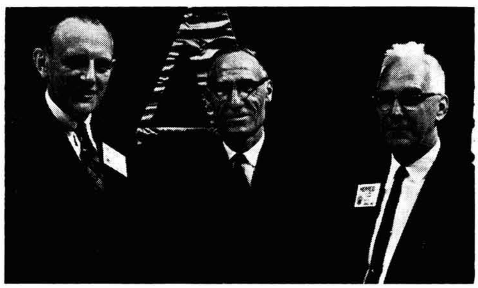
"In recognition of his quarter-century service in the advancement of knowledge, embracing important contributions in pure science as well as its applications to industry; and because he embodies in the highest degree their ideal of unselfish devotion and untiring loyalty, alike to his work and to his fellow workers, this volume is dedicated with admiration and affection, by those who have been privileged to serve under his leadership."

Many years have passed since his associates penned those words. They are worth repeating, however, because the qualities that made him a leader are still evident. It is with real pride that the Committee recommends that the American Dairy Science Association salute this leader by awarding the Distinguished Service Award to Mr. Lore Alford Rogers.

Citation by Dr. Robert Jenness for the Recipient of the Borden Award in Dairy Manufactures for 1962

The 1962 recipient of the Borden Award in Dairy Manufacturing was born in Walla Walla, Washington, in 1905. He was educated at the University of Missouri, receiving the A.B. from that institution in 1929 and the Ph.D. in 1933. From 1933 to 1935 he served as instructor at his Alma Mater and then went to Yale University for 2 yr of post-doctoral study. In the period 1937 to 1939 he was associate professor in the Medical School of the University of Arkansas. In 1939, he joined the staff of the State College of Washington at Pullman, in which institution, now Washington State University, he has served continuously until the present, now occupying the position of Professor of Dairy Science.

The scientific research of the recipient has been principally concerned with basic studies of the nonfat solids of milk and particularly with the milk proteins. His work, characterized by originality, thoroughness, precision, and meticulous attention to detail, has produced valuable techniques now widely used in commercial as well as institutional research laboratories. Examples are a turbidimetric method for estimation of whey proteins as an indication of baking quality of nonfat dry milk, a wettability test for dry milk, a turbidity test for determining efficiency of homogenization, and an improved procedure for determining milk proteins by dye binding. He has been very active in studies of various problems in the field of dry milk including baking quality, reducing substances, solubility and reconstitutability, and flavor. In recent years he has turned his attention to fundamental studies on casein and changes induced therein by the action of rennin.



Mr. J. H. McCain, Vice-President of the Borden Foundation, presented the Borden Award in Dairy Manufacturing to Dr. U. S. Ashworth (center). Dr. E. O. Herreid, substituting for Dr. Robert Jenness, read the citation.

U. S. Ashworth

The recipient is author or coauthor of about 30 publications in scientific journals and of numerous contributions to the scientific sessions of the American Dairy Science Association and of its Western Division. He has served the Association on committees concerned with curd tension, with protein nemenclature and with milk solids. At present he is serving on the Editorial Board of the JOURNAL OF DAIRY SCIENCE.

It is a pleasure to present Dr. U. S. Ashworth of Washington State University as the 1962 winner of the Borden Award in Dairy Manufacturing.

Citation by Dr. J. B. Stine for the Recipient of the Paul-Lewis Award for Cheese Research for 1962

The person chosen by the Committee to receive the 1962 Paul-Lewis Award for cheese research was born in Conway, South Carolina. He received his B.S. in 1943 from Clemson College, his M.S. in 1948 from Iowa State Univer-

E. B. Collins

sity, and in 1949 his Ph.D. from the same institution.

The recipient did research at the Dairy Research Institute at Palmerston North, New Zealand, under the Fulbright Award. He is a member of a number of organizations and societies, including Phi Kappa Phi, Phi Eta Sigma, Alpha Zeta, Phi Lambda Upsilon, Sigma Xi; listed in Who's Who in American Colleges and Universities; member of the American Dairy Science Association, Society of American Microbiologists, and the International Association of Milk and Food Sanitarians. He served in the U. S. Army from 1943-46.

Our nominee for the Paul-Lewis Award has made major contributions to understanding the growth of lactic streptococci separately and in combination with other organisms. Two important aspects have received detailed study. They are the antibiotic production by certain strains of the lactic streptococci, and domination among strains of the lactic organisms, These studies provided information essential for dependable control of composition of cultures in both research and commercial work.

The recipient's studies have provided a program for control of cheese cultures to prevent slow acid production due to action of bacteriophage. The program he worked out involved determining which phages are present in a dairy plant, combining appropriate strains of culture organisms for use in rotation, replacing the combinations routinely to avoid strain domination, examining whey for bacteriophage routinely, and changing the composition of cultures when different phages appear in the dairy plant. This control program has been made available to dairy plants by a commerical laboratory.

The recipient has made a number of contributions to Cottage cheese in the prevention of spoiling of this product. His findings have contributed much to the manufacture of Cottage cheese.

On behalf of the Paul-Lewis Award Selection committee, it is a distinct pleasure to present the recipient of the 1962 Award, Dr. Edwin Bruce Collins, Associate Professor of the University of California, Department of Food Science and Technology, of Davis, California.

Mr. M. W. Hale, Director, Dairy Division, Paul-Lewis Laboratories, presented the Paul-Lewis Award to Dr. E. B. Collins of the University of California. Dr. W. V. Price (right) read the citation.

Citation by H. A. Keener for the Recipient of the American Feed Manufacturers' Award for 1962

The recipient of the American Feed Manufacturers' Award for 1962 was born in Cleveland, Ohio, in 1917. He earned the B.S. degree in 1940, the M.S. in 1941, and the Ph.D. in 1947, all at The Ohio State University. During the past 21 yr he has been the author or coauthor of 130 scientific papers and miscellaneous reports dealing with many phases of dairy cattle nutrition. He has systematically combined fundamental and applied research within the same project to develop physiologically sound, practical feeding programs. His papers have displayed a high standard of scholarship and personal attainment.

The recipient is best known for the following research contributions:

1. Determination of dosage levels and critical time for giving massive doses of Vitamin D for prevention of milk fever.

J. W. Hibbs

2. The development of a high roughage system for raising low-cost dairy herd replacements.
3. Causes and alleviation of anemia in the new-born calf.
4. Low-cost production of dairy beef feeders and relative merits of the dairy breed as economical sources of beef.

Other projects which he has either directed or been closely associated with include the effect of ration changes on feed intake and thyrodial uptake of radioactive iodine, nitrogen metabolism in dairy cows, blood levels of Vitamin A, and the effect of antibiotics on the growth and metabolism of cows.

The recipient received the Borden Award in Dairy Production in 1952. Since 1948 he has been a member of the Graduate Faculty at The Ohio State University. He carries the academic title of Professor of Dairy Science in the Department of Dairy Science, Ohio Agricultural Experiment Station, Wooster, Ohio.

On behalf of the selection committee and the Association, it is a genuine pleasure for me to ask Dr. John W. Hibbs to come forward to receive the American Feed Manufacturers' Award for 1962.

Dr. H. A. Keener (left) read the citation and Mr. W. E. Glennon, President of the American Feed Manufacturers Association, presented the American Feed Manufacturers Award to Dr. J. W. Hibbs (third) of the Ohio Agricultural Experiment Station, with Dr. I. W. Rupel (right), President-Elect of A.D.S.A.

FINAL REGISTRATION, 57th ANNUAL MEETING, AMERICAN DAIRY SCIENCE ASSOCIATION

Men—Members from universities and Federal Government	509
Members from various branches of industry	263
Total members	772
Nonmembers from universities and and Federal Government	81
Nonmembers from various branches of industry	56
Total nonmembers	137
Affiliate members	234
Total males	1,143
Women	440
Children	479
Grand Total	2,062

Previous High—Wisconsin 1961—1,916

The following foreign countries were represented:

Argentina	Ireland
Australia	Netherlands
Belgium	New Zealand
Brazil	Norway
Canada	Peru
Chile	Poland
Colombia	Puerto Rico
Germany	Scotland
Great Britain	Switzerland
India	Union of South Africa
Indonesia	United Arab Republic
Iraq	Venezuela
Vietnam	

All states but Alaska, North Dakota, and Wyoming were represented.

MINUTES OF NATIONAL STUDENT BRANCH MEETING

The third successful meeting of the National Student Branch of the American Dairy Science Association was held at the University of Maryland with President Joseph Lineweaver presiding. Sixteen affiliate chapters were represented, with approximately 60 members attending the business meetings.

The Student Affiliate Chapter Award went to the Georgia Dairy Science Club. Louisiana, Mississippi, and Virginia were given awards of merit for their outstanding work. R. P. Bradley, of Michigan State, was awarded the recognition of being the graduate student who presented the outstanding graduate paper in Manufacturing, while D. E. Otterby of North Carolina State won the award for the outstanding paper in Production.

E. C. Flounders from Abbott Dairies, Philadelphia, addressed the Student Affiliate luncheon, which was attended by 160 affiliates and guests. The main points which he discussed under his topic, What Management Expects from the College Graduate, were:

1. Intelligence
2. Ability to handle people
3. Ability to adapt to the job
4. Ability to communicate
5. Ability to analyze

The breakfast, attended by 65 persons, was the time for recognition of those who helped to make our meeting a success. Dr. J. B. Mickle, our senior advisor, and Miss Rebecca Murray, Maryland's Dairy Princess, were each honored. The present officers, advisors, senior Branch Executive Board, and Past Presidents were also recognized. Miss Louise Knolle, A.D.A. Princess, was honored earlier in the week.

Items of business transacted at the meeting were:

(1) A Student Branch emblem made in the form of a tie-pin was approved. This can be purchased by Student Affiliates from the Secretary-Treasurer of the Student Branch.

(2) The Student Branch agreed to work with W. W. Snyder, editor of the Student Affiliate News, for the JOURNAL OF DAIRY SCIENCE, in featuring one chapter each month along with the regular news in the JOURNAL.

(3) The problem of decreasing membership in the local chapters was discussed extensively.

At the closing meeting of the convention, election of officers was held for our next year's leaders. Those elected were: President—Morris Nichols, Oklahoma; 1st Vice-President—Robert Smargia, Maryland; 2nd Vice-President—Robert Allard, Ohio; 3rd Vice-President—Robert Rossor, Oklahoma; Secretary-Treasurer—Marie Jarvinen, Minnesota.

CAMILLA CRISTMAN, Secretary-Treasurer
Dairy Department
Michigan State University

ACTION ON COMMITTEE REPORTS

a. Awards Rules Revision Committee. This Committee made a final report of a 3-yr. study of the monetary awards rules, designed to clarify and condense the present rules and particularly to organize the dossier material for nominees that is required by the principal nominator. An excellent job has been done. Some of the major changes are as follows: (1) In addition to making nominations in the usual manner, a canvassing committee of two members has been established with a view to canvassing the field to prevent any worthy candidate being overlooked. (2) All nominees for a particular award, other than the winner, will automatically be carried forward as nominees for one additional year. (3) The balloting procedure has been greatly clarified and simplified. (4) The nomination form will be essentially the same as that used in the past, with the exception that it will carry the following statement: "A nominee for an award of honor must be a member of the Association and is recognized for activities in the Association; whereas, a nominee for the distinguished service award (a) may or may not be a member and (b) is recognized for activities in the dairy industry." (5) Forms have been developed stating very clearly what should be supplied by the principal nominator as information supporting the nomines. This, of necessity, varies to some extent depending upon the award. Voted that the report be accepted, properly edited, and placed in the hands of the Secretary for use in connection with the 1963 awards.

b. Journal Management Committee. Voted that the report be accepted and printed in the Journal.

c. International Relations Committee. This Committee has been very active. (1) The reception planned for foreign participants attending the Annual Meeting was a great success, with 150 to 200 present. (2) The Committee planned the symposium on education for leadership in dairying in Latin America. (3) The efforts to work with industry groups on United States membership in the National Dairy Federation have proved to no avail and the Committee feels that if anything further is done, it will have to be by other segments of the industry. (4) There has been some discussion about our Association sponsoring an International Dairy Science Forum. The Board felt that this should be held in abeyance for the time being. Voted to accept the report with commendation. Voted to designate Dr. J. F. Sykes, or a suitable alternate, as a representative of the Association to the World Congress on Fertility and Sterility in Brazil. The Committee is charged with the duty of determining the cost and feasibility of reproducing the JOURNAL summaries of research papers and making them available to appropriate persons in Latin America. The Committee also is to study the possibility of translating the JOURNAL OF DAIRY SCIENCE into Spanish and Portuguese for distribution in Latin America. The Association President is to write the Secretary of the USDA about this when and if the time seems appropriate.

d. Student Affiliate Committee. Voted that the report of the Student Affiliate Committee be accepted with commendation. The report indicated that their major activities during the past year were: (1) Coordination of the activities of the National Student Branch with those of the parent association; (2) stimulation of interest in Student Chapter activity; (3) stimulation of interest in the Graduate Student Presentation content; (4) recruitment of new members and retention of old members; and (5) promotion of the Student Affiliate News Section in the JOURNAL. Voted that a faculty representative of the institution where the president of the student branch is located should be designated as advisor.

e. Public Health Committee. This report was of an unusually informative nature, covering many major items relating to public health. Voted that the report be accepted and the Committee commended for a well-performed job. Also voted that the section pertaining to staphylococcus food poisoning in cheese, prepared by Dr. C. K. Johns and R. B. Read, and the section pertaining to the certification of bacteriological media and the certification of milk and milk products, prepared by Dr. C. K. Johns, J. C. Olson, Jr., and M. L. Speck, be edited and published in the JOURNAL OF DAIRY SCIENCE.

f. Membership Committee. Voted to accept the report with commendation to the Chairman and his Committee, and that the recommendations contained in the report be given to the new Committee Chairman.

g. Revision of Duties of Resolutions Committee. Voted that a notation be made to the statement in the Administrative Handbook to the effect that the Chairman of the Resolutions Committee may present a resolution that has been rejected by the Board. Also make it clear that a resolution may be presented by any member from the floor.

h. Program Committee. Voted that the Board accept the report and refer a copy to the Chairman for 1963.

i. Education Committee. Voted that the report be accepted with the recommendation that the Handbook statement concerning the duties of the Committee be revised.

j. Ballot Tabulating Committee. Voted that the report of the Ballot Tabulating Committee be accepted. The Committee reported the election of the following officers for 1962–63: S. T. Coulter, Vice-President, W. M. Roberts and N. L. Jacobson, Directors. Because S. T. Coulter had served only 2 yr on the Executive Board, F. E. Nelson was elected for 1 yr to serve Dr. Coulter's term.

k. Auditing Committee. Voted that the report of the Auditing Committeee be accepted and placed on file.

l. Policy Committee. Voted that the report of the Policy Committee be accepted.

m. Centennial Commemorative Program Committee. Voted to thank the Committee for the fine program developed in connection with our Annual Meeting and to discharge the Committee.

n. Advisory Committee to the Dairy Society International. President Jack reported that the officials of D.S.I. were very pleased with the assistance rendered on various matters by the Association Advisory Committee. Voted to accept the report of this Committee.

o. Historian. Voted to accept the report of the Historian with instructions to the Journal Management Committee to review the matter of the location of biographical sketches in the JOURNAL.

p. Representative to the National Research Council. Dr. W. E. Krauss presented an informative report and recommends that the A.D.S.A. advise the Division of Biology and Agriculture of the role it thinks this organization should play in matters pertaining to agricultural science development and in providing scientific advice on matters pertaining to agriculture. Voted to accept the report and that a letter be sent to Dr. Krauss, thanking him for his stellar service as representative to the Agricultural Board. It was voted that the Editor publish the salient points of the report in the JOURNAL.

q. Representative to American Association for Advancement of Science. This is a very informative report and it is recommended that A.D.S.A. continue to have strong representation to AAAS and Section O and that greater efforts be made to inform our members of programs of AAAS. Voted to accept the report.

r. Representative to 3-A Standards Committee. The report outlines the principal achievements of 3-A Standards Committee for the past year and recommends that A.D.S.A. re-assert its strong interest in the program of 3-A Sanitary Standards and appoint liaison representatives for ensuing years. It was also recommended that instructions concerning 3-A standards be incorporated in dairy curricula. Voted to accept the report and to send an appropriate letter to the 3-A Standards Committee, commending them on the services it is rendering to the dairy industry.

s. Representative to the Ralston Purina Award. The report stated that the qualifications of most of the applicants this year were excellent and that it is gratifying to see students of such high caliber entering graduate study. The Ralston Purina Company is to be commended for its continuing interest in and support of this program. Voted that the report be accepted.

t. Representative to National Association of

Artificial Breeders. Voted to accept this report.

u. Representative to American Grassland Council. This report covers the program that would appear to be a very informative conference to be held at Hershey, Pennsylvania, August 15–17, 1962. Report also states that it will engage in the preparation of educational material for the use in industry, beginning with the preparation of a silage handbook. It is felt that this presents a fine opportunity for members of scientific societies representing dairy, animal husbandry, agronomy, and agricultural engineering to cooperate in writing publications for mass distribution by industry. Voted to accept the report.

v. Representative to National Mastitis Council. The report details the activities of the first annual meeting of the Council, held in Chicago, February 16, 1962, and recommends that the A.D.S.A. not only continue its affiliation with the National Mastitis Council but encourage its members to participate through their respective organization in the promotion of the program. Voted to accept the report.

w. Representative to Milk and Milk Products Labelling Committee. Voted that the report be accepted.

x. Representative to the U.S. Livestock Sanitary Association. Voted to accept this very informative report.

MINUTES OF THE EXECUTIVE BOARD AND ITS ACTIONS AT THE INTERIM MEETING, FEBRUARY 26–27, AND AT THE ANNUAL MEETING, JUNE 15–16, 1962

H. F. JUDKINS, Secretary-Treasurer
32 Ridgeway Circle, White Plains, N.Y.

1. Minutes of the June, 1961, and February, 1962, meetings. The reading of the minutes of the June, 1961, and February, 1962, meetings was dispensed with.

2. Executive Board and Committee reorganization. President Jack proposed a study of the organization of the Executive Board and Committee functions as follows: (1) the expansion of the Executive Board, (2) creation of an Executive Committee to be the administrative body, (3) establishment of a Finance Committee, and (4) reassignment of some committee functions. Voted that a special committee be named to study the proposal and report to the next meeting.

3. Sustaining Membership. The Secretary reported on the activities of sustaining membership solicitation and stated that 34 memberships had been received to date. Voted that the report be accepted with great satisfaction and that the Association members be encouraged to solicit sustaining members.

4. Acceptance of future award offers. Secretary Judkins announced that all donors of monetary awards have agreed to make them available for 1963. A resolution thanking the donors for their generosity will be sent to them. Voted that the Teaching Award be called the Milk Industry Foundation Teaching Award in Dairy Manufactures in the odd year. In the even years it is to be called the National Dairy Products Corporation Teaching Award in Dairy Production.

5. Secretary-Treasurer's report. Attached.

6. Budget for 1963. Voted to approve a budget in the amount of $103,708.

7. Annual Meeting locations—next five years. Secretary Judkins announced future Annual Meeting locations as follows: In 1963, Purdue, June 17–19; 1964, Arizona, June 22–24; 1965, Kentucky, June 21–23; 1966, Oregon, June 20–22. Since Auburn University is uncertain about accommodating us for the year 1967, the Secretary was instructed to explore the possibilities for a place for that meeting, preferably in the East.

8. Editor's report. Report accepted with instructions to publish salient portions in the JOURNAL.

9. Selection of Editor. E. O. Herreid was re-elected for 1963 and received the commendation of the Board.

10. Selection of Secretary-Treasurer. H. F. Judkins was re-elected for 1963 and received the commendation of the Board.

11. Selection of Journal Management Committee member. J. E. Legates was elected to a 3-yr term. B. H. Webb was elected for 2 yr to fill the unexpired term of F. J. Doan, retired. Professor Doan remains as consultant to the Committee.

12. Selection of Policy Committee member. G. M. Werner was elected to a 3-yr term. G. H. Wise was elected for 2 yr to fill out the unexpired term of N. L. Jacobson, who has been elected to the Executive Board. The Secretary reported that the vote of the Board taken in September, 1961, resulted in the election of G. M. Trout, Michigan State University, to the Policy Committee.

13. Cooperation on Feed and Agricultural Organization and Association of Official Agricultural Chemists on testing procedures. Voted that a three-member A.D.S.A. liaison committee be established to advise with F.A.O. and A.O.A.C. and the Interagency F.A.O. Commit-

tee. This committee will be appointed annually.

14. Distillers' Research Council award proposal. President Jack presented a letter from the Executive Director of the Distillers' Research Council, stating that the Council is considering an award for nutrition in dairy science. A request was made for the rules pertaining to our Association monetary award. This information was supplied. It was the sentiment of the Board that any proposal of this kind, made to our Association, would require careful consideration to avoid conflicts with present awards.

15. Life membership survey. Pursuant to Board action on February 26, the Secretary presented a report showing a classification of the membership according to the number of years dues have been paid. The record shows that 346, or 13.8%, have paid dues for 21 yr or more, indicating that in the next 5 yr our life membership can be expected to increase somewhat from the present number of 53. The report was accepted and it was voted to take no action pertaining to the matter at this time.

16. Election of life members. The following were elected to life membership effective January 1, 1962: John C. Barnes, Morris Baron, Walter C. Bartsch, P. A. Campbell, L. M. Chapman, C. D. Dahle, R. N. Davis, Bruce Q. Engle, Michael Grimes, Harold Macy, W. B. Nevens, and Harold T. Pratt. As of January 1, 1963: L. H. Burgwald, Ara O. Call, C. J. Cohee, W. A. Cordes, A. C. Fay, H. W. Gregory, Lyman Rich, and C. C. Walts.

17. Publication of APHA Standard Methods of Milk Analysis. The Secretary reported on a letter from Dr. E. F. Mattison, Executive Director of APHA, dated December 1, 1961, to the effect that it had been decided that the APHA would publish the next edition rather than to engage in a joint association effort. The letter closed with the statement, "We trust that we can continue to have the valuable assistance of the members of the Association in the preparation of future revision of the Manual."

18. Career Booklet. In view of the career material published by the various universities, and in view of the symposium, Selecting a Career in the Dairy Industry, published in the October, 1961, JOURNAL, it was voted not to pursue the matter of a Career Booklet at this time.

19. Publishing of Annual Meeting Symposia. It was voted that symposia presented at the annual meeting be published in the JOURNAL at the recommendation of the Chairman of the Section involved and the Editor-in-Chief.

20. Commendation for President Jack. President E. L. Jack was commended for his fine leadership and extended best wishes for the years to come.

21. Retiring Board members. Appreciation was extended to retiring Board members F. J. Doan and G. H. Wise, and the hope was expressed that the Association would benefit by their counsel for many years to come.

22. Program Chairman, 1963 Meeting. Dr. Stanley Musgrave of Oklahoma was selected.

23. National Medal of Science Nominations. The President read a letter of May 28 from Dr. Frederick Seitz, President of the National Science Foundation, regarding this Award and inviting A.D.S.A. to submit nominees. Since there is an August first deadline on nominations for 1962, President Jack was authorized to appoint an ad hoc Committee to select nominees and to appoint a continuing committee for 1963 to be selected on the same basis as other award committees that would canvass the field encompassed in the Association and select a list of nominees according to instructions. The President appointed R. E. Hodgson, Chairman, L. A. Moore, B. H. Webb, and R. F. Davis for 1962. The sciences covered in this award are physical, biological, mathematical, and engineering.

SECRETARY-TREASURER'S REPORT

MEMBERSHIP

Total no. members 1961	2,637
Total no. members June 22, 1962	2,576

It would appear that we might finish 1962 with about the same number of members as for 1961. At least it appears that the $2.50 increase in dues has had little or no effect on the results to date.

AFFILIATE MEMBERSHIP

Total no. members 1961	683
Total no. members June 22, 1962	669

SUBSCRIBERS

Total no. subscribers 1961	1,675
Total no. subscribers May 31, 1962	1,611

FINANCIAL

Years ending December 31, 1960, and 1961

	1960	1961
Income	$92,512.65	$ 96,560.48
Expense	87,570.32	104,278.18
Gain or Loss	+$ 4,942.33	−$ 7,717.70 [1]

Value of investments December 31, 1961—$37,875.29

TRAINING MANUAL

Costs to January 31, 1962	$6,400.12
Sales to January 31, 1962	6,824.86
Gain	$ 424.74

Inventory January 1, 1962—204 bound copies; 500 unbound copies

SUPPLEMENT—APRIL, 1960, JOURNAL

The Effect of Cell Damage on Animal Reproduction

Costs to January 31, 1962	$2,674.24
Sales to January 31, 1962	2,575.12
Loss	$ 100.12

Inventory January 1, 1962—410 copies.

[1] Due mainly to increase in size of JOURNAL and 8% increase in printing costs effective July 1, 1961.

1962 PROSPECTS

Prospects for 1962 seem good.

1. Membership and subscriptions have held up well.

2. Journal production costs may be lower for 1962. Costs for the first four months of 1962 were $1,635.61 less than for the same period in 1961, due to the new two-column format and fewer pages per issue.

3. Savings of $2,936.26 will result because of discontinuance of A.D.S.A. Review.

4. As of May 8, 1962, 34 Sustaining ($100) Memberships have been obtained.

The above should more than offset any increase in costs and a possible reduction in returns from advertising.

REPORT OF THE DAIRY MANFACTURING SECTION

The Dairy Manufacturing Section held two business meetings, on June 18 and 19, respectively, with Chairman M. L. Speck presiding. Officers elected for 1962-63 were: Chairman, D. M. Graham, Pet Milk Company; vice-chairman, E. L. Thomas, Minnesota; and secretary, M. E. Ellertson, The Carnation Company.

The Committee to Develop a Score-Card for Sterile and Concentrated Milks for Beverage Purposes (J. C. Flake, chairman) reported further progress. During the year a taste panel was conducted using the proposed score-card and a modified hedonic rating system. Analysis of results revealed that each system has merits but that one system cannot be substituted for the other. Further work is needed to select appropriate flavor terms, to describe defects, and to study the relative merits of the two methods of evaluation. The committee was continued for another year.

The committee on Milk Protein Nomenclature, Classification and Methodology (C. W. Gehrke, chairman) reported further progress on the development of a collaborative program on the isolation and characterization of casein fractions. A collaborative study of the kappa caseins has been initiated. The committee was continued.

The Committee on Judging Dairy Products (E. L. Thomas, chairman) reported a successful Collegiate Students' International Contest in the Judging of Dairy Products held at Washington, D. C., on October 23, 1961. Two fellowships were awarded by the Dairy Industries Supply Association. Twenty-one teams participated in the contest, which was the 27th cosponsored by the A.D.S.A. and the D.I.S.A. and the 40th for the A.D.S.A. The Revision of the Contest score-cards was completed and printed cards have been made available from the A.D.S.A. Significant changes were reported in the official 1962 contest rules as follows: (a) inclusion of Cottage cheese as a fifth product in the contest; (b) a provision for permitting an institution which does not enter a three-member team to enter one or two eligible students who may compete for individual placings and prizes only; and (c) an increase in maximum grade on individual criticisms of from one to two points in the grading of contestants' score-cards. Progress was reported towards development of scoring guides for each of the contest score-cards.

A motion that the recipient of the Borden Award in Dairy Manufacturing be invited to present a paper on a phase of his research the year following presentation of the award was defeated. It was decided that the section officers should give further consideration to instituting such lectures by recipients of both the Borden and Paul-Lewis awards.

Chairman Speck commented on the desirability of arranging for the presentation of invitational papers by outstanding colleagues from foreign countries. This aspect of the program will be investigated further during the coming year.

The Graduate Student Scientific Paper competition in Dairy Manufacturing continues to arouse interest and there were seven competitors representing approximately 9% of the research papers presented. Further consideration will be given towards strengthening this aspect of the program.

The Dairy Manufacturing Extension Section continues to fill a need for many members and eight invitational papers and one regularly submitted paper were presented. The 1961-62 officers of the Section were: chairman, W. S. Arbuckle (Maryland) and secretary, A. L. Rippen (Michigan). At its business meeting on June 18 the following officers were elected for 1962-63: Chairman, A. L. Rippen (Michigan) and secretary, J. C. White (New York).

A total of 77 research papers were presented before the Manufacturing Section meetings.

M. L. Speck, Chairman
D. M. Graham
E. L. Thomas

REPORT OF PRODUCTION SECTION

Production Section Business Meeting 11 AM, June 19, 1962, with Chairman John C. Thompson, presiding. Minutes of the 1961 meeting were read and approved.

The Dairy Cattle Judging Committee report was presented by C. F. Foreman. The 10-yr report of the activity of the Dairy Cattle Judging Committee was not fully summarized, so a report was not made.

The Eligibility of Contestants in the National Contest was changed to read: "The student must be enrolled in a 4-yr or longer course and have completed not less than 36 wk of college work."

The rules pertaining to classes were changed to read: "Ten classes of four individuals each shall be judged. These shall consist of five classes of cows, three classes of yearling heifers, and two classes of heifer classes in the Holstein, Guernsey, Jersey, Brown Swiss, and Ayrshire breeds."

Resolutions committee report was presented by Chairman Philip Kelly (Nebraska). The following resolutions were passed: 1, 2, 3, 4, 6, 8, and 9.[1] There was some discussion on Resolution 2 and the wording was changed to be more compatible with the entire group. There were some objections to Resolution 7, but after an amendment was made the resolution was passed.

I. W. Rupel (Texas) commented on the purposes of the Dairy Shrine Club.

New Committee appointments made by L. H. Schultz (Wisconsin) were as follows: Resolutions: J. B. Frye (Louisiana), Judging: J. W. Crowley (Wisconsin), Breeding: Keith Huston (Kansas), Type: Howard Thoele, (Holstein Assoc.), Dairy Cattle Health: J. F. Sykes (USDA), Feeding and Management: C. A. Lassiter (Michigan), Milk Solids: Lon McGillard (Michigan).

Officers elected for 1962-63 were: Chairman, L. H. Schultz, Wisconsin; Vice-Chairman, Vearl R. Smith, Arizona; and Secretary, Paul Reaves, Virginia.

J. C. Thompson, Chairman
L. H. Schultz, Vice-Chairman
V. R. Smith, Secretary

REPORT OF THE EXTENSION SECTION

There were 133 registrants in the Extension Section, of which 92 were Extension Dairymen.

By action of the Production, Manufacturing, and Extension Sections at the A.D.S.A. Meeting in Madison, Wisconsin, 1961, two new committees were named: (1) Dairy Feeding and Management Committee and (2) Milk Solids Committee.

J. C. Thompson of the Production Section gave the report for the Feeding and Management Committee.

The Milk Solids Committee consists of three members from each of the sections, Production, Manufacturing, and Extension. The chairman of the Committee is to rotate each year from: Extension to Production and to Manufacturing. Four papers were presented. Much interest was shown in solids-not-fat and protein analyses. This committee will continue to function, enthusiastically.

Actions taken at the Business Section:

The Teaching Methods Committee recommended that the exhibits be placed in an area where all members of A.D.S.A. could see them.

The Resolution Committee presented the following resolution for the Extension Section record:

"Whereas, Dr. J. F. Kendrick has served for nearly 30 yr as the leader of the National Dairy Herd Improvement Program and has now been appointed Chief of the Data Processing Branch of the Statistical Reporting Service of the USDA, be it

Resolved, That the Extension Section of the A.D.S.A. recognize and commend the outstanding leadership and inspiration given to the D.H.I. Program by Dr. J. F. Kendrick. We especially recognize his work with the extension dairymen in the development of electronic data processing, standardization of production testing, and sire-proving procedures on a national basis.

The Dairy Records Committee recommended that an additional member be added to this Committee, who shall be a member of a state or local D.H.I.A. organization. This was defeated. Another motion was passed that the Dairy Records Committee should reconsider this recommendation during the ensuing year.

The Subcommittee Report on modified testing program was presented by Mr. Winters of Washington. It was moved that the Extension Section approve the modified record-keeping plan developed at the state level to meet the needs of dairy farmers. This motion was amended so that the letters of D.H.I.A. shall not be referred to in such a program as developed by such states.

Sam Jones from Alabama reviewed the Handbook of Extension Workers on the record-keeping plans. This handbook will go to the printers as a USDA publication about January 1, 1963.

Gerald King, USDA, reported on the revision of the D.H.I.A. Supervisors Manual. This manual will fill the general needs and is to be supplemented by state and regional central processing centers. Publication of this manual will be November, 1962.

The changes in the D.H.I.A. rules as presented by the Dairy Records Committee were amended and adopted by the Extension Section.

A motion was passed requesting that the officers of the extension section assume the responsibilities of revision of the extension section officers handbook. Motion carried.

Expansion of Committee. The committee recommends that the formal organization of the milk composition committee be amended to include three additional committee members from the Dairy industry. These three members should be interested in sales and promotion of dairy products and should be appointed by the President of the American Dairy Science Association. In selecting these three members, one should be interested in sales and promotion of for a 2-yr term, and a third for a 3-yr term. Each year thereafter a person should be appointed for a 3-yr term.

Clarence H. Parsons of Massachusetts was

[1] Numbers refer to resolutions on page 1157.

elected secretary. The officers for the coming year are chairman, C. D. McGrew of Ohio; vice-chairman, Donald Voelker of Iowa; and secretary, C. H. Parsons of Massachusetts.

W. R. VAN SANT, Chairman
C. D. MCGREW, Vice-Chairman
DONALD VOELKER, Secretary

RESOLUTIONS

1. WHEREAS, The members of the American Dairy Science Association attending the 57th Annual Meeting recognize the work and planning done by the dairy department of the University of Maryland and the USDA departments and local supporting groups involved in this 1962 Annual Meeting, it is hereby

   RESOLVED, That we express our appreciation to all of the people who have helped to make this a successful and memorable annual meeting of the American Dairy Science Association.

2. WHEREAS, The generosity of national companies and organizations makes possible a significant progam of annual awards for outstanding achievements in the dairy industry, be it

   RESOLVED, That the American Dairy Science Association hereby recognize the important contributions of the following: The Borden Foundation, American Feed Manufacturers Association, DeLaval Separator Company, Milk Industry Foundation, National Dairy Products Corporation, and Paul-Lewis Laboratories, Inc.

3. WHEREAS, The National Mastitis Council meeting in February, 1962, has set forth the objective of organizing state units, be it

   RESOLVED, That the American Dairy Science Association reiterate its commendation of the objectives of the N.M.C. and urge members in the various states to recognize the need for such activity and give their support and encouragement to the establishment of state units involving the leaders in production, processing, and animal health areas.

4. WHEREAS, The need for research and education in, and promotion of, milk and milk products continues to be a challenge, be it

   RESOLVED, That the American Dairy Science Association commend the work of the American Dairy Association, The National Dairy Council, and public and private organizations for expanding their efforts in this field.

5. WHEREAS, Milk fat is a highly nutritious food and contributes to the flavor of the products in which it is used, be it

   RESOLVED, That the American Dairy Science Association urge the Agricultural Research Service of USDA and the college and university dairy departments to give consideration to initiating and expanding research leading toward new forms of products containing milk fat.

6. WHEREAS, There is increasing emphasis on milk and dairy products of higher relative solids nonfat content, be it

   RESOLVED, That the Agricultural Research Service of USDA and dairy husbandry departments in colleges and universities develop research on breeding, feeding, and management factors which affect solids-not-fat and protein production. Be it further

   RESOLVED, that the American Dairy Science Association encourage the use of higher solids levels in all fluid milk products.

7. WHEREAS, The problem of atomic fallout is of concern to consumers and to the food industry, be it

   RESOLVED, That the American Dairy Science Association commend the government agencies for their valuable services to the industry in the areas of testing, interpretation, and planning for emergency control of food supplies in the event of excessive fallout contamination. We further express our confidence in these agencies as a source of valid information for industry and public use.

8. WHEREAS, The beneficial role of milk fat as a source of lipids in human nutrition continues to be challenged, be it

   RESOLVED, That the American Dairy Science Association recognize the need for further research on the relation of fats to human health by the National Heart Institute of the National Institute of Health and the Agricultural Research Service of the USDA.

D. H. JACOBSEN, Chairman
FRED MEINERSHAGAN
P. L. KELLY
J. C. WHITE
D. E. MOOK

BOOK REVIEW

Lecture Outlines of Preventive Veterinary Medicine for Animal Science Students. I. A. Schipper, Burgess Publishing Company, Minneapolis, Minnesota. 3rd edition, 168 pp., $4.50.

As indicated by the title, the book is an outline of preventive veterinary medicine. It is a very extensive outline and covers anatomy, physiology, endocrinology, reproduction, microbiology, nutrition, pharmacology, environmental factors, stress, and immunology. Diseases of the various systems, acute generalized infectious diseases, parasitology, including internal and external parasites and intoxications caused by insecticides are included in the outline. The outline on infectious disease includes etiology, influencing factors, symptomatology, prophylaxis, public health aspects of the disease, and preventive measures. Management and sanitation, including disinfection, are outlined in detail. The outline is so comprehensive that if covered in detail it would be an abridged course in veterinary medicine. To use all of the outline and cover it in detail would require courses extending over several terms.

Roger P. Link
University of Illinois, Urbana