JOURNAL OF DAIRY SCIENCE

Contents

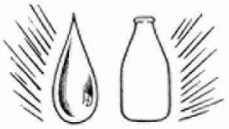
Vol. XXV, No. 2, February, 1942

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION

PART 1 . . . Duraglas

Duraglas is a registered trade-mark, but it needn't be. For without painstaking research, special equipment, and our unapproached skill in glassmaking, the tough, strong, light-weight Duraglas container cannot be duplicated.

PART 2 . . . Reason for Shape of Handi-Quart



Milk, all liquid—even molten glass—when poured forms a "tear-drop." That's Nature's way of evenly distributing liquid mass, of insuring best distribution of thickness and weight. The Handi-Quart is a natural "tear-drop"—modified to traditional milk bottle shape.

PART 3 . . . Resultant Economies of Handi-Quart

Bear in mind that these amazing economies—extended to the approximately 12 billion glass containers of milk delivered yearly in America—would save 1,595,000 tons weight alone. More, since 100 Handi-Quarts can be made from the same amount of glass needed for 76 old-style quarts, much glass can be released for defense!

FOR DAIRYMEN . . . The O-I Handi-Quart provides: 1. Substantially lower bottle costs. 2. Maximum capping economies because the Handi-Quart is ideal for small finishes. 3. Savings in load-weight—less weight for route and plant men. 4. Minimum of production "change-over" cost. 5. A distinct "merchandising" package—a *natural* for store trade.

FOR CONSUMERS . . . The O-I Handi-Quart is easier to hold and pour from—easier to slide into refrigerator shelves.

• • •

We are proud indeed of our part in pioneering the development of this distinctly economical and perfect container for milk.

OWENS ILLINOIS *Complete Dairy Service*

TOLEDO, OHIO

WHERE QUALITY PREDOMINATES

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION
Published at
NORTH QUEEN ST. AND MCGOVERN AVE., LANCASTER, PA.

The Journal of Dairy Science is issued monthly. Subscription is by the volume and one volume is issued per year.

Manuscripts should be typewritten and carefully revised before submission to T. S. Sutton, The Ohio State University, Columbus, Ohio. Twenty-five reprints will be furnished gratis to authors. Cost of additional reprints and reprint order blank will be submitted with proof.

The use of material published in the Journal is encouraged and a liberal policy will be followed concerning reproduction of articles with proper notation as to source.

Subscriptions. Price; $6.00 per volume in United States and Canada; $6.50 in all other countries. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume. Renewals should be made promptly to avoid a break in the series. Subscriptions should be sent to R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Subscriptions for the British Isles and British Empire, except for Canada and Australia, should be ordered through our agents: Messrs. Bailliere, Tindall and Cox, 7 and 8 Henrietta Streets, Covent Garden, London, W. C. 2, England. Subscriptions for Australia should be sent to our agent: John H. Bryant, 19 Bridge Street, Sydney, Australia.

Advertising should be mailed direct to the Science Press Printing Company, N. Queen St. and McGovern Ave., Lancaster, Pennsylvania.

Correspondence regarding business policies of the Journal should be addressed to the Secretary-treasurer, R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Post Office Notices of undeliverable copies and changes of address should be sent to R. B. Stoltz, The Ohio State University, Columbus, Ohio.

Entered as second-class matter April 13, 1934 at the postoffice at Lancaster, Pa., under the act of March 3, 1879.

JOURNAL OF DAIRY SCIENCE

VOLUME XXV FEBRUARY, 1942 NUMBER 2

A PROPOSED SCORE GRADE METHOD OF DETERMINING THE QUALITY OF MILK*

P. A. DOWNS

University of Nebraska, Lincoln, Nebraska

The quality of milk is of great interest to the consuming public and the dairy and other food industries. Continued efforts have been made to devise score cards by which the quality of milk can be evaluated. Such cards have been numerous and varied in type and have often required laboratory determinations to complete the scoring. Score cards of this type have only partially fulfilled the need of the consumer, the teacher, the grader on the factory platform, and the milk inspector in the field.

From an educational standpoint, the present score cards present many problems. The lack of uniformity in the values allowed on the score cards for flavor when scoring milk, butter, cheese, or ice cream, is always difficult to explain, as well as the variation in the score which indicates the highest quality. If we are to hope for a greater interest in the quality of these products, we must furnish a simple understandable method of designating quality. It should be definite enough so that different judges can get similar results on the same product with the minimum amount of preliminary preparation. It would be very desirable if the score allowed for high quality could be the same for all dairy products. This would make it far easier for the layman or student to fix in his mind the levels at which high, medium, or low quality is expressed by numerical values.

With the question of simplicity as well as that of uniformity in mind, the writer has attempted to use the score grading system, which is followed in the Handbook of Official United States Standards for Quality of Creamery Butter,[1] for the scoring of milk, with the further thought in mind that cheese and ice cream might be likewise scored by the same system.

If this should be successful, much confusion could be avoided. Uniform high and low scores could be in the minds of the consumers as well as the

Received for publication September 13, 1941.

Journal Series No. 295, Nebraska Agricultural Experiment Station.

* The system proposed in this article is not sponsored by the American Dairy Science Association but is submitted in an attempt to stimulate interest in the subject and the possible unification of scoring methods for the four major products.—THE AUTHOR.

[1] U. S. D. A., Agricultural Marketing Service, February, 1940.

handlers of all dairy products. The use of terms could be made uniform and thus the whole problem of quality determination would be simplified.

The score grade method would allow the housewife to place a numerical value on a bottle of milk in the home. The milk grader on the factory platform could grade to a certain quality as designated by the numerical value. The question of bottle and sediment could be considered where it was possible. Its adaptation to a great variety of situations would seem to increase its value to all those interested in milk quality.

In an effort to meet these objectives, the Handbook of Official United States Standards for Quality of Creamery Butter have been followed as closely as possible in preparing a score grade method of scoring milk. With the completion of a similar system for ice cream and cheese, it is hoped that it may bring forth a practical, uniform, standard procedure for the determination of quality in the four major dairy products.

QUALITY OF MARKET MILK

The discontinuance of the factors of bacterial count, percentage of fat, acidity, and temperature will be noted. It may be assumed that the milk meets the requirements of the grade as designated on the package and that it meets the requirements of the public health authorities where it is offered for sale.

The standards for flavor provide ratings for different flavors and degrees of their intensity. Flavor and defects in bottle and cap and sediment are rated independently and the score is determined by application of a general rule as outlined. Only 9 points in a score range (85–93) are used, as is the case with official butter scoring.

Section I—Terms Defined

For the purpose of this discussion the grades here suggested refer to the quality of market milk.

(a) *Milk*—The lacteal secretion obtained from the complete milking of cows or goats.

(b) *Market Milk*—Milk which is used by the consuming public in a liquid form.

(c) *Score Grade*—The score grade of a lot of market milk consisting of packages of the same shall be expressed in terms of a score using whole numbers only. The score grades shall be from 85 to 93 inclusive.

Section II—Grades for Market Milk

The following grades for market milk are suggested.

(a) A 93 score will possess a fine, full flavor. It may not possess any noticeable defects in flavor. The total permitted defects in sediment are limited to a rating of one-half.

(b) A 92 score milk shall possess a pleasing flavor. It may possess a very slight normal feed flavor, be slightly flat, or have a very slight cooked flavor. The total permitted defects in sediment are limited to a rating of one-half unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to exceed one-half: provided, however, that the total ratings for defects in sediment must not exceed one in 92 score milk regardless of flavor rating.

(c) A 91 score milk shall possess a fairly pleasing flavor. It may possess a flat, slightly feed, or slightly cooked flavor. The total permitted defects in sediment and bottle cap are limited to a rating of one-half unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to exceed one-half.

(d) A 90 score milk shall possess a fairly pleasing flavor but may possess such flavors as definitely cooked, definitely feed, slightly salty, very slightly cowy, very slightly bitter, very slightly unclean, or very slightly oxidized. The total permitted defects in sediment and bottle and cap are limited to a rating of one-half unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to be in excess of one-half.

(e) An 89 score milk may possess any of the following flavors but only to a slight degree: salty, unclean, cowy, bitter, oxidized, and malty, or metallic or weedy to a very slight degree. The total permitted defects in sediment and bottle and cap are limited to a rating of one unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to exceed one.

(f) An 88 score milk may possess any of the following flavors to a definite degree: salty, unclean, cowy, bitter, oxidized, and malty, or metallic or weedy to a slight degree. The total permitted defects in sediment and bottle and cap are limited to one unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to exceed one.

(g) An 87 score milk may possess an onion or garlic flavor only to a slight degree. It may be definitely metallic or weedy. The total permitted defects in sediment and bottle and cap are limited to two unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to exceed two.

(h) An 86 score milk may possess a definite onion or garlic flavor or a pronounced metallic or weedy flavor. The total permitted defects in sediment and bottle and cap are limited to a rating of two unless the flavor rating is sufficiently high to permit the total ratings for defects in these factors to exceed two.

(i) An 85 score milk may possess a pronounced onion or garlic flavor or a very slightly rancid or high acid flavor. The total permitted defects in sediment and bottle and cap are limited to three unless the flavor rating is sufficiently high to permit the total rating for defects in these factors to exceed three.

(j) "No grade"[2] milk is milk that is below 85 score because of its flavor or other conditions or because of excessive defects in sediment and bottle and cap.

Section III—Basis for Determination of Quality of Market Milk

The basis for determination of quality of market milk, except "no grade," shall be the ratings given flavor and the defects in sediment and bottle and cap. The score of individual samples of market milk shall be determined by the following general rule:

General Rule: The score of an individual sample of market milk shall be determined by deducting from the flavor rating[3] of the sample the amount that the total ratings of the defects in sediment and bottle and caps are in excess of the ratings for defects permitted in these factors for milk of the particular flavor rating (table 1), the score to be expressed as a whole number by lowering any half score to the next lower full score: provided, however, that the total ratings for defects in sediment must not exceed one in 92 score milk regardless of flavor rating.

Section IV—Ratings of Certain Identified Flavors in Market Milk

The various identified flavors in market milk listed below shall be rated as follows:

Identified Flavor	*Flavor Rating*
(a) Fine and full	93
(b) Pleasing	92
(c) Fairly pleasing	91–90
(d) Normal feed	
Very slight normal feed	92
Slight normal feed	91
Definite normal feed	90
(e) Flat	
Slightly flat	92
Definitely flat	91
(f) Cooked	
Very slightly cooked	92
Slightly cooked	91
Definitely cooked	90
(g) Salty	
Very slightly salty	90
Slightly salty	89
Definitely salty	88
(h) Cowy	
Very slightly cowy	90
Slightly cowy	89
Definitely cowy	88

[2] See Section V for flavors that cause milk to be classified as "no grade."

[3] When more than one flavor is discernible in a sample of milk, the flavor rating for the sample shall be established by the flavor that carries the lowest rating.

(i) Bitter	
Very slightly bitter	90
Slightly bitter	89
Definitely bitter	88
(j) Malty	
Very slightly malty	90
Slightly malty	89
Definitely malty	88
(k) Oxidized	
Very slightly oxidized	90
Slightly oxidized	89
Definitely oxidized	88
(l) Metallic	
Very slightly metallic	89
Slightly metallic	88
Definitely metallic	87
(m) Weedy	
Very slightly weedy	89
Slightly weedy	88
Definitely weedy	87
(n) Onion or garlic	
Slightly onion or garlic	87
Definitely onion or garlic	86
Pronounced onion or garlic	85
(o) Rancid	
Very slightly rancid	86
(p) High acid	
Very slightly high acid	85
(q) Unclean	
Very slight unclean	89
Slight unclean	88
Definite unclean	87

Section V.—Flavors and Conditions in Market Milk that Cause It To Be Classified as "No Grade"

Market milk possessing the following flavors or in which the following conditions are present shall be classified as "no grade."

A. *Flavors*	B. *Conditions*	C. *Bottle and Cap*
Rancid	Ropy or stringy	Dirty bottle (inside)
High acid	Bloody	Chipped lip
Chemical	Garget	
Pronounced unclean	Clabbered	

Section VI—Ratings for Defects in Sediment and Bottle and Cap

Rule (*a*): Sediment as observed on disk shall show less than three very small specks.

Defects	*Rating*
Very slight (over 3 but under 10 very small specks)	½
Slight (10 to 20 specks)	1
Definite	2

Rule (*b*): Clean bottle shall be full of milk, pouring lip protected by water-proof covering and sealed.

Defect	*Rating*
Not full	½
Unprotected	1
Partially protected	½
Unsealed	½
Leaky cap	½

Section VII—Defects Permitted in Sediment and Bottle and Cap without Causing Score To Be Placed Below Flavor Rating

The maximum total ratings for defects in sediment and bottle and cap

TABLE 1

Flavor	Maximum total ratings for defects permitted in sediment and bottle and cap	Limitation of factor
93	½	1 factor (sediment only)
92	½	1 factor (sediment only)
91	½	1 factor only
90	½	
89	1	
88	1	
87	2	
86	2	
85	3	

TABLE 2

Application of general rule

Example No.	Flavor rating	Defects present in		Total defects present	Defects permitted	Defects in excess of those permitted	Final score
		Sediment	Bottles and cap				
1	93	0.5	0.0	0.5	0.5	0.0	93
2	93	0.0	1.0	1.0	0.5	0.5	92
3	93	0.5	1.0	1.5	0.5	1.0	91*
4	92	0.5	0.0	0.5	0.5	0.0	92
5	92	0.0	1.0	1.0	0.5	0.5	91
6	91	1.0	1.0	2.0	0.5	1.5	89
7	90	1.0	0.0	1.0	0.5	0.5	90
8	89	0.5	0.5	1.0	1.0	0.0	89
9	89	1.0	1.0	2.0	1.0	1.0	88
10	88	0.0	1.0	1.0	1.0	0.0	88
11	87	0.5	1.5	2.0	2.0	0.0	87
12	87	1.0	2.0	3.0	2.0	1.0	86
13	86	0.5	1.0	1.5	2.0	0.0	86
14	85	1.0	1.5	2.5	3.0	0.0	85
15	85	2.0	1.5	3.5	3.0	0.5	No grade

* Score is lowered 2 points below instead of one because defects in 92 score milk must not exceed one point.

permitted in market milk that do not cause the score of market milk to be lowered below the flavor rating are given in table 1.

When the sum of the ratings for defects in sediment and bottle and cap exceeds that permitted by table 1 for market milk of a specified flavor rating, the market milk shall be given a score below the flavor rating in accordance with general rule (Section III) for determining the score of individual samples of market milk.

Section VIII—Application of General Rule

In presenting this plan for determining the quality of milk, no attempt has been made to give at this time a discussion of details.

The factor of flavor and classification of flavors according to origin are very completely presented in the U. S. handbook on butter. The giving of the material here would only be a repetition. If the system is applicable to the four major products it would be possible to present a discussion of this nature which would furnish greater clarity and understanding of the terms used in describing the factors of quality in dairy products.

It is suggested that a copy of the *Handbook of Official United States Standards of Quality of Creamery Butter* be at hand if a critical study of the method is to be made. There would seem to be a large advantage in a uniform system for the four major products.

THE REVERSIBILITY OF OXIDATIVE INACTIVATION OF MILK LIPASE IN RELATION TO ITS ACTIVITY IN CHEDDAR CHEESE

I. HLYNKA AND E. G. HOOD

Division of Chemistry and the Division of Bacteriology and Dairy Research,[1] *Science Service, Department of Agriculture, Ottawa, Canada*

The study of the properties of milk lipase in relation to the development of rancid flavor in cheddar cheese is a problem of some practical importance. In a recent publication the authors showed that a higher amount of proteolytic enzymes (rennet and pepsin) can bring about a decrease in the intensity of rancid flavor in cheddar cheese which contained added commercial lipase (9). Freeman and Dahle (7) showed a similar improvement in the flavor of cheddar cheese by the use of proteolytic enzymes without added lipase. Considering the presence of a small amount of endogenous milk lipase, their results may be explained on the same basis as ours. Other methods of inhibiting lipase activity in cheese remain to be investigated.

Copper in the presence of oxygen is an active lipase inhibitor. Davies (5) showed that the activity of milk lipase was depressed in unpasteurized butter to which 2–10 p.p.m. Cu had been added. Herrington and Krukovsky (8) confirmed this for raw milk. Later Krukovsky and Sharp (4) showed that dissolved copper caused no inactivation in the absence of oxygen. However, oxygen alone was active, its activity being greatly accelerated by small amounts of copper.

Oxidative inactivation of enzymes is common and, in general, reactivation is possible with reducing agents. Thus it is stated that the activity of serum lipase and human milk esterase is augmented proportionally with the degree of reduction (10). Our interest lies in the properties of milk lipase in raw milk cheddar cheese where strongly reducing conditions prevail (6). It was decided, therefore, to investigate whether oxidative inactivation of milk lipase was reversible in the presence of reducing systems simulating those in cheese.

Three systems were studied:

1. Anaerobic—Milk under anaerobic conditions develops a strongly negative potential. Aeration or copper cause the milk to maintain a high potential. The range of E_h thus covered is approximately – .2 to .3 volts. It may be expected, however, that the same systems would be operative in cheese where the interior is anaerobic.

2. Ascorbic acid—This acid is a normal constituent of milk and is held to be a part of an oxidation-reduction system concerned in preventing the

Received for publication September 22, 1941.

[1] Journal Series No. 131.

development of oxidized flavor in milk (16). It is of further interest because ascorbic acid has been suggested as a component or a precursor of the coenzyme of lipase (11, 15). The oxidation-reduction potential of this system is reported as $E_o' = -.066$ volts at pH 7 (4).

3. Cysteine—This amino acid was chosen because it is a good reductant. The oxidation-reduction potential of the cysteine-cystine system is given as $E_o' = -.39$ volts at pH 7 (3). It may also be considered as a representative of the sulfhydryl system. It has been shown that ripened cheddar cheese gives a nitroprusside reaction characteristic of the $-SH$ group (12). We have checked raw milk Canadian cheddar cheese and find the appearance at a very early stage of a positive nitroprusside test—the second or third day after manufacture. The sulfhydryl system is therefore not foreign to cheddar cheese. A general similarity of the reducing properties of sulfhydryl proteins or protein derivatives and amino acids might be expected.

EXPERIMENTAL

Two liters of raw whole milk were obtained from the Experimental Farm Dairy before the usual day's milk was pasteurized. The milk lipase in the sample was then activated by the method of Krukovsky and Herrington (12). The milk was pre-cooled in ice water and subsequently warmed to 30° C. At this stage it was divided, as required, into 3 or 4 portions of 500 ml. each and placed into wide-mouth bottles of 1 liter capacity. The bottles were fitted with large 2-hole rubber stoppers and glass tubing so that the milk could be aerated by aspiration using a water pump or deaerated by nitrogen gas from a cylinder. Each bottle of milk was then treated according to plan.

As an example of the treatment, let us consider experiment no. 12, table 3. From a stock solution of $CuCl_2$ 2 p.p.m. Cu was added to each bottle of milk. Nitrogen was bubbled through the first bottle for 15 minutes. It was then aerated for the remaining 30 minutes. To the second bottle of milk was added 100 mg. of Merck's cysteine hydrochloride dissolved in a small quantity of water. (100 mg. of Merck's l-ascorbic acid was used in experiments 6–9, table 2.) It was aerated for 30 minutes and then deaerated by bubbling nitrogen for an additional 15 minutes. The third bottle was treated in the same way, except that cysteine was added after aeration was completed. The last bottle was deaerated for 45 minutes. In this way each portion of milk received a total of 45 minutes of agitation by bubbling in order to avoid unequal activation of milk lipase by this method (13). Also bottles 1–3 received the same amount of aeration. At the end of this treatment the first bottle was allowed to remain open to the air, while in the remaining bottles both the inlet and the exit tubes were clamped. These bottles were then stored in a refrigerator at 5° C.

On the fourth day the milk lipase activity was determined. The rubber

stoppers were replaced with ground glass stoppers, the milk was warmed to 17° C. and churned in an end-over-end shaker. The butter granules so obtained were filtered off on a Buchner funnel using a cheese cloth filter. The butter was then transferred to test tubes, melted in a 60° C. oven and the butterfat pipetted off into 15-ml. centrifuge tubes. The centrifuge tubes were warmed and centrifuged to separate the final traces of the aqueous phase. Three to five gm. portions of the clear butterfat in 50 ml. of 95 per cent boiling ethanol were titrated in duplicate using N/20 NaOH and phenolphthalein indicator. Since we were interested only in the differences in lipase activity of the variously treated milk the alcohol was used without neutralization. The values are recorded as ml. of N NaOH per 100 gm. butterfat. The results are shown in tables 1 to 3.

TABLE 1

The effect of aeration, deaeration and copper on milk lipase

Expt. No.	Cu	Aerated	Aer.-deaerated	Deaerated
	p.p.m.			
1	0	3.1	3.9	4.4
2	1	1.8	1.7	2.6
3	2	2.1	2.1	3.1
4	4	1.3	1.3	2.3
5	8	1.0	1.1	2.1

TABLE 2

The effect of aeration, deaeration, copper and ascorbic acid on milk lipase

Expt. No.	Cu	Aerated	Asc. acid aer.-deaerated	Aer.-asc. ac.-deaerated	Deaerated
	p.p.m.				
6	0	1.9	2.4	2.1	2.6
7	0	1.4	1.6	2.2	2.6
8	2	0.9	0.7	0.7	1.7
9	2	2.3	1.8	2.3	3.1

TABLE 3

The effect of aeration, deaeration, copper and cysteine on milk lipase

Expt. No.	Cu	Aerated	Cysteine-aer.-deaerated	Aer.-cysteine deaerated	Deaerated
	p.p.m.				
10	0	1.8	2.8	2.9	2.5
11	2	1.0	2.0	1.8	1.5
12	2	1.3	3.3	2.5	2.2

All values expressed as ml. N NaOH per 100 gm. butterfat.

DISCUSSION

From table 1 it may be seen that in milk to which 1–8 p.p.m. Cu was added there was no significant difference between the lipase activity of the

corresponding aerated and the aerated-deaerated samples while in each case the deaerated sample showed a higher lipase activity. This indicates that deaeration of milk under the conditions described does protect lipase from oxidation, confirming the results of Krukovsky and Sharp. However, the deaeration of aerated milk gave no protection when copper was present. In the milk containing no added copper the lipase activity of the aerated-deaerated milk was between that of the aerated and the deaerated samples. This indicates that some of the inactivated lipase was probably reduced back to its original active state under anaerobic conditions. This view is confirmed by the cysteine experiments.

The experiments with ascorbic acid (table 2) gave erratic results. Either the ascorbic acid cannot reduce oxidized lipase or it is too readily destroyed to be an effective reducing agent under our experimental conditions.

Cysteine yielded the most interesting results. It will be seen from table 3 that, with or without the addition of copper, whether cysteine was added before or after aeration, the milk lipase activity was highest in the aerated-deaerated milk. The following conclusions might be drawn. In the cysteine-aerated-deaerated milk the lipase was either protected against oxidation or the oxidized milk lipase was subsequently reduced by the cysteine present. In the aerated-cysteine-deaerated milk the latter mechanism is supported, *i.e.*, the reversibility of oxidatively inactived lipase is indicated rather than straightforward protection. Finally, since the cysteine experiments showed higher lipase activity than even the deaerated milk augmentation of lipase is indicated. This might be interpeted as the reduction of milk lipase which was originally in the oxidized or inactive form in the milk. Or, some destruction of lipase occurred in the deaerated milk due to a small amount of oxygen or other oxidizing substances.

From these data it might be inferred that any oxidized milk lipase would be reduced in cheddar cheese, thus restoring it to its active condition. Oxidative inactivation as a means of lipase inhibition would therefore be limited to the possible proteolytic inactivation of oxidized lipase before reduction took place. Experimental cheese work is being done to study this phase of the investigation.

SUMMARY

The reversibility of oxidative inactivation of milk lipase has been studied using three oxidation-reduction systems of interest in cheddar cheese. It is concluded that cysteine can reverse the inactivation of milk lipase brought about by aeration, or by aeration and copper. Some augmentation of lipase activity has also been noted. Anaerobic environment may bring about some reversibility of oxidatively inactivated milk lipase, but not in the presence of copper. The results with ascorbic acid are inconclusive.

REFERENCES

(1) ASSOC. OFF. AGR. CHEM. Official and Tentative Methods of Analysis, 5th Edition, 1935.

(2) BARNICOAT, C. R. The Effect of Certain Metallic Contaminants on the Cheddar Cheese Making Process. Jour. Dairy Res., 8: 1, 53–60. 1937.

(3) BORSOOK, H., ELLIS, E. L., AND HUFFMAN, H. M. Sulfhydryl Oxidation-Reduction Potentials Derived from Thermal Data. Jour. Biol. Chem., 117: 281–308. 1937.

(4) BORSOOK, H., AND KEIGHLEY, G. Oxidation-Reduction Potential of Ascorbic Acid (Vitamin C). Natl. Acad. Sci. Proc., 19: 875–878. 1933.

(5) DAVIES, W. L. The Inactivation of Lipase in Dairy Products by Traces of Heavy Metal Salts. Jour. Dairy Res., 3: 2, 254–263. 1932.

(6) DAVIS, J. G. Studies in Cheddar Cheese. I. The Oxidation-Reduction Potentials of Ripening Cheddar Cheese. Jour. Dairy Res., 3: 2, 241–253. 1932.

(7) FREEMAN, T. R., AND DAHLE, C. D. Rate of Ripening in Cheddar Cheese. Penna. Agr. Expt. Sta. Bul., 362: 20 pp. 1938.

(8) HERRINGTON, B. L., AND KRUKOVSKY, V. N. Studies on Lipase Action. I. Lipase Action in Normal Milk. JOUR. DAIRY SCI., 22: 3, 127–135. 1939.

(9) HLYNKA, I., HOOD, E. G., AND GIBSON, C. A. Effect of Proteolysis on Lipase Induced Rancidity in Cheddar Cheese. JOUR. DAIRY SCI., 24: 7, 561–565. 1941.

(10) ITOH, R., KAYASHIMA, S., AND FUJIMI, K. Studies on Lipase. VI. Effects of Reduction and Oxidation on the Splitting Action of Serum Lipase and Milk Esterase. Jour. Biochem. (Japan), 30: 283–289. 1939.

(11) KRAUT, H., AND PANTSCHENKO-JUREWICZ, W. v. Über Struktur und Eigenschaften der Esterasen. Biochem. Ztschr., 275: 114–135. 1935.

(12) KRUKOVSKY, V. N., AND HERRINGTON, B. L. Studies of Lipase Action. II. The Activation of Milk Lipase by Temperature Changes. JOUR. DAIRY SCI., 22: 3, 137–147. 1939.

(13) KRUKOVSKY, V. N., AND SHARP, P. F. Effect of Shaking on the Lipolysis of Cow's Milk. JOUR. DAIRY SCI., 21: 11, 671–682. 1938.

(14) KRUKOVSKY, V. N., AND SHARP, P. F. Inactivation of Milk Lipase by Dissolved Oxygen. JOUR. DAIRY SCI., 23: 11, 1119–1122. 1940.

(15) PANTSCHENKO-JUREWICZ, W. v., AND KRAUT, H. Über Struktur und Eigenschaften der Esterasen. II. Mitteilung. Ein Zusammenhang Zwischen Ascorbinsaüre und Leberesterase. Biochem. Ztschr., 285: 407–419. 1936.

(16) SHARP, P. F., TROUT, G. M., AND GUTHRIE, E. S. Vitamin C, Copper and the Oxidized Flavor in Milk. Tenth Ann. Rept. N. Y. Assoc. Dairy and Milk Insp., p. 153–164. 1936.

VARIOUS OILS AND FATS AS SUBSTITUTES FOR BUTTERFAT IN THE RATION OF YOUNG CALVES[1]

T. W. GULLICKSON, F. C. FOUNTAINE[2] AND J. B. FITCH

Division of Dairy Husbandry, University of Minnesota

The literature dealing with the value of various fats and oils in nutrition is very extensive, yet but few studies have been reported comparing their feeding value with butterfat for young calves. This fact is rather unusual considering the obvious practical value of such information in relation to economical calf raising and especially to profitable veal production.

The studies reported have largely been confined to a comparatively few oils and fats and results have generally been unfavorable. Lindsey (7) using calves several months old reported generally favorable results from feeding "oleo" at the rate of one ounce per quart of skim milk and mixed thoroughly. He states, "Scarcely any of the calves were able to take more than this amount per quart without disturbing their digestion." Other products used were corn oil and cottonseed oil, but these could be fed only at the rate of one-half ounce per quart of skim milk "without producing bad effects." A calf fed a combination of corn oil and cottonseed oil seemed to thrive at first but later its condition became less favorable and when slaughtered the carcass "contained very little fat." Hendricks (5), also reported less growth in calves fed cottonseed oil and skim milk than in those fed whole milk or skim milk and cod liver oil. Leach and Golding (6) using calves 15 to 22 days old fed pilchard oil homogenized into skim milk. Severe scouring developed but increases in weight continued during the first week, then their condition became unsatisfactory and in no case did a calf live more than three weeks. Rats on a similar diet grew satisfactorily and produced litters of living young. Schmalfuss and co-workers (11) found emulsified coconut oil to be equal to cod liver oil for feeding to calves. Similarly, Fingerling (3) found that emulsified peanut oil was a satisfactory supplement to skim milk for calves provided it was not added in too great amounts.

In 1939 we (4) reported, very briefly, our results obtained from feeding calves butter oil, lard, corn oil, cottonseed oil and soybean oil, respectively, homogenized into skim milk. The results as measured in terms of rate of gain in weight, physical appearance and general well-being of calves indicated clearly the superior nutritive value of butterfat over all the other fats and oils tested. The calves fed lard made nearly as rapid gains in weight

Received for publication September 22, 1941.

[1] Published with the approval of the Director as Paper No. 1925, Scientific Journal Series, Minnesota Agricultural Experiment Station.

[2] Member of staff Idaho Agricultural Experiment Station.

but were inferior in appearance to those receiving butterfat. The animals fed the other three oils made little or no gains in weight and were very poor in appearance and some of them died. Evidence indicating similar differences in the nutritive value of these fats and oils for rats has more recently been presented by Schantz, Elvehjem and Hart (8).

Because of the nature of the results obtained in our original experiments, the study has been continued and enlarged. Some of the earlier work has also been repeated. The present paper is a report on the work completed to date.

EXPERIMENTAL

The following oils and fats were tested in feeding trials: soybean oil, corn oil (Amaizo and Mazola), cottonseed oil (Wesson), coconut oil, peanut oil, lard, beef tallow and butterfat. The latter was prepared by oiling off freshly churned unsalted butter from unpasteurized cream. As in our previous trials, the feeding value of different oils and fats for young dairy calves was measured by rate of gain in weight or growth, physical appearance and general well-being of animals.

The calves used were grades, crossbreds and purebreds of the various dairy breeds and included both males and females obtained from several dairy herds, including the one at University Farm. Calves were usually left with their dams for several days after birth or until they had received colostrum milk. They were then taught to drink from a pail and put on the experimental diet at a week to two weeks of age, and in some cases later. Environmental conditions were kept as nearly uniform as possible for all animals but not all trials were run concurrently. All animals included were adjudged healthy at the time they were placed on experiment.

The fats or oils, except as indicated, were mixed at the rate of 3.5 pounds to every 96.5 pounds skim milk and emulsified at a temperature of about 120° Fahrenheit by means of a Gaulin type homogenizer at 3000 pounds pressure, single action. Each mixture was usually run through the machine three times to insure more complete homogenization. The resulting product was fed at a temperature of 90° Fahrenheit and at the rate of one pound per day per 10 pounds of live weight of calf, except as otherwise indicated. In order to check on any possible effect of the process of homogenization on the butter oil in skim milk, several calves were fed normal whole milk. Hay (alfalfa) and concentrates were usually not fed until the calf was about a month old. In some cases no alfalfa hay was fed. The concentrates mixture was designed to be very low in fat. It was made up of 200 pounds ground dry beet pulp, 50 pounds dry skim milk and 50 pounds gluten meal.

To determine whether calves require any fat in their diet a very fat-poor diet was fed to one group of calves. It consisted of skim milk (.01–.02 per cent fat) along with a concentrates mixture of 100 pounds ground molasses

beet pulp, 50 pounds dry skim milk, 50 pounds starch and 25 pounds cerelose. No hay was fed to calves in this group.

Each calf in all groups was fed 25 to 35 cc. U.S.P. cod liver oil daily or its equivalent in concentrated products. The plan was for all calves to receive the same amounts of nutrients according to weight and at a level adequate for growth, but this was found to be impossible in some cases because of inability or lack of desire on the part of the animal to consume the required amount of food.

Each calf was kept in a separate pen, fed individually and regularly twice daily, all feed was carefully weighed or measured and amounts consumed recorded. All calves were turned outdoors for exercise several hours daily when weather permitted. Weights of each animal were obtained regularly, some at weekly intervals and others every ten days. Frequent observations were made and recorded in regard to physical condition and other facts about each animal. Post mortem examination was made of all animals that were slaughtered or died.

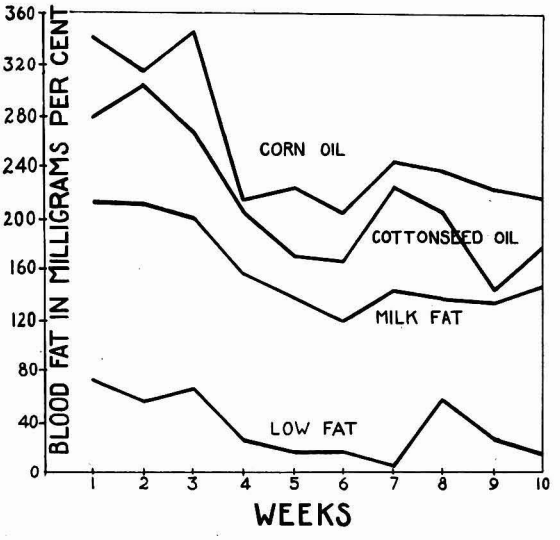


FIG. 1. Average fat content of blood of various groups. Age of animal not considered.

Blood samples for plasma fat volume determination by Allen's method (1) were obtained at weekly intervals from a few animals after they were 90 days old. These data are presented graphically in figure 1. Attempts were also made with several calves about four months old to determine the course of the absorbed fat in the body by means of fat stains or dyes, but results invariably were negative.

RESULTS

No real difficulty was encountered in getting calves to drink the desired amounts of the various prepared skim milk, oil or fat products. However,

TABLE 1

Average weight at 30-day intervals and nutrient per day and per 100 pounds live weight of calves fed various oils and fats

Age	Weight	Nutrients per day		T.D.N. per* 100 lbs. weight	Weight	Nutrients per day		T.D.N. per* 100 lbs. weight
		Protein	T.D.N.			Protein	T.D.N.	
days	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
	Whole Milk Group (2 calves)				Butter Oil Group (2 calves)			
30	100	.35	1.73	1.96	108	.35	1.70	1.72
60	140	.38	1.89	1.58	141	.45	2.19	1.75
90	186	.45	2.37	1.45	176	.67	3.23	2.03
120	231	.59	3.14	1.50	225	.74	3.58	1.79
	Average	.....	.....	1.62	.....	.....	.....	1.82
	Low Fat Group (5 calves)				Lard Group (6 calves)			
30	101	.31	1.16	1.18	104	.30	1.45	1.54
60	123	.48	1.53	1.37	135	.49	2.36	1.98
90	155	.73	2.60	1.87	163	.57	2.79	1.87
120	176	.88	3.07	1.85	209	.73	3.55	1.91
	Average	.....	.....	1.57	.....	.....	.....	1.83
	Tallow Group (4 calves)				Coconut Oil Group (4 calves)			
30	89	.27	1.33	1.64	86	.24	1.19	1.55
60	119	.41	2.02	1.94	112	.30	1.46	1.47
90	165	.71	3.45	2.43	141	.48	2.32	1.84
120	.....	.....	.....	.....	176	.65	3.14	1.99
	Average	.....	.....	2.00	.....	.....	.....	1.71
	Peanut Oil Group (3 calves)				Corn Oil Group (6 calves)			
30	84	.29	1.43	1.83	79	.29	1.42	1.82
60	112	.40	1.94	1.98	92	.32	1.48	1.74
90	.....	.....	.....	.....	109	.38	1.72	1.72
120	.....	.....	.....	.....	123	.38	1.79	1.54
	Average	.....	.....	1.90	.....	.....	.....	1.71
	Cottonseed Oil Group (2 calves)				Soybean Oil Group (5 calves)			
30	85	.29	1.42	1.73	87	.25	1.12	1.32
60	104	.31	1.30	1.38	102	.30	1.29	1.37
90	119	.36	1.51	1.36	109	.36	1.52	1.45
120	127	.49	2.31	1.88	132	.39	1.62	1.35
	Average	.....	.....	1.59	.....	.....	.....	1.37

* Based on average weight during period.

it was necessary in some cases, due to poor physical condition of the calf, to either reduce the amount of the product fed, to change temporarily to whole milk, or to reduce the fat content of the milk fed (see table 2). This occurred almost wholly with calves fed either corn oil, cottonseed oil or soybean oil. The necessity of limiting the food intake in these groups made equivalent reductions necessary in other groups in order to keep them on approximately the same nutrient intake basis. The average nutrient intake of the various groups at different ages and weights is indicated in table 1. Table 2 indicates the kind of fat or oil fed and the fat content of milk fed to each calf along with facts relating to its physical condition. It also shows the age and weight of the animal at start and end of experimental period, together with average daily gain in weight of each group. Figure 2 indicates the growth of the calves in each group.

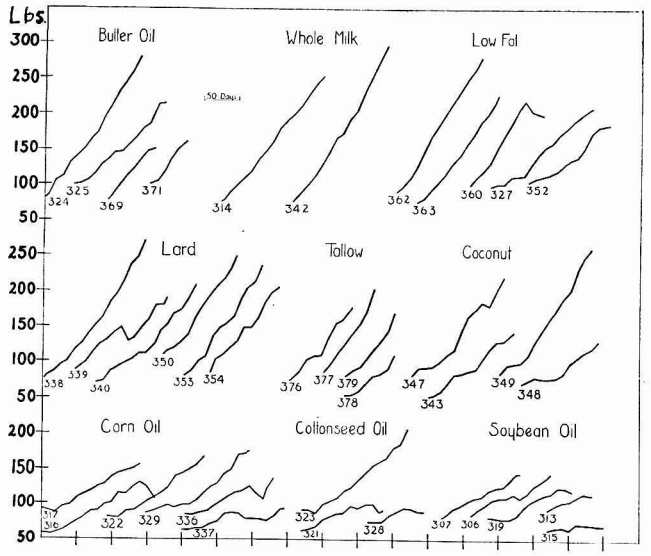


FIG. 2. Growth curves of calves fed various fats and oils.

It will be observed from table 2, that the calves fed fats of animal origin, butterfat, tallow and lard, made significantly greater average daily gains in weight than those receiving the vegetable oils, but especially soybean oil, cottonseed oil and corn oil. Another significant difference noted between the groups was the greater amount of fat present in the carcasses of milk-fat fed calves. Even lard- and tallow-fat fed calves that had made good gains in weight and were in healthy, thrifty condition when slaughtered were inferior in this respect. This fact may be of special significance in relation to the quality of veal produced.

No apparent differences were observed between calves fed whole milk and those receiving the butter oil homogenized in skim milk. Both groups were

TABLE 2

Number, breed and sex of calves fed different fats and oils; their age and weight at beginning and end of experimental period and physical condition while on experiment; also, fat content of milk fed

Number, breed & sex of calf	Age—days		Weight—lbs.		Physical condition of calf, fat content of milk fed, etc.
	Start	End	Start	End	
Whole Milk Group					
314 Gr. H. M	7	147	77	253	3.5 per cent fat. Condition excellent.
342 " " F	7	149	75	301	" " " " " "
Average daily gain in weight, 1.43 pounds					
Butter Oil Group					
324 Gr. H. M	10	141	84	284	3.5 per cent fat. Condition excellent.
325 " Ayr. "	8	137	98	209	" " " " " "
369 " H. "	9	65	80	150	" " " " " "
371 " " "	9	60	100	160	" " " " " "
Average daily gain in weight, 1.22 pounds					
Low Fat Group					
327 Gr. H. M	9	154	100	211	Indigestion at start, otherwise thrifty and healthy.
352 " " "	11	126	106	185	Severe indigestion part of time; condition fair.
360 " " "	22	128	100	214	Fed up to 18 pounds skim milk daily; condition excellent.
362 " " F	22	140	92	280	Fed up to 18 pounds skim milk daily; condition excellent.
363 Jer. M	20	135	76	227	Fed up to 18 pounds skim milk daily; condition excellent.
Average daily gain in weight, 1.07 pounds					
Lard Group					
338 Gr. H. M	6	150	75	270	3.5 per cent fat. Condition good.
339 " " "	6	148	89	205	3.5 per cent fat-lard milk to 82 days of age. Scoured, weak. Whole milk to 106 days of age. Scouring ceased. 3.5 per cent lard-milk to end. Condition fair to good.
340 Guern. M	7	151	71	212	3.5 per cent lard milk. Scoured occasionally. Condition good.
350 Gr. H. F	15	119	110	250	3.5 per cent lard milk. Scoured occasionally. Condition good.
353 " " M	12	122	82	238	3.5 per cent lard milk. Scoured occasionally. Condition good.
354 " " F	17	119	85	207	3.5 per cent lard milk. Scoured occasionally. Condition good.
Average daily gain in weight, 1.17 pounds					
Tallow Group					
376 Gr. H. F	15	105	75	182	3.5 per cent tallow milk fed up to 18 lbs. daily. Some scouring but condition fair to good.
377 " " M	8	81	88	206	3.5 per cent tallow milk fed up to 18 lbs. daily. Some scouring but condition fair to good.

TABLE 2—(*Continued*)

Number, breed & sex of calf			Age—days		Weight—lbs.		Physical condition of calf, fat content of milk fed, etc.
			Start	End	Start	End	
Tallow Group (*Continued*)							
378	Jer.	M	12	85	53	118	3.5 per cent tallow milk. Some scouring but condition fair to good.
379	Gr. H.	"	12	83	80	170	3.5 per cent tallow milk. Some scouring but condition fair to good.
Average daily gain in weight, 1.24 pounds							
Coconut Oil Group							
343	Jer.	M	14	134	52	143	3.5 per cent oil-milk. Indigestion occurred but condition fair to good.
347	Gr. H.	M	12	151	81	233	3.5 per cent oil to age 31 days. Indigestion. Whole milk to 39 days, then 3.5 per cent oil to end. Condition fair to good. Fair amount of internal fat present.
348	Gr. H.	F	12	120	71	131	3.5 per cent oil-milk fed. Scoured. Condition poor to fair.
349	" "	M	9	140	85	260	3.5 per cent oil-milk fed. Scoured. Condition poor to fair.
Average daily gain in weight, .96 pounds							
Peanut Oil Group							
381	Jer.	M	11	92	62	125	3.5 per cent oil-milk. Scoured some but condition fair to good.
382	Guern.	M	12	63	65	100	3.5 per cent oil-milk. Scoured some but condition fair to good.
383	Gr. H.	M	9	63	90	141	3.5 per cent oil-milk. Scoured some but condition fair to good.
Average daily gain in weight, .80 pounds							
Corn Oil Group							
316	Guern.	F	12	170	59	107	3.5 per cent oil to age 21 days. Scoured and dermatitis. Fed half and half whole milk and corn oil milk to age 32 days, then whole milk to 41 days, 2 per cent corn oil milk to 105 days and 3.5 per cent oil to end. Declined gradually in strength and died. Emaciated, with little or no depot fat. Liver pale and friable, kidneys showed fatty degeneration.
317	Gr. H.	M	12	148	92	155	3.5 per cent oil to age 31 days. Scoured. Whole milk to 41 days. Scours ceased. 2 per cent oil to 106 days. No indigestion, then 3.5 per cent oil to end. Gained slowly. Appeared unthrifty.
322	Gr. G.	F	14	151	83	168	3.5 per cent oil to age 34 days. Indigestion and dermatitis. Whole milk to 44 days. 2.0 per cent oil to 139 days of age then 3.5 per cent oil. Fairly thrifty when discontinued.

TABLE 2—(*Continued*)

Number, breed & sex of calf			Age—days		Weight—lbs.		Physical condition of calf, fat content of milk fed, etc.
			Start	End	Start	End	
Corn Oil Group (*Continued*)							
329	Guern.	M	9	154	87	176	3.5 per cent oil throughout but limited to not over 10 pounds milk daily. Severe dermatitis and slow gain in weight. Appeared emaciated and unthrifty.
336	Guern.	M	21	150	86	137	3.5 per cent oil milk fed. Slight indigestion. Very slow or no gain in weight. Thin and rough appearance.
337	Guern.	M	11	155	64	95	3.5 per cent oil-milk fed but limited to not over 7 lbs. daily. Scoured. Some dermatitis. Little or no gain in weight. Weak and emaciated. Died.
385	Albino	F	13	33	56	40	3.5 per cent oil-milk fed. Severe scouring. Died. Hock joints swollen. Severe gastritis and enteritis.
392	Jer.	M	10	61	59	75	3.5 per cent oil-milk fed. Slight indigestion. Was quite active and playful. Good appetite but thin. Hair rough. Became weak and unable to stand. When changed to whole milk at 61 days made rapid recovery.
Average daily gain in weight, .40 pounds							
Cottonseed Oil Group							
321	Gr. H.	F	12	126	65	92	3.5 per cent oil to age 29 days. Unthrifty and slight indigestion, weak. Whole milk to 41 days, 2 per cent oil milk to 103 days of age, 3.5 per cent oil to 124 days, then whole milk again. Thin, emaciated appearance, rough, weak, died. Little or no internal fat. No evident changes in liver and kidneys.
323	Gr. H.	M	10	151	93	209	3.5 per cent oil to age 27 days. Whole milk to 39 days, 2 per cent oil to 100 days, then 3.5 per cent oil milk. This was a very rugged calf at start. Little or no scouring, considerable loss of hair. Ate considerable alfalfa hay. Gained slowly but steadily. Appearance fair.
328	Gr. H.	F	10	85	77	90	3.5 per cent oil milk throughout. No indigestion. General decline set in at about 8 weeks of age. Died. Several hemorrhagic areas in abomasum. Decided absence of depot fat.
389	Gr. H.	M	6	45	85	77	3.5 per cent oil milk throughout. Weakened, declined, died. Emaciated appearance.
Average daily gain in weight, .31 pounds							
Soybean Oil Group							
305	Gr. H.	M	7	39	90	87	3.5 per cent oil milk. Severe indigestion. Died.

TABLE 2—(*Continued*)

Number, breed & sex of calf	Age—days		Weight—lbs.		Physical condition of calf, fat content of milk fed, etc.
	Start	End	Start	End	
Soybean Oil Group (*Continued*)					
306 Gr. H. F	29	144	87	144	2.0 per cent oil milk limited to not over 10 pounds daily. Rough and unthrifty throughout.
307 " " "	13	125	83	144	3.5 per cent oil milk to age 25 days. Scouring. Then 2 per cent oil milk limited to not over 10 pounds daily. Unthrifty appearance. Condition poor.
313 Gr. H. M	10	93	96	121	3.5 per cent oil milk to age 29 days. Slight indigestion. Whole milk to 41 days, then 2 per cent oil milk. Thin, rough, slow gain in weight. Declined and died. Decided lack of depot fat. No other significant abnormalities noted.
315 Gr. H. F	11	95	65	72	3.5 per cent oil milk to age 30 days—refused to drink it. Whole milk to 42 days, then 2 per cent oil milk. Some loss of hair. No indigestion. Thin and scrawny. Declined in strength. Unable to stand. Heart was flaccid and edematous. Evidence of gelatinous infiltration in kidneys. No evident internal fat.
319 Gr. H. M	20	129	83	120	3.5 per cent oil milk to age 40 days. Scoured with considerable loss of hair. Whole milk to 52 days. Scouring ceased. 2 per cent oil milk to 115 days, then 3.5 per cent oil to 129 days. Became weak and unable to stand; when changed to whole milk made remarkable recovery.
386 Jer. M	14	26	52	44	3.5 per cent oil milk fed. Became weak and died.
Average daily gain in weight, .32 pounds					

healthy and thrifty with sleek coats and bright eyes. Although the lard- and tallow-fed groups made almost, if not, as rapid gains in weight as those receiving the milk fat, they were slightly inferior in general appearance but were nevertheless thrifty and alert.

The excellent gains made by calves on the low-fat diet (average daily gain 1.07 pounds) perhaps suggest that they have no need for more than the extremely limited amount of fat provided in their ration. In appearance the calves in this group were typical of calves raised on skim milk under farm conditions. They were healthy and thrifty but did not have quite the sleek, well-fed appearance of calves raised on whole milk. It should be added that several of the animals in this group were continued on the low-fat diet until about two years of age. They remained normal in appearance and made excellent gains in weight throughout.

The condition of the calves in the groups fed coconut oil and peanut oil respectively were on the whole inferior to calves fed lard or tallow but were definitely superior to the animals fed either corn oil, cottonseed oil or soybean oil. In the latter three groups, the calves almost invariably appeared thin and emaciated with rough unkempt hair. Some of them also showed a characteristic loss of hair or dermatitis, the areas about the face, ears and neck being first affected. Subsequent losses occurred on the lateral and medial areas of the cannons of the rear legs. A brown, oily-like crust covered the denuded areas. The time of the appearance of the condition, its extent and duration varied widely in different individuals. The fact that some animals in these groups were not affected, that it appeared in a few individuals in other groups and also that it sometimes occurs in calves on normal rations makes it difficult to suggest a probable cause.

Indigestion or scours appeared among the calves in all groups but those fed corn oil, soybean oil and cottonseed oil were the most seriously affected. Some calves in these groups died from this disorder at an early age (data not included) and others probably would have done so if the ration had not been changed as indicated in table 2. Others in these three groups, although not affected by scours, gained very slowly in weight for a time although they appeared rather haggard and dull, as though starving. This was followed by gradual weakening and some loss in weight, often terminating in death if whole milk was not substituted in time. Several calves (319 and 392) that were in a very weakened condition and unable to stand made remarkable recoveries after such a change in diet was made.

DISCUSSION

The study indicates that under the conditions of the trials, butterfat was superior to all other fats and oils tested as a food for young dairy calves. It appears that tallow and lard may also be used quite satisfactorily for this purpose under the plan of feeding followed. The reason for the superiority of milk fat over other fats and oils tested and for the reasonably good results obtained with the lard and tallow is not indicated by the data. It is true that the calves in these groups were fed on a slightly higher plane than those in some of the other groups but this alone is hardly sufficient to account for the marked differences observed in the rate of gain in weight and physical condition of the calf. No doubt the more frequent and perhaps more severe cases of scours among calves in the corn oil, cottonseed oil and soybean oil groups affected the results but this was probably not the most important factor involved, for death or slow gain in weight also occurred in calves in these groups in which indigestion was absent. It may be pointed out as a matter of general observation in regard to these three groups that the older the calf and the more vigorous it was when placed on experiment the better the results obtained. The latter is probably the chief reason for the fairly satisfactory growth of calf No. 323 on cottonseed oil.

A question may be raised as to whether or not each of the various oils actually were digested and absorbed into the body. Unfortunately, no digestion trials were conducted. However, the relatively high fat volume of the blood plasma of the animals fed the less satisfactory oils as compared to that of those fed milk fat suggests that these oils probably were absorbed. Too much emphasis should not be given to this fact, however, because of the very limited amount of data on hand. What happened to these oils if they actually were absorbed is not known. Were they altered and later excreted through the skin, causing the dermatitis-like condition previously described, or were they excreted back into the intestine? Only further investigations can answer these questions. Post mortem examinations indicated that they were not stored as depot fat in the body to any great extent.

No attempt will be made at this time to explain the differences noted in the nutritive value of the fats and oils tested. It may be pointed out, however, that the work of Burr and Burr (2) and the more recent studies of Hart and co-workers (9, 10) suggests that the nature and kind of fatty acid combinations present may be extremely important. Also, it is possible that some of the oils fed lacked in certain essential factors or that they contained substances toxic to the young calf. We are now investigating these and other phases of this problem.

SUMMARY

Feeding tests were conducted to compare the feeding value of the following fats and oils for calves: butterfat, lard, tallow, coconut oil, peanut oil, corn oil, cottonseed oil and soybean oil. The effect of a very fat-poor diet on calves was also determined. Each oil or fat was added to skim milk, homogenized to form a product containing 3.5 per cent fat and fed along with a low fat content concentrate mixture, cod liver oil and some alfalfa hay. One control group was fed normal whole milk not homogenized. Test periods ranged from a few days to about six months.

In average daily gain in weight as well as in general well-being, the calves fed butterfat excelled those in all other groups. Following closely were those receiving lard and tallow. Corn oil, cottonseed oil and soybean oil were the least satisfactory. The average daily gains of calves in the latter three groups were .40 pound, .31 pound and .32 pound, respectively. They appeared unthrifty, listless and emaciated. Some calves in these groups died and others were saved only by changing to whole milk.

Post mortem examinations showed considerably more fat deposited in calves fed butterfat than in those that had been fed other oils and fats.

REFERENCES

(1) ALLEN, N. N. A Simple Volumetric Method for Determination of Fat in Blood Plasma. Soc. Expt. Biol. and Med. Proc., **31**: 991–993. 1934.

(2) BURR, G. O., AND BURR, M. M. On the Nature and Role of the Fatty Acids Essential in Nutrition. Jour. Biol. Chem., **86**: 587–621. 1930.

(3) FINGERLING, G. Beitrage zur Physiologie der Ernährung wachsender Tiere. I. Ersatz von Vollmilch durch Magermilch mit und ohne surrogate bei Kälbern. Landw. Vers. Sta., **68**: 141–188. 1909.

(4) GULLICKSON, T. W., AND FOUNTAINE, F. C. The Use of Various Oils and Fats for Calf Feeding. JOUR. DAIRY SCI., 22: 471–472. 1939.

(5) HENDRICKS, J. Calf Feeding Experiments with Separated Milk and Oils. Highland and Agr. Soc. Scot. Trans., **25**: 259–282. 1913.

(6) LEACH, T. A., AND GOLDING, N. S. A Preliminary Report of the Substitution of Pilchard Oil for Butterfat in Milk for Calf Feeding. Sci. Agr., 12: 204–205. 1931.

(7) LINDSEY, J. B. Feeding Calves for Veal. Mass. Agr. Expt. Sta., 12th Ann. Report, 125–145. 1894.

(8) SCHANTZ, E. J., ELVEHJEM, C. A., AND HART, E. B. The Comparative Nutritive Value of Butterfat and Certain Vegetable Oils. JOUR. DAIRY SCI., **23**: 181–189. 1940.

(9) SCHANTZ, E. J., BOUTWELL, R. K., ELVEHJEM, C. A., AND HART, E. B. The Effect of Added Egg Phospholipids on the Nutritive Value of Certain Vegetable Oils. JOUR. DAIRY SCI., **23**: 1201–1204. 1940.

(10) SCHANTZ, E. J., BOUTWELL, R. K., ELVEHJEM, C. A., AND HART, E. B. The Nutritive Value of the Fatty Acid Fractions of Butterfat. JOUR. DAIRY SCI., **23**: 1205–1210. 1940.

(11) SCHMALFUSS, H., WERNER, H., AND ESSKUCHEN, E. Vergleich von Lebertran, Lebertran-emulsion, und Kokosol Emulsion an Kälbern. Zuchtungskunde, **13**: 31–43. 1938.

THE INTRODUCTION OF CATTLE INTO COLONIAL NORTH AMERICA*

G. A. BOWLING

Department of Dairy Husbandry, West Virginia University, Morgantown

The scarcity of data relative to the first importations of cattle into Colonial North America has lent obscurity to one of the most interesting phases of early American husbandry. In fact this paucity and incompleteness of information dealing with the introduction of cattle into what is now the United States of America has led many authors in the field of animal and dairy husbandry to an almost studied disregard of this primary stage in the development of our national livestock industry. When it is considered that the foundations of cattle husbandry were laid in every one of the thirteen original colonies and in the south and southwestern part of our present United States before any appreciable progress had been made in the systematic improvement of cattle in England and Continental Europe, the question of where our foundation animals came from should be of more than passing interest. Allen (2) in 1890 in his work, **American Cattle,** dealt briefly with colonial cattle importations. Bidwell and Falconer (6) in 1925 and Gray (25) in 1933 in their general histories of agriculture in the United States to 1860 have presented a considerable amount of information relative to early importations. It was with the hope of assembling, in one body, additional information on the introduction of cattle into Colonial North America that this review of literature was undertaken.

It is quite apparent that Colonial Americans were so busy making economic history that they failed to write sufficiently about it. Authentic records were, in many cases, incidental and are found in several fields. This has increased the difficulty of presenting data that are both complete and accurate. Quotations have been offered frequently in order that a better picture might be had of the actual conditions and circumstances surrounding many of the colonial cattle raising undertakings. It is hardly necessary to point out that this review of literature is incomplete. It is offered at this time, however, with the thought that it may be of some assistance to the teachers of courses in dairy cattle history.

During the period of discovery and colonization there were four possible paths of introduction of cattle into what is now the United States of America. First, from the West Indies to any portion of the Atlantic and Gulf of Mexico coast line. Second, from Mexico into southwestern areas and California. Third, from the French colonies of the St. Lawrence Valley into

Received for publication September 27, 1941.

* Published with the approval of the Director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 277.

the area of the "Old Northwest." Fourth, directly from the colonizing European nations to the American colonies. Historical evidence supports the belief that all of these paths of entry were used.

INTRODUCTION OF CATTLE BY THE SPANISH

Encouraged by the glowing reports carried back to the Old World by Columbus in 1492, the Spanish throne decided to colonize the New World at once. To this purpose Columbus made a second voyage in 1493, carrying with him besides colonists, a large variety of agricultural seeds and plants, and the first shipment of domestic livestock destined to inhabit the New World. "Besides a few horses for cavalry service there were carried for breeding purposes mares, sheep, heifers and other animals. Vegetables, wheat, barley and other cereals were not forgotten nor the vine and fruit trees. All kinds of tools, too, that would be needed in a colony were included. At the Canary Islands they added to their stock calves, she-goats, ewes, pigs, chickens, seeds of oranges, lemons, and other garden plants, and most of all, sugar cane" (37). It was necessary for Columbus to carry these things to the new lands for, though "gloriously rich in some aspects of nature, the New World was notably poor in food plants and domestic animals" (8).

Whether the attempts to develop an animal industry in the New World were at once successful is not known. Because of the small size of sea-going ships during the sixteenth century, it is entirely possible that only a small number of cattle, or more correctly "neat cattle," were brought over at first. As the first shipment was made up of heifers and calves, it can be concluded that for the first few years there could not have been a large number of cattle for slaughter. Although we have no information that would lead one to believe the Spanish were large consumers of beef or dairy products, yet there was an immediate need for cattle above the numbers taken over, and their increase. In an attempt to fill this need, Columbus, in 1494, urged the Spanish King and Queen to authorize contractors to deliver to the new country cattle and beasts of burden annually, for which they might be paid by giving them Indian slaves (53). Whether or not this recommendation of Columbus' was adopted and followed to any great extent, we do not know. By 1512, however, stock-raising had become a fixed industry in the West Indies (8), and considerable numbers of cattle were being raised.

The Spanish took cattle from one island to another in the West Indies until they became quite common in the eyes of voyagers who had occasion to stop from time to time. Hakluyt (28) in relating the voyage of John Hawkins to the West Indies in 1565 said "The tenth day (of March) at night we departed from thence (the first island seen) and the fifteenth had sight of nine islands, . . . and the sixteenth of an island, called Margarita,

where wee were entertayned by the alcalde, and had both Beeves and sheepe given us. . . ." During this same voyage "The sixth of May aforesaide, we came to an yland called Curacao. . . . In this place we had trafigue for hides, and found great refreshing both of beefe, mutton and lambs, where of there was such plentie, that saving the skinnes, we had the flesh given us for nothing. . . ."

"The increase of cattell in this yland is marveilous, which from a doozen of each sort brought thither by the governour, in 25 years he had a hundreth thousand at the least & of other cattel was able to kill without spoile of the increase 1500 yeerely, which he killeth for the skinnes, and of the flesh saveth only the tongues, the rest hee leaveth to the foule to devoure. And this I am able to affirme, not onely upon the Governours own report, who was first to bring the increase thither, which so remaineth unto this day, but also by that I saw my selfe in one field, where an hundred oxen lay one by another all whole, saving the skinne and tongue taken away. And it is not so marveilous a thing why they doe thus cast away the flesh in all the ylands of the West Indies, seeing the land is great, . . . the people fewe, having delicate fruites and meates ynough besides to feede upon, which they rather desire, . . . : for in S. Domingo an yland called by the finders thereof Hispaniola, is so great a quantitie of cattel, and such increase thereof that notwithstanding the daily killing of them for their hides, it is not possible to asswage the number of them, but they are devoured by wilde dogs, . . . that they eate and destroy 60,000 a yeere, and yet small lacke found of them."

These quotations give the impression that the cattle taken by the Spanish adventurers into the New World possessions were primarily for the purpose of furnishing hides, with beef tongues as a secondary consideration, or what might be termed a by-product of the hide-producing industry. In fact, hides seem to have been one of the leading export articles, not only of the West Indian Islands but of sixteenth century Mexico. More than one reference is made by Halkuyt to the hides produced, and to the Spanish dairies of Mexico. While these are perhaps the earliest references to dairies in the New World, the places referred to were probably not dairies but cattle ranches. Due to the fact that dairies existed as agricultural enterprises in England at that time, the English narrator probably used the term he associated with herds of cattle, without thought as to the marketable product produced.

In 1572 the cattle business was flourishing in New Spain (Mexico) and it is written that one man had 20,000 head (27). Hides were the chief source of income, but a certain amount of tallow was shipped. Oxen were used at this date to haul goods, some of which was transported 700 miles.

Sir Walter Raleigh's expedition, under Sir Richard Grenville, to the Atlantic coast of the New World stopped at Hayti in 1585 where it was

entertained by the Spanish (27). "Which banquet being ended, the Spanish in recompence of our courtesie, caused a great herd of white buls and kyne to be brought to gether from the mountaines, and appointed for every Gentleman and Captaine that would ride, a horse ready saddled, and then singled out three of the best of them, to bee hunted by horsemen after their manner . . . the next day wee played the Marchants in bargaining with them by way of trucke and exchange of divers of their commodities, as horses, mares, kine, buls, goates, swine, sheepe, bull-hides, sugar, ginger, pearle, tabacco, and such like commodities of the Ilands."

The reference made by the English visitors regarding the cattle on Hayti gives proof that the early English colonists had knowledge of the West Indies as a source of cattle. The fact that this group of colonists purchased cattle and other classes of livestock on this island may justify the statement that the first livestock brought to the eastern coast of North America by the English was of Spanish origin. As this group of colonists, who landed on Roanoke Island, was mysteriously lost, the history of this importation of livestock must remain unwritten forever. In 1616 the English who settled on Summer Isles, or the Bermudas, purchased cattle for their plantation from the Spaniards in the West Indies (50).

In 1539 cattle were taken from Mexico into the present boundaries of the United States (38) and in 1541, 500 cows were taken across the Rio Grande by Coronado. As early as 1598 a large number of cattle, 4,000 in fact, was taken from New Spain, or Mexico, into what is now New Mexico by Don Juan de Oñate (20). The town of Santa Fe was established in 1609 and the cattle business was planted firmly in that section of the country. In 1769 cattle were taken from Mexico into what is now the state of California, by Serra and Portolá (31), and these were the nuclei for large herds that showed the influence of Spanish ancestry for many, many years.

It seems evident that by this time the cattle had become so numerous in the Spanish possessions in the New World they had no monetary value except as a source of hides and perhaps as a means of sport. This, of course, was exclusive of their value as beasts of burden. No references have been found that would indicate that the Spanish in the West Indies were users of dairy products or eaters of beef, although they seemed to esteem the flesh of swine, and kept large droves of them. From the Cabeca (33) description of the American bison and a comparison with the Spanish cattle of that day, the latter must have been rather large animals with long, heavy horns, and comparatively coarse flesh.

Cattle were taken into Florida by the Spaniards about the time the first permanent settlements were effected. In volume one of the **Colonial Records of Spanish Florida** (14) much evidence is presented concerning the first importations of cattle into Florida. These cattle were shipped from the Spanish islands of the West Indies, and apparently were kept on islands

along the coast of Florida. This was necessary because of the difficulties which arose with the Indians. Since these islands were not very productive, and since hostile natives prevented extensive crop cultivation, the raising of cattle was a difficult task. It was not until conditions permitted the production of cattle on the mainland that the cattle population reached significant numbers.

It is evident that among the inducements offered the colonists was the promise of livestock, for in 1576 dissatisfied colonists who wished to return to Spain claimed that they had not been given the cattle of all kinds that had been promised them, including "Twelve head with the bull." That the cattle were taken into Florida previously, however, there can be no doubt as the following evidence which grew out of an investigation made in Madrid by Licentiate Gamboa on matters concerning Florida will show.

"On being asked what kinds of cattle, large and small, the said Adelantado brought to the said province, and how he divided it up, to whom he gave it, and under what conditions: this witness said that he remembers that the first year he brought a certain number of cows, mares, hogs and goats, and he thinks there were sheep likewise; whereof the goats and sheep were eaten and consumed, and the Indians killed the hogs. He also knows and saw that the said cows and all of the mares were consumed and eaten by the soldiers and the other people without anything remaining; and this witness knows and saw that afterwards the said Adelantado again brought to the said country a quantity of cows and hogs, and he knows not how many; and they multiplied and there was stock raising in the land, especially in hogs." The date of this inquiry was February 5, 1573. This witness had gone to Florida six years before, and if cattle were taken at that time the approximate date would have been 1567.

A second witness who claimed to have gone from Spain to Florida in 1566 testified as follows: "At the beginning, which was about two years after this witness went there, as many as twenty horses and mares were brought, and twelve cows, forty hogs, thirty goats and a few sheep, which were all consumed and eaten because of the famine and want that occurred; and the Indians killed the hogs. Afterward the said Adelantado again stocked the land, with eighty cows, one hundred hogs, and another hundred in Santa Elena, and about twenty goats; which was all for the Adelantado, and none of it had been distributed; at least this witness does not know it."

Another witness who had gone to Florida about 1566 testified as follows: "As soon as he arrived in the land, he saw there cows, mares, goats, hogs and sheep; but that he does not know the number, not how they were apportioned, further than that, in the straits they were in, everything was eaten, and the Indians killed and ate the hogs."

Since many of the first colonists were placed in or about the fort on the island of Santa Elena they complained bitterly because of the lack of agri-

cultural possibilities, and the extreme difficulties in growing livestock. Even at St. Augustine the farming opportunities were limited, partly because of the insects and partly because of a scarcity of suitable feed.

When one witness was "Asked if there are in the country any cattle and vegetables wherewith the said people can sustain themselves, he said that in St. Augustine there were left fifteen or sixteen mares and ten or twelve cows; that the said cattle cannot sustain themselves because the mosquitoes eat them and the Indians kill them; . . ."

From these testimonials it is evident that the establishment of the cattle industry in Florida was accompanied by many difficulties.

The cattle brought into Florida were, without doubt, from the Spanish West Indies. With an abundance of cheap cattle so close at hand it would have been out of the question to ship them from more distant points. Cattle from the West Indies also found their way into South Carolina (25).

The influence of the cattle of Spanish origin on the characteristics of the cattle of Southern United States has never been appreciated fully by most students of livestock history in this country. When it is remembered, however, that all of the first cattle introduced into the southwest, and into Louisiana and Florida, were of Spanish origin and that large numbers of this type of cattle were introduced into practically every coastal colony, it must be admitted that the early influence of Spanish cattle was indeed great. One of the main reasons why native cattle in the South differ somewhat in conformation and utility from those in the North may be attributed to the original Spanish cattle in the southern part of the United States. The large numbers of cattle found in Florida in the early part of the eighteenth century as pointed out by Gray (25) lend further weight to the belief that Spanish cattle contributed an influence to our present day cattle that should not be minimized.

INTRODUCTION OF CATTLE BY THE FRENCH

The French, who made their first permanent settlements along the St. Lawrence, brought cattle to the American Continent as early as the middle of the sixteenth century. Cartier, when he sailed on his second voyage to the New World in 1541, had with him cattle, goats, hogs and other beasts. These were taken for breeding purposes in the new country (21). While this may have been the first introduction of cattle into the St. Lawrence watershed, yet it is apparently a fact that cattle were taken into that part of the world even before Cartier made his second voyage. When Sir Humphrey Gilbert reached St. Johns, Newfoundland, in August 1583 he learned from a native of Portugal that over forty years before some Portuguese had placed on Sable Island both neat cattle and swine for breeding purposes, and that these animals had increased greatly in numbers. The informing Portuguese claimed to have been present when this project was accom-

plished (21). Other historians (45, 54) have mentioned these cattle but their explanations are that these cattle had escaped from a wrecked Spanish or Portuguese ship. It is entirely possible that these animals may have been placed on Sable Island by the Portuguese since their presence there would constitute a distinct aid, from the standpoint of food, to Portuguese fishing vessels. Parkman (45), however, cites evidence that "in 1518 the Baron de Léry made an abortive attempt at settlement on Sable Island, where the cattle left by him remained and multiplied."

In regard to these same cattle on Sable Island Governor Winthrop of Plymouth (54) recorded on June 24, 1635, the following interesting account: "Mr. Graves in the **James,** and Mr. Hodges in the **Rebecka,** set sail for the Isle of Sable for sea-horse (which are there in great numbers) and wild cows. Mr. John Rose, being cast ashore there in the (Mary and Jane) two years since, and making a small pinnace of the wreck of his ship, sailed thence to the French upon the main, being thirty leagues off, by whom he was detained prisoner, and forced to pilot them to the island, where they had great store of sea-horse teeth, and cattle, and store (of) black foxes; and they left seventeen men upon the island to inhabit it. . . . He saw about eight hundred cattle, small and great, and many foxes, whereof some were perfect black." On August 26 of the same year Winthrop wrote: "They returned from their voyage. They found upon the island sixteen Frenchmen, who had wintered there. . . . They had also killed many of the cattle, so as they found not above one hundred forty, and but two or three calves."

The French came to North America primarily to trade. Trapping for furs and trading with the Indians proved so remunerative that a permanent type of agriculture had little appeal. For several years the cattle that were kept supplied only some of the necessities of diet and had little commercial importance. Later, with the coming of the Jesuits, who had visions of a more self-sufficing New France, more attention was given to agriculture and stock-raising.

The first cattle brought into Canada by the French probably were of the type common to Brittany, for Cartier sailed from that region of France (45). Sanders (49) has written that "in 1620 a few cattle were landed at Quebec, and in 1665 Messers. Tracet and de Courcelle brought from France a small shipment described as black and brindle in color. These early selections were from Brittany, Normandy, and probably from the Island of Jersey, and their descendants to this day are not unlike the darker Jerseys in coloring." The present French-Canadian breed of cattle undoubtedly descended from the French types brought over by the early colonists.

The Jesuits, and the colonists who followed the paths of the religious trail blazers, brought cattle from the St. Lawrence Valley into the middle west. This did not occur until many years after the English and Spanish

had brought cattle to the Atlantic seaboard, but as foundation animals they exerted an influence on the early cattle of our present cornbelt area. Parkman (44) presents evidence which indicates that as early as 1649 the French had "fowls, swine, and even cattle" at Sainte Marie near the waters of Georgian Bay. Colonization occurred later at Detroit, and the area round about became populated, first by dependent Indians, followed by traders, and later by farmers and stock raisers. Carrier (13) points out that cattle were taken to Kaskaskia in 1712, and that Charlevoix, in 1721 found thriving settlements at these places with droves of "black cattle."

The first cattle that were taken into the lower Mississippi Valley by the French were, in most cases, of Spanish origin. In 1701 Iberville stopped at San Domingo and took on horses, cattle and swine for the new colony (Mobile) in Louisiana (29). On his first trip he had brought "a small number of bulls, cows, hogs, poultry, and turkey" (32). In 1703 four oxen were sent for in Havana (36). In 1704 there were 9 oxen, 14 cows and four bulls, and by 1708 there were 50 cows in milk, 40 calves, four bulls and 8 oxen (29). Cattle increased slowly in the French colony and many efforts were made, some which were successful, to obtain cattle from the Spanish islands near by. By 1724 there were 1100 cows, and 300 bulls in the colony (36), and by 1746 it was estimated there were 10,000 head of cattle in Louisiana (25). Here again the heavy influence of Spanish cattle in Colonial America must be acknowledged.

Hamilton in his book **Colonial Mobile** (29) has assembled much interesting information relative to the cattle population in the vicinity of that city. For example, he notes that in 1766 "there are from the highest to the lowest, on the east side of the Bay of Mobile, seventeen plantations, thirty-nine white men who can bear arms, thirty-two negroes of which twenty-nine are men grown, twenty-one women and children. In all, 124 souls and 2280 head of cattle." In another place he records that a man writing from Mobile in 1812 stated that he has "about 30 head of cattle and hundreds of hogs, the hogs wild." He also wrote that the cattle and hogs did well on his land with no expense. In 1814 when Andrew Jackson took over the territory in the vicinity of Mobile Bay, "There were a great many cattle east of the bay, the property of the Mobilians." This was the same area in which the census of 1766 revealed 2280 head of cattle. In the hundred years since Iberville first took cattle into that territory they had indeed made a very great increase. Similar development in cattle raising had taken place throughout the Gulf area before it became a part of the United States.

INTRODUCTION OF CATTLE BY THE DUTCH

While the English were colonizing Virginia and Massachusetts, and the Spanish were founding settlements in Florida and at Santa Fe, the Dutch had not been idle. In 1609 they established a trading post on the present site of Albany and by 1621 the settlement on Manhattan was started.

Four years elapsed before cattle were imported, but in **Narratives of New Netherlands** (52) it is stated that in November 1625 a ship arrived, and after unloading passengers "the cattle carried thither were removed upwards to a convenient place abounding with grass and pasture. Only two animals died on the passage. This gave great satisfaction to the freighter, who had managed the transportation so neatly."

The success of the first shipment of cattle led to further development along this line and by 1626 the colony had "increased to two hundred souls; and afterwards some ships, one with horses, the other with cows, and the third with hay; two months afterwards a fly-boat was equipped to carry sheep, hogs, wagons, ploughs and all other implements of husbandry. These cattle were, on their arrival, first landed on Nut Island, three miles up the river, where they remained a day or two." These cattle were taken later to Manhatas. "Being put out to pasture here, they throve well, but afterwards full twenty in all died. . . . But they went in the middle of September to meadow grass, as good and as long as could be desired" (52). By this same authority it was pointed out that the West India Company of New Netherlands agreed to transport cattle free of charge for those patrons who were founding colonies.

The few details available relative to the importations of cattle into New Netherlands might indicate that relatively few were imported directly from Holland. On the other hand the importations of these animals may have been such a common occurrence that they did not elicit comment from the Dutch historians. Nevertheless, cattle played an important role in the agriculture of New Netherlands.

Under the early Dutch system of colonial agriculture "the Company furnished the farmer a house, farming implements and tools, four horses together with four cows, sheep and pigs in proportion, the usufruct and enjoyment of which the husbandman should have during six years, and on the expiration thereof, return the number of cattle received. The entire increase remained with the farmer. The farmer was bound to pay yearly 100 guilders and 80 pounds of butter rent for the cleared land and bowverie" (43). Here we see the strong influence of the homeland occupations guiding the colonists in the choice of a livelihood and a medium of exchange. In Virginia tobacco was used for money. In New England debts could be paid in terms of cattle. To the dairy-minded Dutch, however, the giving up of their cows was like surrendering ownership of the mine from which the gold is taken; and so they kept the cows and paid their rentals with butter.

About 1640 a war broke out with the Indians. Before this conflict ended the Dutch had lost a great many of their cattle at the hands of the Indians, and it was several years before they recovered from this loss. In 1650 a resolution by the States General forbade the exportation of cows

from the colony except by permission of the Council. In that same year, however, Cornelis van Tienhoven, secretary of the colony wrote (presumably in Holland) "Cattle, such as horses, cows, hogs need not be sent from this place, in consequence of the great expense, as they can be got at a reasonable price from the Dutch, and principally among the English, who have plenty of them" (43). This would indicate at least a partial recovery from the losses suffered during the Indian war, and it would also point definitely to the fact that the Dutch and English were on trading terms.

"Prior to the end of the Dutch regime, Long Island had been settled rather extensively with English farmers from New England and had become quite heavily stocked with cattle. Johnson gives 1640 as the date of the beginning of the English settlements on Long Island, but that was the date a church was organized. There were apparently individual settlers there a few years earlier" (13). This authority does not give the source from which the cattle came. They may have been from New England or Virginia, or they may have been purchased from the Dutch at New Amsterdam; for it is known that the Dutch and English carried on inter-colonial commerce (9). Denton (17), however, states "The Island is plentifully stored with all sorts of English cattle" and this would lead one to believe that most of the cattle were purchased from the English colonies.

The growing tendency of the English cattle to dominate, even within what the Dutch considered their own boundaries, is shown in a report of the conditions existing in 1649 within the Dutch limits as far East as Stamford. ". . . their cattle, including cows and horses, are computed at thirty thousand; their goats and hogs cannot be stated. . . ." Also, "Flushing, which is a handsome village and tolerably stocked with cattle; the fourth and last isheemstee, which is superior to all the rest, for it is very rich in cattle" (43). A reason for the trend towards English cattle is contained in this paragraph from a report, written in 1649, on conditions in New Netherland. "The domestic cattle are here in size and other respects about the same as in Netherland, but the English cows and swine thrive and feed best, yea, appear to be better suited to this country than those from Holland; they require also less trouble, expense and attention, for it is not necessary to look so much after the inferior stock, such as swine, in winter; but if done in some sort, whenever there is deep snow, t'will be so much the better. Milch cows, also are much less trouble than in Holland, for, most of the time, or when necessity demands, a little hay is only occasionally thrown to them" (43).

The influence of Dutch cattle in New Jersey is indicated by the following quotation. "When the English gained control in 1665 and undertook systematically to settle that part of America, East Jersey was already stocked with excellent horses and cattle, the original breeds coming from Holland and Sweden. It was early discovered that the improved animals

from the continent did not stand the adverse conditions of those early days as well as did the less improved English breeds. For that reason many animals were purchased in New England and brought to New Jersey. The crossing of the two strains gave a good general purpose breed" (13). Here is a direct inference that the cattle of Holland and Sweden were of higher quality and accustomed to better treatment than the English cattle. It is inferred also that of all the different nationalities that colonized on the North American continent the Dutch were superior in the field of animal husbandry. The English coming into New Jersey were willing to lose the higher production possibilities of the Dutch cattle rather than improve their own husbandry practices to the point where the Dutch cattle might have compensated them for their efforts. At such a price was a low level of production purchased as a foundation for many generations of American dairy cattle! That the good qualities of the Dutch and Swedish cattle were not all lost, however, is carried in the following description of the cattle belonging to John Bartram about 1750 as it was recorded by William Darlington (16). "His cows were then returning home, deep-bellied, short-legged, having udders ready to burst; seeking, with seeming toil, to be delivered from the great exuberance they contained."

It is unlikely that any cattle were imported directly from England as a basis for the early animal husbandry of New Jersey.

IMPORTATIONS BY THE SWEDES

Sweden's only attempt at colonization on the Atlantic coast was in 1638 (24). But it was not until 1640 that immigrants from Stockholm arrived with "cattle and implements of husbandry" (23). They settled in what is now the state of Delaware. Previous to this, in 1631, a Dutch ship, with colonists and cattle, had arrived on the Delaware river and a settlement was established, but it was destroyed by the Indians. Later cattle were imported from New Amsterdam and near-by territory and it is quite possible that cattle were purchased from the English in Virginia. At least this was suggested in the report of Governor Rising in 1654 (41). Although the Swedish influence as a colonial power lasted but a short time the influence of Swedish cattle was felt for a great many years. The people who came later into what is now Pennsylvania were glad to obtain good cattle from the Delaware Counties.

INTRODUCTION OF CATTLE BY THE ENGLISH

Although the quest for gold was the primary stimulus for English and Dutch explorations in the New World, they were willing to accept rich, productive land as a substitute for the precious metal. After the realization dawned that gold could not be dug out of every hill of the western hemisphere, groups in these respective countries turned their thoughts to the

serious consideration of colonization. Sweden, who wanted a home-made market for manufactured products, also decided to try her hand at colonization. So, at the beginning of the seventeenth century we find the zone of exploration, conquest and colonization shifting from the torrid to the temperate zone, and the white heat of the gold quest giving way to deliberate plans for the expansion of empires.

The first English colony was founded in 1607 at Jamestown in the present state of Virginia. By 1609 the colony was fairly well stocked with poultry, swine and sheep, and a few horses had been brought over. According to Captain John Smith (50) it was not until May 10, 1611, however, that cattle were first brought over from England. He also states that the next year, 1612, six ships bringing 100 "kyne" with other cattle arrived about the first day of August. While May 10, 1611, is the first date mentioned by Smith for the landing of cattle, Lord Delaware (47), who left the colony before the arrival of the ships on May 10 of that year stated in his **Relation** that "The cattell already there are much encreased, and thrive exceedingly with the pasture of that Country: The Kine all this last Winter, though the ground was covered most with snow, and the season sharpe, lived without other feeding than the grasse they found, with which they prospered well, and many of them readie to fall with Calve; Milke, being a great nourishment and refreshing to our people, serving also (in occasion) as well for Physicke as for Food, so that it is no way to be doubted, but when it shall please God that Sir Thomas Dale, and Sir Thomas Gates, shall arive in Virginia with their Extraordinary supply of one hundred Kine and two hundred swine. . . ."

There seems to be a discrepancy of one year's time between Smith and other chroniclers as to the exact date of the arrival of the first importation of domestic cattle into Virginia. It is possible that Delaware could have been mistaken were it not for the date of publication of his paper. Smith may also have been in error as to the date of the arrival of the six ships with 100 kine. He gives this date as August 1, 1612, while the records of Delaware (47), Hamor (30), and William Simmonds (40) indicate the date to have been 1611. Since these last three authorities wrote independently it is natural to conclude that they had the date listed correctly. If Delaware was correct in his statement that cattle were in Virginia before 1611 then we must conclude that the first importation was made in 1610.

Here it should be pointed out that there is some difficulty in distinguishing cattle from other domestic animals, when one is gleaning information from available literature. The terms "cattle," "cattell," or "cattel" were quite often used by early writers to include all kinds of domestic farm animals. Those of the bovine species were distinguished, quite often, from the others by the terms "neat," "horned," or "kyne."

The fact that the first colonists valued their animals highly is indicated

by the fact that they made careful preparation for their security and protection (50). The first cow stable was erected in Virginia in 1611 at the direction of Governor Dale (11).

Under the rule of Governor Dale the colony was brought to a fair degree of prosperity. In order to encourage the immigration of colonists certain very definite inducements were extended. Hamor (30) wrote regarding each colonist: "he shall be furnished with necessary tooles of all sorts, and for his better subsistence he shall have Poultry, and swine, and if he deserve it, a Goate or two, perhaps a cow given him." Although this livestock was loaned and not "given," this liberal policy on the part of Governor Dale was conducive to the rapid increase of livestock in Virginia, and the large number of domestic animals available was one of the chief inducements to families to come to America (1). That the preservation of the livestock was of greatest concern to the Plantation is shown in one of the provisions of the Martial Code enforced by Governor Dale. "No man shall dare to kill or destroy any bull, cow, calfe, mare, horse, colt, goate, swine, cocke, henne, chicken, dogge, turkie, or any tame cattle or Poultry of what condition soever. . ." (11).

Little is written about the special uses of cattle during the early days of the Virginia Plantations. It is known, however, that they were used as draft animals, for in 1614 Hamor (30) indulged in the hope that the following year three or four plows would be set to work, there being a sufficient number of steers at that time to draw them. Smith (50) in 1619 wrote of the need for men who could build and make carts and plows, and for skillful men who could train cattle to draw them. Mention is also made of the fact that in 1622 Captain Nuse shared with the starving members of the Colony his own portion of milk and rice, indicating the use of milk as a food for adults as well as for children.

In spite of the great interest in livestock, however, cattle seem to have multiplied slowly. By 1616 there was a total of only 144 head of cows, heifers, heifer calves, steers and bulls in Virginia (48) and in 1617 the number had decreased to 128. Argall, the Governor, sought to obtain an ample supply of winter feed for the livestock by prohibiting the use of hay in the preparation of tobacco for sale. When Argall fled the colony in March, 1619, however, all the *public* livestock had been killed except six goats; and when Sir George Yeardley took charge he had to make provision for supplying newcomers with cattle. In 1619 Sir Edwin Sandys proposed to the Virginia Company of London that 20 heifers be sent over, at a freight cost of ten pounds per heifer, to the colony for every 100 tenants. This would have amounted to 60 head in that year (1). On June 25, 1619, a shipment of corn (probably not *Zea mays*) and cattle was landed safely. By 1620 the total number of cattle in Virginia was estimated at 500 head. The twenty-second of November, 1621, a ship arrived from Ireland with

people, provisions, and cattle; and it is recorded in that year that 80 head of cattle were brought into Virginia (50).

There is much confusion as to the number of shipments of cattle leaving England and the number arriving in the colony. Losses of ships and of cattle were not unusual in those days and it is not possible to determine the exact number of cattle imported. From 1619 to 1622 there was a great deal of interest in the export cattle business to the colony. While it is noted that the Company required that cattle should be fine and spring from English breeds, yet it is a fact that many of the cattle came into Virginia from Ireland. Only female cattle were wanted at this time as there was a sufficient number of steers and bulls in the colony. A cow was valued in the colony at 15 pounds Sterling, and it cost 10 to 12 pounds Sterling to ship a heifer from England to Virginia. It is interesting to note that it cost only two pounds less to bring over a heifer than to bring over a man (11).

Whether by importations or by good husbandry, or a combination of the two, the number of cattle in Virginia had increased to 2000 by 1627. This estimate by Captain John Smith (50) included cows, bulls and oxen, and in 1629 this same authority recorded that in this year several people estimated the cattle population at about 5000 "kine, calves, oxen and bulls." As late as 1629, however, the Council of Virginia ordered that no healthy female cattle be killed unless they were non-breeders (26).

We may conclude that after about 1630 there were few importations of cattle into Virginia, except perhaps the occasional purchase of an outstanding breeding animal. This conclusion is based on the fact that by 1633 the youthful Plymouth colony in New England was buying cattle from the Virginians (18). Governor Winthrop of the Massachusetts Bay colony (54) recorded on August 3, 1636, that "Samuel Mavarick, who had been in Virginia near twelve months, now returned with two pinnaces, and brought some fourteen heifers, and about eighty goats." This is only one of many cases where definite records exist of exportations of cattle from Virginia. In 1631 it was ordered that each 20th calf, pig and kid should be given as a tithe to the religious minister (26). In 1649 there were 30,000 "head of Cattell, and an infinite number of Hogges," in Virginia (12) and in 1655 cattle were so plentiful that one cow was being offered as a bounty to the Indians for the bringing in of lots of eight each of wolf heads (26).

Smith (50) recorded that by 1629 there was a tendency to change from tobacco culture to a pastoral type of agriculture. "Jamestown is yet their chiefe seat, most of the wood destroyed, little corne there planted, but all converted into pasture and gardens. . . . Here most of their cattle doe feed, their Owners being . . . about their plantations. . . . Here in the winter they have hay for their cattell: but in other places they browze upon wood, and the great huskes of their corne, with some corne in them doth keepe them well."

Due to the difficulty of fencing, a large number of cattle ran at large and became wild. These cattle, however, could not be hunted without a license. Because of the range conditions existing, little provision was made for winter feeding and during the winter of 1673 it was estimated that 50,000 cattle perished because of the severity of the weather (11).

Although the first cattle taken into Virginia were under the strict supervision of the Company one should not be led to believe that the raising of cattle was entirely a public trust. As plantations increased in number, private herds came into being and increased both in number and size; and while it is estimated that the number of wild cattle, some of which were ear marked or branded, exceeded the number of tame cattle, yet there were several large herds kept in inclosures, and a few contained over 100 head each (11). From this time forward the increase in the number of cattle in Virginia continued until the beginning of the Revolutionary War.

The Plymouth Colony, although founded in 1620, did not import any "neat" cattle until four years later. We have Governor Bradford's statement (9) that in 1624 "Mr. Winslow came over, and brought a perty good supply, and the ship came on fishing, a thing fatall to this plantation. He brought 3 heifers and a bull, the first beginning of any cattle of that kind in the land. . . ." Faulkner (22) in commenting on this said "cattle were brought in as early as 1624 and formed the basis of rapidly increasing herds and successful dairying." Bradford (9) records further that in 1625 the factors of the colony from Plymouth, England, sent a shipment of cattle, cloth and other goods, in the custody of Mr. Allerton and Mr. Winslow, who were to sell them at their discretion. He further comments that "the cattle were the best goods, for the other being ventured ware, were neither at the best (some of them) nor at the best prices."

The idealistic system upon which the Plymouth Colony was founded did not function to the satisfaction of the colonists and in 1627 it was decided that goods and property should be divided among the members. "And first accordingly the few cattle which they had were divided, which arose to this proportion; a cow to 6, persons or shares, and 2 goats to the same, which were first equalized for age and goodness, and then lotted for; . . ." (9).

Captain John Smith (50) in commenting upon the founding of Salem, Massachusetts, in 1629 wrote: "In the yeare 1629, about March, six good ships are gone with 350 men, women and children: . . . Also 150 head of cattell, as horses, mares, and neat beasts; 41 goats. . . ." In discussing the islands at the mouth of the Charles River, Smith stated: "In the Isles you may keepe your hogs, horse, cattell, conies or poultry and secure for little or nothing." Thus did the colonists utilize this provision of nature to fence their livestock. He also recorded that in the summer of 1630 another ship arrived with twenty "cattell" and forty or fifty passengers. Bradford mentions a shipment of "kattle" brought over by Mr. Allerton and Mr.

Hatherby in 1630 and sold. A ship, the **White Angel** arrived at Sauco June 27, 1631, with "cows, goats, and hogs, and many provisions" (54). The record shows also that on July fourteenth of the same year the **Friendship,** of Barnstable, arrived at Plymouth and landed "eight heifers, a calf and five sheep." She had been at sea eleven weeks. On July 22 the **White Angel** that had arrived at Sauco nearly a month before landed 21 heifers at Plymouth.

Cattle importations hit a full stride in the 1630's, and the following are only a few of the recordings by Winthrop (54) relative to the bringing in of cattle. October 29, 1630; Mr. Goffe's ship "brought out twenty-eight heifers, but brought but seventeen alive."

June 12, 1632; The **James** arrived from London. "She brought sixty-one heifers and lost forty."

May, 1633; the **William and Jane** arrived . . . with thirty passengers and ten cows or more."

July 24, 1633; "A ship arrived from Weymouth, with about eighty passengers and twelve kine. . . ."

September 4, 1633; "The **Bird** arrived bringing some cattle."

October 10, 1633; The **James** arrived at Salem, "having been but eight weeks between Gravesend and Salem." She brought some sixty cattle.

It should not be supposed that the importation of cattle was without hazards. For example, Winthrop (54), reported the arrival of the **Mayflower** and the **Whale** at Charles Town harbor, July 1, 1630, with most of their cattle dead. The **Handmaid** arriving at Plymouth, October 29, 1630, lost 10 of 28 cows. The following are also reported by Winthrop:

October 29, 1630. Mr. Goffe's ship "brought out twenty-eight heifers, but brought but seventeen alive."

September 6, 1630. "The wolves did much hurt to calves and swine between Charles River and Mistick."

September 30, 1630. "The wolves killed six calves at Salem."

June 12, 1632. The **James** arrives from London. "She brought sixty-one heifers and lost forty."

On the other hand a few ships made the crossing without the loss of a single animal.

Winthrop (54) recorded at least 12 ships that brought cattle to the Massachusetts colonies during the years 1630–32. During 1633–34 at least 270 head of cattle were imported. He also reported the arrival of a ship from Texel, North Holland, in 1635 that brought 63 heifers.

It is interesting to note this early importation of Dutch cattle into the English colonies. It is reasonable to assume that the cattle introduced from Holland were similar to the ancestors of our present-day Holstein-Friesians. It is also interesting to speculate as to the possible relationship of the cattle of those early importations to our present breeds. One should bear in mind

that those early importations took place almost 250 years before the establishment of any of the registry associations for the maintenance of pure breeds of dairy cattle in the United States. We must go back to the time when cattle were designated as "black," "horned," "hornless," "short-horned," "middle horned," or "long horned" (3, 10, 15, 55). As these designations mean little to us to-day it is necessary for us to associate the cattle with the area from which they were shipped. Such a method is both reasonable and helpful.

It is logical to assume that cattle shipped from Plymouth and Barnstable came from the surrounding Devonshire area. In this area the Devon breed of cattle was developed. As there is no record of any mass movement of cattle to or from Devonshire during or following the colonization of North America it may be concluded that the first cattle brought to the New England colonies were of an inheritance similar to the Devon breed that was later developed and improved in Devonshire. The fact that Devon cattle have always been rather popular in the New England States adds further to the belief that the first cattle imported were of the Devon type.

The cattle that were shipped to the New England colonies from Virginia probably were of mixed origin. The first cattle brought to Virginia were of English origin. A little later Irish cattle of superior quality were brought in; and still later, when trade routes via the West Indies were established, Spanish cattle were imported by the Virginians. The result of importing from these various sources is presented well by Bruce (11) who, in writing of the Virginia cattle as they appeared in the seventeenth century, said, "from the variety of colors distinguishing the horned cattle entered in the appraisements, it would be inferred that there were no distinct breeds in the colony, the original ones having become by repeated crossings so confused in blood as to represent no separate types except in an extremely modified form." From this statement it is reasonable to conclude that the cattle shipped from Virginia into the Massachusetts colonies were of mixed inheritance and were, quite likely, inferior to the cattle imported from Devonshire and Holland.

Winthrop (54) recorded a shipment of cattle from Ipswich, and they were, no doubt, of the Essex and Suffolk type. He also noted a shipment from Gravesend and Southampton, and thus Hampshire and Kent made their contributions.

As the population of Massachusetts grew in numbers and the herds increased it became necessary for each man to enlarge his land holdings to take care of his livestock. "And no man thought he could live, except he had cattle and a great deal of ground to keep them; all striving to increase their stocks" (9). The Governor of Plymouth wrote in 1638, "It pleased God, in these times, so to bless the cuntry with such access and confluance of people into it, as it was therby much inriched, and catle of all kinds stood

at a high rate for diverce years to-gether. Kine were sold at 20 li and some at 25 li. a peace, yea, sometimes at 28 li. A cow-calfe usually at 10 li. A milch goate at 3 li, and some at 4 li. And femall kids at 30 s. and often at 40 s. a peece. By which means the anciente planters which had any stock begane to grow in their estats." Similar conditions prevailed in the Massachusetts Bay colony also, and in 1633, in writing of conditions Governor Winthrop (54) said: "They spent much in tobacco and strong waters, etc., which was a great wealth to the commonwealth, which, by reason of so many foreign commodities expended, could not have subsisted to this time, but that it was supplied by the cattle and corn, which was sold to new comers at very dear rates, viz., corn at six shillings the bushel, a cow at £20,—yea some at £24, some at £26,—a mare at £35, an ewe goat at 3 or £4; and yet many cattle were every year brought out of England, and some from Virginia." On November 17, 1636, he again wrote that "cattle were grown to high rates;—a good cow, £25 or £30; a pair of bulls or oxen, £40. Corn was now at 5 s the bushel, . . ."

People continued to flow into New England steadily and Winthrop recorded that in 1638 at least 3,000 people came over to the Massachusetts Bay Colony. The importation and raising of cattle brought prosperity to a height previously unknown in that part of the New World.

The law of supply and demand recognizes no territorial integrity, however, and we find that as a result of the great stimulus to stock raising an over-supply of cattle soon was in evidence. It may be that cows being priced from 25 to 28 pounds per head attracted shipments from across the ocean, as we know it did from Virginia. And so we read in Governor Bradford's History of the Plymouth Plantation (9) that in 1640 many began to fear a drop in the price of cattle. "And this was not a vaine feare; for they fell indeede . . . and that so suddenly, as a cowe that but a month before was worth 20 li., and would so have passed in any payments, fell now to 5 li. and would yield no more; and a goate that wente at 3 li., or 50 s. would not yield but 8. or 10 s. at most. all men feared a fall of cattle, but it was thought it would be by degrees; and not from the highest pitch at once to the lowest, as it did, which was greatly to the damage of many, and the undoing of some." The same conditions prevailed throughout the Massachusetts Colonies (54).

This crash ended the commercial shipments of cattle from England to the colonies in New England. Their low value in the colonies was not equal to the cost of shipping cows from England to America. When prices recovered the New England demand was supplied from other colonies. By 1645 cows were selling at 30 pounds sterling and many were shipped from Virginia to the English colonies to the north (7).

Because of the comparatively late dates of the colonization of Maryland and Pennsylvania there is little question but that they obtained their cattle

from their neighbors to the east or to the south. Carrier (13) says, "The agricultural foundation laid by the early Dutch and Swedish settlers in New Jersey, New York and Delaware was of great value to Penn's followers. Here were excellent draft horses, oxen, Dairy cows and swine in numbers to supply all newcomers who possessed the necessary means to buy them." Cornelius Bon wrote in 1684, "I have a cow which gives plenty of milk" (35) indicating the availability of good cows. William Penn wrote in 1681 that newcomers "may as soon as they come buy cows more or less, as they want, or are able, which are to be had at easy rates" (41).

Rhode Island and Connecticut both probably obtained their first cattle from the neighboring English or Dutch colonists. There is no doubt of this in the case of Connecticut, and little doubt in the case of Rhode Island.

Although both the Dutch and the English had established forts or trading posts on the Connecticut River at an earlier date, the first real effort to found a permanent settlement was made in 1635. John Winthrop recorded (54) that on October 15, 1635, "about sixty men, women and little children, went by land towards Connecticut with their cows, horses and swine, and, after a tedious and difficult journey, arrived safely there." This is substantiated by Johnston (34) who writes that "In October of the same year (1635) a party of sixty persons, including women and children, largely from Newton, made the overland march and settled where Hartford now stands. Their journey was begun so late that the winter overtook them before they reached the river, and, as they brought their cattle with them, they found great difficulty in getting everything across the river by means of rafts." In Winthrop's history under the date of April 1, 1636, the following statement is found: "Those of Dorchester, who had removed their cattle to Connecticut before winter, lost the greater part of them this winter; yet some, which came late, and could not be put over the river, lived very well all the winter without any hay. The people also were put to great straits for want of provisions. They ate acorns, and malt, and grains. They lost near £2,000 worth of cattle." There is a further statement recorded on May 15, 1636, to the effect that "Mr. Hooker, pastor of the church of Newtown, and most of his congregation, went to Connecticut. His wife was carried in a horse litter; and they drove one hundred and sixty cattle, and fed of their milk by the way."

Less has been found relative to the introduction of cattle into Rhode Island. According to Carrier (13), among the early settlers were men of means who possessed livestock. In all probability some of these men went from the Massachusetts colonies and took cattle with them. Because of the strong feeling in Massachusetts against the Rhode Island group, however, there was little commerce between them. It is entirely possible that cattle were obtained from Virginia, or from the Dutch in the near-by colony of New Netherland. The fact that the dairy cattle of Rhode Island received

more than local notice at a very early date as being of very superior quality, would indicate a strong infusion of the Dutch cattle characteristics. In fact, before breeds of cattle were established in this country the "Rhode Island Cow" was well known as an excellent producer. The butter and cheese produced in that colony became known throughout the world and was an important item in the extra-territorial trade of the colony. William Douglass (19), in commenting upon the dairy industry of Rhode Island in the middle of the eighteenth century states: "The most considerable farms are in the Narraganset Country. Their highest Dairy of one Farm; *communibus annis* milks about 110 cows, cuts about 200 Load of Hay, makes about 13,000 wt. of Cheese, besides Butter; and sells off considerably in Calves and fatted Bullocks. A farmer from 73 milch Cows in five Months made about 10,000 wt. of Cheese; besides Cheese in a Season, one Cow yields one Firkin of Butter, 70 to 80 wt. In good Land they reckon after the rate of 2 Acres for a milch Cow." While the "Rhode Island Cow" does not exist as a breed at the present time she was the foundation of the commercial dairy cows, and contributed much to the profitableness of the dairy industry in the New England States.

According to Pirtle (46) the early "New Hampshire cattle were from the 'large yellow' Danish cattle." Allen (2) has pointed out that in 1631, 1632 and 1633 Captain John Mason imported cattle from Denmark for the Danish colonists in New Hampshire.

North Carolina was settled largely by people who left other English colonies in search of religious freedom, cheap land or security from persecution (4).

The first attempt at organized colonization was made in 1660 when a stock Company sent people from New England who settled near the mouth of what is now known as the Cape Fear River. These people had English Cattle on their plantations (42). The settlement was later abandoned and a portion of the cattle probably was left there. In 1664 an expedition was financed by people of Barbados, and a colony was established at Charles Town. Some cattle were raised here also but the enterprise failed. Whether these settlers took cattle into Carolina or appropriated those already there is a question that may be debated. They found cattle there, however, as is shown in this narrative of the first impression obtained upon arrival in 1664.

"We viewed the Cape-land, and judged it to be little worth, the Woods of it shrubby and low, the Land sandy and barren; in some places Grass and Rushes, and in other places nothing but clear sand; a place fitter to starve Cattel in our judgment, than to keep them alive; yet the Indians, as we understand, keep the English Cattle down there, and suffer them not to go off the said Cape, as we suppose, because the Countrey-Indians shall have no part with them, and as we think, are fallen out about them, who shall have the greatest share. They brought aboard our Ship very good and fat Beef

several times, which they could afford very reasonable; . . . ." And as a forecast of their own feelings at a later date they found a discouraging note which they answered thus—"Whereas there was a Writing left in a Post at the Point of Cape Fair River, by those New England-men that left Cattel with the Indians there, the Contents whereof tended . . . to the disparagement of the Land . . ." (39).

That the land did have livestock possibilities, however, is indicated by the description written in 1666 by Robert Horne. "The Marshes and Meadows are very large from 1500 to 3000 Acres, and upwards, are excellent food for Cattle, and will bear any Grain being prepared; some Cattle both great and small, which live well all the Winter, and keep their fat without Fodder; . . . ." But Cattle were not to be had easily as is indicated by this selection from a letter written by Governor Sayle and Council (39), Sept. 9th, 1670.

"Wee have received some cowes and hoggs from Virginia, but at an imoderate rate, considering the smalnesse of their growth. . . . If yor Honors had a small stoke in Bermuda from thence may be transported to this place a very good breed of large Cowes, Hoggs and Sheep at farr easier rates." Definite progress was made, however, and Henry Brayne stated, in a letter to Lord Ashley, dated November 9, 1670, that he had "6 head of Cattle that my people have milk enough twice a day and that he had "there alsoe 7 hoggs," three sheep, 6 geese, 8 turkeys and twelve chickens (51).

By 1622 the Carolinas were becoming "Cattle Country" and dairying was not unknown.

In Thomas Ashe's description of Carolina in 1682 he wrote "The great encrease of their Cattel is rather to be admired than believed; not more than six or seven years past the Country was almost destitute of Cows, Hogs and Sheep, now they have many thousand Head." And he also wrote that "The Cows the Year round brouzing on the sweet Leaves growing on the Trees and Bushes, or on the Wholesome Herbage growing underneath; They usually call them home in the Evening for their Milk, and to keep them from running wild" (39).

In the same publication, in Wilson's account of Carolina in 1682 we find that "Neat Cattle thrive and increase here exceedingly, there being particular Planters that have already seven or eight hundred head, and will in a few years in all probability, have as many thousands, unless they sell some part; . . ."

Because of the low cost of production due to year around pasture it was the expression of Wilson that—"many judicious Persons think that Carolina will be able to supply those Northern Collonys, with salted Beef for their Shipping, cheaper than they themselves with what is bred amongst them; for, considering that all the Woods in Carolina afford good Pasturage, and the small Rent that is paid to the Lords Proprietors for Land, an Ox is raised at almost as little expence in Carolina as a Hen is in England."

Archadle (39) was also enthusiastic about the livestock possibilities of the Carolinas for he wrote that "so advantageously is the Country scituated, that there is little or no need of Providing Fodder for Cattle in the Winter; so that a Cow is grassed near as cheap as a Sheep here in England. . . ."

The place of Cattle and livestock and dairy products in the economy of the Carolinas is set forth in the letters of Thomas Newe (39) written in 1682. "Severall in the Country have great stocks of Cattle and they sell so well to new comers that they care not for killing, which is the reason provision is so dear in the Town, whilst they in the Country are furnished with Venison, fish, and fowle, by the Indians for trifles, and they that understand it make as good butter and cheese as most in England." And in speaking of the circumstances of the first settlers who came to the Carolinas, Newe continued—"few of them having wherewithall to purchase a Cow, the first stock whereof they were furnished with, from Bermudas and New England, from the latter of which they had their horses which are not so good as those in England, but by reason of their scarcity much dearer, an ordinary Colt at 3 years old being valued at 15 or 16 *lis.* as they are scarce, so there is but little use of them yet, all Plantations being seated on the Rivers, they can go to and fro by Canoo, or Boat as well and as soon as they can ride, the horses here like the Indians and many of the English do travail without shoes. Now each family hath got a stock of Hogs and Cows, which when once a little more encreased, they may send of to the Islands cheaper than any other place can, by reason of its propinquity, which trade alone will make it far more considerable than either Virginia, Maryland, Pensilvania, and those other places to the North of us."

By 1728 cattle were apparently plentiful near the Virginia-Carolina line for they were found roaming at large and subsisting on natural feeds throughout the winter season (4).

South Carolina was colonized for the primary purpose of producing tropical and semi-tropical plants of economic value. The ideal grazing conditions and the extremely light winters obtaining in that area, however, caused cattle raising to become the principal occupation at an early date. Cattle were purchased from Barbados, the Bermudas, Virginia and New York. The cattle from Virginia were small and high in price. Those from New York were large and very heavy milkers, and the colonists preferred them to the cattle from Virginia or Barbados. As an indication of the development of the cattle industry Governor Nicholson of Maryland in 1695 spoke of the "vast flocks of cattle" in the Carolinas, and Nairne wrote that South Carolina had more "black cattle" than any other English colony (25).

The continuous reference to black cattle by many of Gray's authorities (25) has led him to the conclusion that most of the southern cattle of colonial and post-Revolutionary days were black and descendants of the early Spanish cattle. If this is true, the foundation for our southern cattle probably

had few of the qualities so greatly desired in a dairy animal. This may explain in part the low production of the average cow of the southeastern part of the country.

It is entirely possible, however, that Gray was mistaken when he concluded, because of the numerous references to "black cattle," that most of the cattle of colonial America were black in color. A more plausible explanation of the term "black cattle" is contained in the following statement by Cadwallader John Bates (5) who, because of his familiarity with the history of livestock improvement, may be accepted as a good authority. "So prevalent was the black colour in the North of England and the South of Scotland that bulls, cows, and oxen were given the generic name of 'black cattle.' Originally the Scottish thieves appear to have called the 'black cattle' they were driving off, their 'blackmail' or 'black-rent'; the terms being afterwards applied to the money paid them for foregoing these exactions in kine." Because the designation "black cattle" was in such common usage in England during the seventeenth century it is quite possible that the term was not truly descriptive of the color of the American cattle population of that day. That the greater portion of the cattle in the southeastern part of the Colonial North America was of Spanish origin can scarcely be questioned, but to say that they were black is perhaps imposing upon the available historical evidence.

According to Carrier (13) the foundation cattle of Georgia were purchased in South Carolina. It is quite probable also that cattle from Florida found their way into Georgia.

SUMMARY

The data contained in the literature reviewed, points to the fact that cattle were imported directly to Virginia, Massachusetts, New York, New Hampshire, Delaware, and possibly southern New Jersey, from the colonizing European countries. Many cattle, however, were brought into the southwest, the Gulf area, Florida and the southeast from the Spanish possessions in the West Indies and from Mexico. It also appears that many cattle containing at least some Spanish inheritance were shipped into Virginia, Delaware, New Jersey, and Massachusetts.

The initial mass importations of cattle from Europe into the North American colonies ceased about 1640. From that date to the American Revolution the cattle needs of the colonies were taken care of through intercolonial trade, or through trade with the Spanish colonies in the Western Hemisphere. A few cattle from the French Colonies in the St. Lawrence River Valley found their way into the "Old Northwest."

The cattle improvement era did not start in England until many years after the initial period of importations into America had closed, and in America there was no basic work in cattle improvement during that period.

American breeders waited for the English and European stockmen to supply the superior breeding stock which was so necessary in grading up the common cattle that by 1800 had increased to several million head.

From 1640 to 1800 there was only an occasional animal imported and the only real possibility for general improvement of the milch cows lay in selection from within the existing cattle population.

From 1800 to 1860 there were few attempts to protect the "purity" of the improved cattle which were being imported from time to time. The efforts made in the past 80 years to improve cattle in general, and particularly dairy cattle, have not been sufficient to eliminate all of the influence of the cattle that were bred in America for the first 250 years. To be convinced of this fact one needs only to travel through the southeastern part of the United States—the oldest cattle country in our nation.

REFERENCES

(1) Abstracts of Proceedings of the Virginia Company of London, vol. 1, p. 22. Virginia Historical Society, Richmond, Virginia. 1888.

(2) ALLEN, LEWIS F. American Cattle. Orange Judd Co., New York. 1890.

(3) BAILEY, J., AND CULLEY, G. Agriculture in the County of Northumberland. London, third edition. 1805.

(4) BASSETT, JOHN SPENER. The Writings of "Colonel William Byrd." Doubleday, Page & Co., New York. 1901.

(5) BATES, CADWALLADER JOHN. Thomas Bates and The Kirklevington Shorthorns. Robert Redpath, Newcastle Upon Tyne, p. 26. 1897.

(6) BIDWELL, PERCY WILLS, AND FALCONER, JOHN I. History of Agriculture in the Northern United States to 1860. Carnegie Institution, Washington, D. C. 1925.

(7) BISHOP. History of American Manufactures, vol. 1, p. 431. Cited by Philip A. Bruce, Economic History of Virginia in the Seventeenth Century, p. 333.

(8) BOURNE, EDWARD GAYLORD. American Nation, vol. 3. Spain in America. Harper & Brothers, New York and London. 1904.

(9) BRADFORD, WILLIAM. History of Plymouth Plantation 1608–1646. Chas. Scribner's Sons, New York, 1923. (Reproduced under the auspices of the American Historical Association.)

(10) BROWN, ROBERT. Treatise of Rural Affairs. Oliphant and Balfour, Edinburgh. 1811.

(11) BRUCE, PHILIP A. Economic History of Virginia in the Seventeenth Century. The Hamilton Co., New York. 1895.

(12) BULLOCK, WILLIAM. Virginia, Impartially Examined. Printed by John Hammond, London, p. 7. 1649.

(13) CARRIER, LYMAN. The Beginnings of American Agriculture. McGraw-Hill Book Co., New York. 1923.

(14) CONNOR, MRS. JEANNETTE M. (THURBER). Colonial Records of Spanish Florida, vol. 1. (Fla. Hist. Soc. Pub. No. 5.)

(15) CULLEY, GEORGE. Observations on Livestock. London. 1807.

(16) DARLINGTON, WILLIAM. Memorials of John Bartram and Humphrey Marshall, p. 50. Philadelphia. 1849.

(17) DENTON, DANIEL. A Brief Description of New York. The Burrows Brothers Co. 1902. Reprinted from the original edition of 1670.

(18) DEVRIES. Voyages from Holland to America, p. 64. Cited by Philip A. Bruce.
(19) DOUGLASS, WILLIAM. An Historical Account of the British Settlements in America. Vol. II, p. 100. Daniel Fowle, Boston. 1750.
(20) DUFFUS, R. L. The Santa Fe Trail, Longmans, Green & Co., New York. 1930.
(21) Early English and French Voyages. Original Narratives of Early American History. Edited by J. F. Jameson. Chas. Scribner's Sons, N. Y. 1906. Original source: Hakluyt.
(22) FAULKNER, H. U. American Economic History. Harper & Bros. 1935.
(23) FERRIS, BENJAMIN. Original Settlements on the Delaware, p. 52. Wilmington. 1846.
(24) FISHER, SYDNEY G. The Quaker Colonies. Yale University Press. 1921.
(25) GRAY, LEWIS C. History of Agriculture in Southern U. S. to 1860. Carnegie Institution. 1933.
(26) HENNING, WILLIAM WALLER. Statutes at Large of the Laws of Virginia, vol. 1, p. 395. R. & W. & A. Bartow, New York. 1823.
(27) HAKLUYT, RICHARD. The Principal Navigations, Voyages, Traffiques, and Discoveries of the English Nation. E. P. Dutton & Co., New York, vol. 6.
(28) HAKLUYT, RICHARD. The Principal Navigations, Voyages, Traffiques, and Discoveries of the English Nation. E. P. Dutton & Co., New York, vol. 7.
(29) HAMILTON, J. P. Colonial Mobile, p. 38. Houghton Mifflin Co., New York. 1910.
(30) HAMOR, RALPH. A True Discourse of the Present State of Virginia. London. 1614.
(31) HUNT, R. D., AND SANCHEZ, NELLIE. A Short History of California, Thos. Crowell Co., New York. 1929.
(32) IBERVILLE, LE MAYNE. Historical Journal (French Historical Collections, New Series 110). Cited by J. P. Hamilton.
(33) INMAN, HENRY. The Old Santa Fe Trail. Crane & Co., Topeka, Kan., p. 2. 1898. Original Source Narrative of Alvar Hunez Cabeca de Vaca.
(34) JOHNSTON, ALEXANDER. Connecticut. American Commonwealth Series. Houghton, Mifflin & Co., New York, p. 22. 1887.
(35) KUHNS, OSCAR. The German and Swiss Settlement of Colonial Pennsylvania.
(36) LA HARPE. Journal Historique 81. Cited by Gray. History of Agriculture in Southern U. S. to 1860.
(37) LAS CASAS. Historia, Vol. 1, p. 497; Vol. 2, p. 3. Cited by Bourne Edward Gaylord. Spain in America. Harper Bros. 1904.
(38) LOWERY, WOODBURY. The Spanish Settlements within the Present Limits of the United States. 1513–1561.
(39) Narratives of Early Carolina. William Hilton's Relation, 1664. Original Narratives of Early American History. Edited by Alexander S. Salley, Jr. Chas. Scribner's Sons, New York. 1911.
(40) Narratives of Early Virginia, p. 203. Original Narratives of Early American History. Chas. Scribner's Sons, New York. 1907.
(41) Narratives of Early Pennsylvania, West New Jersey, and Delaware. Edited by A. C. Myers. Chas. Scribner's Sons, New York. 1912. (Footnote citation, p. 7.)
(42) North Carolina Colonial Records vol. 1. Raleigh, North Carolina. 1886.
(43) O'CALLAGHAN, E. B. Documents Relating to the Colonial History of the State of New York, Vol. 1. Albany. 1856.
(44) PARKMAN, FRANCIS. The Jesuits in North America. Little, Brown & Co., Boston, p. 366. 1895.
(45) PARKMAN, FRANCIS. Pioneers of France in the New World. Little, Brown & Co., Part 1, p. 212. 1876.

(46) PIRTLE, T. R. History of the Dairy Industry. Majonnier Bros. Co., Chicago, Ill.
(47) Relation of Lord Delaware. Printed by William Hall, London, 1611. Contained in Narratives of Early Virginia, pp. 209–214. Original Narratives of Early American History. Chas. Scribner's Sons, New York. 1907.
(48) ROLFE, JOHN. Relation of the State of Virginia, 15th Century. Virginia Historical Register. MacFarlane and Fergusson, Richmond. 1848.
(49) SANDERS, ALVIN HOWARD. The Taurine World. National Geographic Magazine, 58, No. 6: 591–710. 1925.
(50) SMITH, CAPTAIN JOHN. Travels and Works, vol. 2, p. 658. Edited by Edw. Arber and A. G. Bradley. Published by John Grant, Edinburgh. 1910.
(51) South Carolina Historical Society. Collections, vol. V. Charleston, South Carolina. 1897.
(52) VAN WASSENGER, NICHOLAS. Historich Verheal. Cited in Narratives of New Netherland. Chas. Scribner's Sons, New York. 1909.
(53) WINSOR, JUSTIN. Christopher Columbus, p. 281. Houghton, Mifflin and Company, New York. 1892.
(54) WINTHROP, JOHN. Winthrop's Journal. Original Narratives of Early American History, vol. 1. Chas. Scribner's Sons, New York. 1908.
(55) YOUATT, W. Cattle (American Edition). C. M. Saxton, New York. 1851.

THE ANATOMY AND PHYSIOLOGY OF THE TEAT SPHINCTER*

DWIGHT ESPE AND C. Y. CANNON
Iowa Agricultural Experiment Station, Ames, Iowa

Three workers (1, 2, 3) have reported that a slight negative pressure develops at the external opening of the teat when the pressure of milking is released. This negative pressure would tend to draw bacteria into the teat canal if they were present at the teat opening. If this is true, when cows are machine milked the constant vacuum within the teat cup should prevent any danger of infection during the milking process. This seems quite important in view of the great amount of trouble which dairymen are having with mastitis at the present time.

Since the upper end of the teat canal opens directly into the gland cistern it is difficult to see how there could be any negative intra-teat pressure unless the teat walls have certain elastic properties. As the teat walls are quite vascular and as experimental evidence has indicated that the "letting down" of milk is associated with increased tonus of the smooth muscle of the udder, it is conceivable that the teat walls might develop a certain tone (a) by contraction of the smooth muscle present or (b) by "erection," due to increased blood pressure. Because the teat does not tend to diminish in diameter when the "letting down" reflex is greatest, it seems logical to assume that any rigidity which the teat wall possesses at milking time is not due to a contraction of the circular or longitudinal muscles fibers in the walls of the teat.

The second theory to be considered is that the teat walls become turgid due to filling of the vascular bed of the teat at milking time. To test this theory a cow which had freshened recently was milked just enough to cause her to let down her milk. A small amount of barium paste was then quickly injected into two teats at a time and x-ray pictures taken before the increased tonus had lessened appreciably. Figure 1 A is a typical picture of the teat at this time. A milking tube was then inserted into each teat to relieve the pressure of the milk on the inner walls and another series of pictures taken. A typical picture of this series is shown in figure 1 C. About half an hour later, after the cow had been milked and all reflex activity had disappeared, barium was again injected into the teat canal and a third series of pictures taken (fig. 1 B). From these pictures it is apparent that the teat walls do not become engorged with blood when cows "let down" their milk. In other words, it apears that erection of the teat walls isn't necessarily associated with "letting down" of the milk in the udder.

Another type of experiment was then performed to study the vascular

Received for publication October 6, 1941.

* Journal Paper No. J-937 of the Iowa Agricultural Experiment Station, Ames, Iowa, Project No. 47.

supply to the udder. The cow used was in milk and had a fistula of the rumen. By inserting the hands into the rumen through the fistula and pressing the fingers against the dorsal wall, it is possible to close the left external iliac artery. This is the chief source of arterial blood to the udder. Although the closing of this artery also shuts off the blood supply to the left limb and adjacent parts, no reason was seen why this should interfere with the experiment. Just prior to the beginning of milking, an assistant closed the left external iliac artery as just described. The milker then attempted

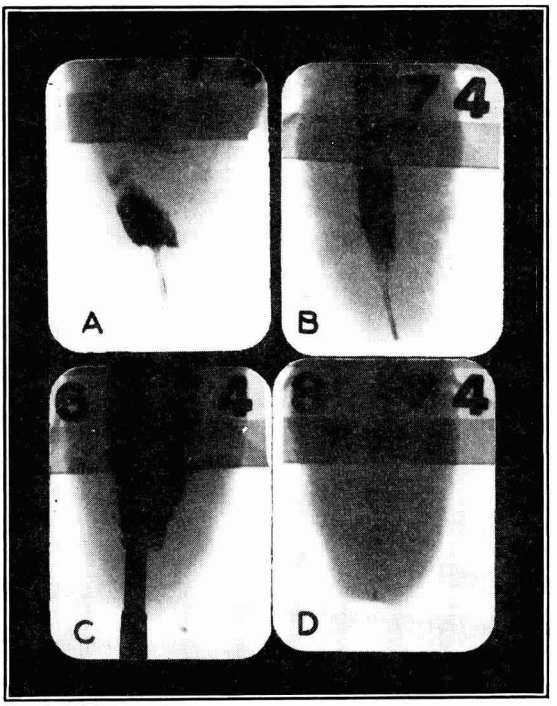


FIG. 1. A. X-ray picture of teat wall and cistern during maximum tonus of mammary gland. B. X-ray picture of teat wall and cistern one-half hour after milking. C. Same as A except that milking tube has been inserted into teat to relieve milk pressure. D. X-ray picture showing small amount of barium in the end of lactiferous duct.

to empty both sides of the udder at an equally rapid rate. At the same time he tried to discern any difference in tonus of the two halves of the udder. When milking was about half completed still more careful observations were made. The left external iliac was then released. Repeated trials failed to show any difference in the turgidity of the teat wall with the artery occluded. These observations along with the results of the x-ray pictures convince the authors that erection of the teat is not an important physiological process in

milking. If erection does not occur it is difficult to understand how a negative pressure could develop at the teat orifice on release of the positive pressure of milking.

In order to study the theory of negative intra-teat pressure the experiment by Davis (1) was repeated with the following modifications. Instead of inserting the teat opening into a dye solution as milking pressure was released, the teat was inserted into a suspension of barium. An x-ray picture was then taken of the end of the teat. No barium could be detected in the lactiferous duct. This procedure was repeated with twenty cows. A commercial preparation of lipiodol was also tried on two cows, with negative results. Although these trials would tend to indicate that the negative pressure is negligible it is possible that the barium was strained out by the smallness of the opening or the barium concentration was too dilute to be registered on the film.

On numerous occasions it had been noted that the teat sphincter tended to evert slightly while milk was being forced from the teat. A barium paste was therefore rubbed over the end of several teats when the greatest pressure possible was exerted without causing the milk to escape. X-ray pictures indicated that on release of this pressure a certain amount of barium had been drawn into the lower portion of the lactiferous duct. A picture, typical of these results, is shown in figure 1 D.

Various workers have expressed the belief that the healthy cell protects itself from bacterial invasion by secreting a substance having bacteriostatic properties. If the teat sphincter closes normally, practically all of the milk is forced out. Even though a slight contamination of the lower end of the canal does occur, as was shown with barium in figure 1 D, it is evident that the chances are slight for bacteria to migrate the remaining distance into the teat cistern and thence gain entrance into the udder. If the teat sphincter is patent or the lining of the duct becomes infected and rough the chances would seem much greater for bacteria to gain entrance into the udder.

Although anyone can detect the difference between a hard milker and an easy milker it is difficult to give an accurate numerical value to differences in tone of the teat sphincter, especially when these differences are slight. A standard Tycos sphygmomanometer was tried. In place of the usual rubber bladder and sleeve band a small rubber bladder and sleeve was made to fit about the teat. The teat was then closed at the base with a pair of rubber covered clamps just sufficient to prevent the milk in the teat from returning to the gland cistern. Readings were made when pressure on the bladder by the hand caused a very small stream of milk to be forced from the teat.

This device gave only fair results even after considerable experience in its use. The personal element of gauging the size of the stream could not be ruled out. But even more serious than that was the standardization of the physiological conditions. Although the clamp was applied at the base

of the teat with just enough force to prevent the milk in the teat from escaping when readings were being made this pressure exerted an unpredictable effect on the teat sphincter. Even with fairly hard milkers the tightening of the clamp might cause the teat to begin leaking milk even when the teat was only half full. These results could not be consistently duplicated nor can a satisfactory explanation be given for these inconsistencies.

Still another difficulty was found in making accurate determinations of the milking pressure. Not infrequently the mercury might rise 100 mm. in the manometer before milk would begin to flow, while after the flow had begun a pressure equivalent to 50 mm. of mercury would maintain the same degree of flow. From x-ray pictures just before and during the time that pressure was applied to the teat it is evident that the canal through the teat

FIG. 2. Teat showing healthy condition of tissue about the teat orifice.

sphincter is reduced from about 12 mm. to 8 mm. in length. At the same time the teat cistern tends to balloon out as the milk in the teat cistern is put under pressure until the folds in the mucosa disappear. It is quite possible that this tension also flattens out Furstenberg's rosette until it no longer interferes with the escape of the milk. When pressure is applied slowly in making readings with the sphygmomanometer it is possible that folds of the rosette may temporarily block the internal orifice of the teat canal.

In the light of the few cases observed and due to the variability in readings of milking pressures it is not possible to tell whether easy milking cows are more susceptible to infection with mastitis than hard milking cows. Certainly, there is no definite trend.

On numerous occasions the milkers of the Experiment Station herd have mentioned the frequency with which soreness at the end of the teat is associated sooner or later with the development of mastitis in that quarter.

In most of the cases referred to there seems to be a tendency for the teat sphincter to remain slightly everted and become eroded. A severe case of erosion is shown in figure 3. This should be compared with the healthy teat shown in figure 2. All gradations of this condition were noted in the herd.

Since the condition was much more prevalent among the machine milked cows it seemed important to find out whether the withdrawal of milk from the teat by suction, as in machine milking, was more severe on the teat than forcing the milk past the sphincter, as in hand milking. The company which manufactures the milking machine used very kindly supplied us with a transparent teat cup. It was quite evident from watching this cup in operation that on the release of the vacuum outside the rubber teat cup liner the teat is compressed over its entire length. This compression of the teat forces

FIG. 3. Teat showing eroded condition of tissue about teat orifice.

the teat cup down and probably gives the teat a better chance to fill on the application again of vacuum to the outside of the teat cup liner. During the entire milking process there is no release of the vacuum on the end of the teat. In order to see what effect this vacuum might have on the teat, the inner rubber liner was cut off just high enough to allow the teat to show at the end of the liner when the vacuum was applied. Cutting the liner made it necessary to shut off the pulsator line but normal milking could be maintained by pulling down on the teat cup every time the adjoining cup was forced down by the pulsator. As mentioned before, this motion apparently prevents the teat cup from squeezing the teat canal shut at the base of the teat.

In spite of the so-called pulsator device on most milking machines, the withdrawal of the milk is a continuous process once the machine has been attached to the cow. Although a properly operated machine should be able to

remove the milk from the udder more rapidly than can be done by hand milking, due to the continuous withdrawal of milk from all quarters, the continued application of a high negative pressure to the end of the teat may offset this advantage. A large number of herds should be studied over a period of years to adequately determine what effect long continued negative pressures have on the teat, especially the teat sphincter. In this experiment when vacuum was applied for two minutes the end of the teat became red and appeared badly congested. The congestion disappeared on breaking the vacuum in the teat cup. Although the cutting of the teat cup liner prevented the machine from functioning normally, it seems quite evident that the constant suction on the end of the teat is in part responsible for the eroded condition shown in figure 3. In order to verify this theory, a herd of over two hundred milking cows which have always been milked by hand was examined for this condition. This herd contains several of the heaviest milking cows in the United States, some of those examined having produced over one thousand pounds of fat in a year on official test. Although three cows in this herd had one or more quarters with slightly eroded sphincters, the difference was sufficiently great between this herd and our own as to offer substantial evidence of the danger of carelessly operated milking machines. A large proportion of the many cows in the college dairy herd show perfectly healthy teats after having been milked for years by machine but it is quite evident that certain cows are more sensitive to this type of milking than others. In most cases the teat orifice of hand milked cows appears as a slight depression at the end of the teat. With machine milked cows the opening of the teat is more likely to appear raised even though erosion of the sphincter lining has not occurred. Certainly extreme care should be exercised with cows showing any tendency toward irritation after machine milking, especially in not allowing the machine to remain on too long.

SUMMARY

No evidence was obtained to indicate that a negative pressure develops at the external orifice of the teat when the pressure of milking is released.

With machine milked cows there is a greater danger of injury to the teat sphincter than with hand milked cows. A teat whose sphincter becomes eroded at the external orifice seems to offer a greater opportunity for infection of that quarter than one which shows no erosion.

REFERENCES

(1) DAVIS, D. J. The Dissemination of Human Pathogenic Streptococci through the Cow's Udder. Jour. Bact., 29: 42–43. 1935.

(2) JOHNSTON, THOMAS. Anatomical and Experimental Study of the Teat of the Cow with Particular Reference to Streptococcal Mastitis. Jour. Compar. Path. and Ther., 51: 69–77. 1938.

(3) LITTLE, R. B. Bovine Mastitis. II. The Production of Mastitis by the Suction of Streptococci into the Duct of the Teat. Cornell Vet., 27: 309–316. 1937.

ACCURACY OF LIVE WEIGHTS OF DAIRY COWS ON PASTURE[1]

R. E. HODGSON[2] AND J. C. KNOTT[3]

INTRODUCTION

The importance of accurate live weight records in investigations with dairy cattle can hardly be over-emphasized. This is particularly true in pasture experiments where live weights form the basis of calculating the nutrients required for maintenance and live weight changes of animals during grazing periods. The influence of variation in live weight of grazing animals upon the yield of experimental pastures has been the subject of considerable discussion among investigators working with pastures (5). Some have expressed the opinion that variations in live weight may be so large that a satisfactory measurement of the yield as expressed in terms of the grazing animal cannot be attained. Little work has been done, however, to determine the significance of variations in live weights of cows in pasture experiments. An almost universal recommendation has been to base the initial and final weight on the average of three successive days weighings.

Lush and Associates (4) reported that the probable error of a one-day weight was 4 to 8 pounds and that by weighing two additional days 42 per cent of this error was eliminated. These results were obtained from feeding experiments with steers, cows and heifers, largely in dry lot, conducted at different experiment stations in this country. Brown (1) and Brown and Slate (2), using steers in pasture experiments, found that two-day weights reduced the probable error over a one-day weight by 29 per cent. Thirty-three per cent of the two-day weights of steers varied less than 6 pounds and only 10 per cent varied more than 20 pounds. The following is an analysis of the variation in the live weights of lactating dairy cows used in grazing experiments.

EXPERIMENTAL

The data used in these analyses were taken from a grazing experiment reported in detail in another place (3). Holstein-Friesian cows grazed in five-acre pasture at periodic intervals during each of five seasons. Four or five grazings were obtained each year. Grazing was at the average rate of about 2.5 cows per acre during the time the cows were on the pasture. The

Received for publication October 8, 1941.

[1] Published as Scientific Paper No. 501, College of Agriculture and Agricultural Experiment Station, State College of Washington.

[2] Dairy Husbandman, Bureau of Dairy Industry, U. S. D. A., formerly Agent, Bureau of Dairy Industry, U. S. D. A., Assistant Dairy Husbandman, Washington Agricultural Experiment Station, and Assistant Dairy Husbandman, Western Washington Experiment Station.

[3] Dairy Husbandman, Washington Agricultural Experiment Station.

cows were required to graze the pasture uniformly after which they were removed to other pasture of comparable character until the experimental plot had made new growth. Grazing was begun when the grass had grown to a height of 6 to 10 inches, depending upon the season.

The cows were maintained on pasture day and night except for the time they were removed for milking. They were milked twice daily and were out of the pasture about 3 hours morning and evening. They were fed a small amount of supplementary feed at this time (the nutrients consumed as supplement constituted an average of only 4 per cent of the total nutrient requirements of the animals).

Initial and final live weights of each cow were taken, to the nearest pound, on three successive days at the beginning and end of each grazing period. The initial weights were the averages of weights taken the two days preceding and the first day of the grazing period. The final weights were the averages of weights taken on the last two days of the grazing period and the day following. The cows were always weighed in the afternoon following milking.

The experimental errors, the standard deviation of the daily trend of the total weight of each group of cows and the standard errors of the mean

TABLE 1

*Live weights of cows used in grazing experiment taken on three consecutive days at the beginning of the first grazing period in 1936**

Cow No.	Weights of cow on			Total
	May 4	May 5	May 6	
	lbs.	*lbs.*	*lbs.*	*lbs.*
124	1283	1267	1284	3834
129	1355	1353	1358	4066
133	1170	1165	1188	3523
134	1276	1285	1294	3855
135	1231	1235	1255	3721
138	1210	1221	1201	3632
145	1121	1139	1125	3385
147	1219	1221	1218	3658
148	1286	1288	1299	3873
150	1104	1078	1124	3306
153	1097	1108	1127	3332
157	1082	1082	1076	3240
160	1162	1177	1171	3510
161	1155	1170	1135	3460
168	1043	1008	1025	3076
179	982	986	980	2948
181	1015	1053	1047	3115
187	1130	1142	1135	3407
188	1127	1137	1121	3385
189	1127	1126	1097	3350
Total	23175	23241	23260	69676

* This table illustrates the basic data used for analysis of variance in the initial and final live weights of the cows used in each grazing period.

initial and final live weights of the cows for each grazing period were determined by analyses of variance (6).

RESULTS

Table 1 illustrates the original data from which the analysis of variance in live weights was made. It gives the weights of the individual animals in the group for three successive days for the beginning of the first grazing season in 1936. Table 2 shows the analyses of variance in these weights and is fairly representative of all such tables. Similar analyses were made of

TABLE 2

*Summary of analyses of variance of initial live weight of cows used in the first grazing period, 1936**

Variation due to	Degrees of freedom	Sum of squares	Mean square	Standard deviation
All causes	59	542337.7	9192.16	.....
Daily changes†	2	199.0	99.50	.....
Difference between animals	19	536346.4	28228.76	.....
Remainder, experimental error	38	5792.3	152.43	12.34

* Similar analyses were made for initial and final live weights of cows used in each grazing period.

† Represents day to day changes in the weight of the entire group of animals.

the initial and final weights for each grazing period, 46 in all. The experimental errors, *i.e.*, the square root of the mean square error, are given in table 3. There was considerable variation in the experimental errors, which did not appear to show any consistant differences with advancement of the pasture season, with different years, or with initial versus final weights. The weighted average experimental error was 14.0 pounds and the range was from 7.0 pounds to 28.3 pounds.

The standard deviation of the day to day changes in the weight of the whole group of cows is depicted in table 4. This was obtained by dividing the square root of the mean square of the daily changes (see table 2) by the square root of the number of animals in the group. The average day to day change in the group weight for all 46 weigh periods was found to be 7.7 pounds with a range from 0.5 pounds to 20.8 pounds. The deviations of the initial weights and the final weights were of about the same magnitude. This variation in day to day changes of the weight of the whole groups of cows is not greatly significant as indicated by the fact that in only nine instances out of the total of 46 did it exceed the size of the experimental error (standard deviation of remainder). The average was only half that of the experimental error.

The standard error of the average initial and final live weights and the average gain in live weight of the cows for each grazing period is given in table 5. The standard error was obtained by dividing the experimental

TABLE 3

Experimental errors of initial and final weights of cows for the various grazing periods

Grazing period	Degrees of freedom of the remainder	Experimental error of initial live weights	Experimental error of final live weights
		lbs.	*lbs.*
		Pasture season of 1936	
1	38	12.3	14.2
2	28	13.6	17.2
3	28	10.3	11.8
4	28	13.0	13.5
5	28	8.4	7.0
		Pasture season of 1937	
1	32	11.7	9.2
2	28	14.7	10.5
3	28	13.9	17.2
4	26	15.6	13.9
5	22	28.3	11.0
		Pasture season of 1938	
1	20	11.2	11.1
2	18	11.5	16.0
3	22	16.4	13.2
4	22	14.3	19.1
		Pasture season of 1939	
1	22	7.5	10.9
2	24	12.9	14.5
3	22	16.6	13.3
4	18	13.7	10.0
		Pasture season of 1940	
1	20	10.9	11.8
2	18	10.4	13.5
3	18	14.8	19.2
4	22	12.6	13.4
5	22	19.3	15.0

error by the square root of the product of the number of cows in the group times the number of days weighed. The average standard error of the initial live weights was 2.2 pounds with a range of from 1.2 pounds to 2.8 pounds, while that of the final live weights was 2.2 pounds with a range of 1.0 pounds to 3.6 pounds. The average standard error of the gains was 3.1 pounds with a range of from 1.6 pounds to 5.0 pounds.

The results of these analyses compare favorably with those obtained by Lush and Associates (4), who found an average experimental error in three successive days live weights of cattle of 10.0 pounds (range 4.0 to 17.0 pounds) and a probable error[4] of 1.0 to 2.0 pounds and a probable error

[4] The probable error is 0.6745 times the standard error.

TABLE 4

Standard deviation in day to day changes in live weights of groups of cows

Grazing period	Number of cows	Standard deviation of daily changes	
		Initial weights	Final weights
Pasture season of 1936			
1	20	2.2	11.9
2	15	2.8	20.8
3	15	1.9	8.8
4	15	6.6	4.7
5	15	3.3	3.2
Pasture season of 1937			
1	17	5.3	2.4
2	15	10.3	13.7
3	15	4.7	3.0
4	14	3.7	5.9
5	12	6.2	17.6
Pasture season of 1938			
1	11	11.0	16.3
2	10	0.5	6.1
3	12	12.5	12.7
4	12	3.8	8.0
Pasture season of 1939			
1	12	4.8	2.0
2	13	4.3	7.9
3	12	4.2	10.4
4	10	6.3	3.5
Pasture season of 1940			
1	11	10.6	7.2
2	10	11.6	4.1
3	10	2.6	8.4
4	12	16.0	7.9
5	12	20.7	19.9

for gains in weight of 1.0 to 3.0 pounds. Under the conditions existing in the present experiment the variations in live weight of milking cows grazing on pasture were approximately the same as found by them for cattle maintained under feed lot conditions. The small standard errors obtained indicate the reliability of the live weight data used in calculating the total digestible nutrient yield of pasture in this experiment.

CONCLUSIONS

The average experimental error of live weights of cattle weighed on three successive days as determined by analyses of variance was 14.0 pounds. The range of 46 groups of weights was from 7.0 pounds to 28.3 pounds. The standard deviation of day to day changes in the weight of the groups of cows

TABLE 5

Average initial and final live weights and gain in weights with the corresponding standard errors of cows grazing on pasture

Grazing period	Number of cows	Average initial weight	Average final weight	Average gain in weight
		lbs.	*lbs.*	*lbs.*
		Pasture season of 1936		
1	20	1161 ± 1.6	1207 ± 1.8	46 ± 2.4
2	15	1205 ± 2.1	1246 ± 2.5	41 ± 3.3
3	15	1239 ± 1.5	1274 ± 3.0	35 ± 3.3
4	15	1277 ± 1.9	1313 ± 2.1	36 ± 2.8
5	15	1301 ± 1.2	1339 ± 1.0	38 ± 1.6
		Pasture season of 1937		
1	17	1165 ± 1.6	1224 ± 1.3	59 ± 2.1
2	15	1261 ± 2.2	1281 ± 1.6	20 ± 2.8
3	15	1306 ± 2.1	1332 ± 2.5	26 ± 3.3
4	14	1241 ± 2.4	1280 ± 2.1	39 ± 3.1
5	12	1260 ± 4.8	1298 ± 1.8	38 ± 5.0
		Pasture season of 1938		
1	11	1217 ± 1.9	1298 ± 1.9	81 ± 2.8
2	10	1311 ± 2.1	1369 ± 3.0	58 ± 3.6
3	12	1279 ± 2.8	1352 ± 2.2	55 ± 3.6
4	12	1293 ± 2.4	1321 ± 3.3	28 ± 4.0
		Pasture season of 1939		
1	12	1069 ± 1.2	1167 ± 1.8	98 ± 2.1
2	13	1228 ± 2.1	1275 ± 2.4	47 ± 3.1
3	12	1255 ± 2.8	1304 ± 2.2	49 ± 3.4
4	10	1207 ± 2.4	1248 ± 1.8	41 ± 3.0
		Pasture season of 1940		
1	11	1091 ± 1.9	1177 ± 2.1	86 ± 2.8
2	10	1234 ± 1.9	1256 ± 2.5	22 ± 3.1
3	10	1219 ± 2.8	1230 ± 3.6	11 ± 4.5
4	12	1142 ± 2.1	1185 ± 2.2	43 ± 3.0
5	12	1145 ± 3.3	1182 ± 2.5	37 ± 4.2
Range in standard error		1.2 to 4.8	1.0 to 3.6	1.6 to 5.0

averaged 7.7 pounds. The standard error in the weights of 1200-pound cows was on the average only 2.2 pounds.

It is concluded that the method of weighing used in this experiment gave an accurate measure of the live weights of the cows from which the nutrient yield of the pasture was calculated.

REFERENCES

(1) BROWN, B. A. Pasture Investigations. Fourth Report. Effect of Fertilizer on the Total and Seasonal Production. Storrs Agr. Expt. Sta. Bul. No. 189, 33 pp. 1933.

(2) BROWN, B. A., AND SLATE, W. L. The Maintenance and Improvement of Permanent Pasture. Storrs Agr. Expt. Sta. Bul. No. 155, 250 pp. 1929.

(3) HODGSON, R. E., KNOTT, J. C., MILLER, V. L., AND WOLBERG, F. B. Measuring the Yield of Nutrients of Experimental Pasture. Wash. Agr. Expt. Sta. Bul. No. 411.

(4) LUSH, J. L., CHRISTENSON, F. W., NELSON, C. V., AND BLACK, W. H. The Accuracy of Cattle Weights. Jour. Agr. Res., 36: 6, 551–580. 1928.

(5) Pasture Investigation Technique. Committees of The American Dairy Science Association, The American Society of Animal Production and The American Society of Agronomy. A Preliminary Report. Soil Conservation Service. Mimeo. Cir. No. 1046, 13 pp. 1936.

(6) SNEDECOR, G. W. Statistical Methods. 314 pp. Iowa State College Press, Inc., Ames, Iowa. 1937.

REPORT OF A STUDY ON THE TOXICITY OF SEVERAL FOOD PRESERVING AGENTS[1]

K. E. HARSHBARGER
Department of Dairy Husbandry
University of Illinois

The deterioration of some foods caused by the activity of microorganisms may be prevented and the keeping quality of the foods greatly improved by the addition of certain chemical compounds. It is obvious that preservatives which produce a marked toxic effect should not be used in food intended for human consumption. On the other hand, even when a marked toxicity is not shown, the consumption of food containing unusual quantities of preservatives may be dangerous and harmful because of the hidden cumulative effect.

Definite proof of toxicity lies in knowing how the chemical agent is handled in the body. By tracing the chemical reactions of the preserving agent in the animal body and determining the method by which it is eliminated from the body, an accurate statement concerning its toxicity can be made.

This experiment was designed to yield information that may contribute to the knowledge of the toxic properties of certain chemical substances used in human food, and a bactericidal material used for sterilizing utensils. The amount of gain made by growing white rats was used as an indication of the toxic effects. Individual feeding trials were conducted with diets to which were added calcium propionate, sodium propionate, sodium benzoate, zephiran, and sodium benzoate plus glycine. Propionates are used in the bread industry and to some extent in packaged cheese in order to control mold. Zephiran is a new germicide which may be used for disinfecting dairy utensils. Sodium benzoate has been used for some years as a preservative for various food products.

Griffith (1) has shown that when 1.5 per cent or more sodium benzoate was in the diet, the rate of growth in young rats was decreased. The excretion of hippuric acid in the urine accounted for 66 to 95 per cent of the benzoic acid consumed as sodium benzoate. Small doses of sodium benzoate gave nearly perfect quantitative recovery of hippuric acid. As the amount of sodium benzoate was increased, the percentage recovered as hippuric acid decreased. It was assumed that this showed a lack of sufficient glycine in the animal for the detoxication of the benzoic acid. The addition of glycine

Received for publication October 14, 1941.

[1] This study was a graduate research problem conducted under the direction and supervision of Professor T. S. Hamilton, Department of Animal Husbandry, University of Illinois.

to the diet containing sodium benzoate increased the growth rate and decreased the toxic effects.

Rittenberg and Schoenheimer (4) showed that animals use tissue glycine in preference to dietary glycine for the detoxication of benzoic acid. About two-thirds of the nitrogen in the hippuric acid excreted was not of dietary origin. An excess of dietary glycine did not change this ratio.

PLAN OF EXPERIMENT

White rats were fed diets containing calcium propionate, sodium propionate, sodium benzoate, zephiran, and sodium benzoate plus glycine. Feeding of the experimental diets started when the rats were about four weeks of age and continued for four to five weeks. The paired-feeding technique (2, 3) was used, with a modification so that one control animal was compared with two experimental animals. Eight triplicates (24 rats) were fed during each part of the experiment. In each triplicate, litter mates of the same sex were used and the maximum weight variation of the young rats at the start was 4 grams.

In series I the control animals were fed a basal diet containing calcium lactate, a second group was fed diets containing 1 per cent and 3 per cent calcium propionate, and a third group was fed diets containing 1 per cent and 3 per cent sodium propionate.

In series II the control diet contained calcium lactate, one experimental diet contained 3 per cent sodium benzoate, and the other experimental diet contained 3 per cent zephiran, a germicidal agent. Zephiran is sold as a ten per cent aqueous solution of a mixture of high molecular alkyldimethylbenzylammonium chlorides. When used as a rinse for utensils, 1 part of zephiran is added to 5,000 to 10,000 parts of water.

In series III the control diet previously used was compared with an experimental diet containing 1 per cent sodium benzoate and another containing 3 per cent sodium benzoate plus glycine. Theoretically, .52 gram of glycine is required to detoxify 1 gram of sodium benzoate, but one gram of glycine was fed for each gram of sodium benzoate in order to supply more glycine than was needed.

In series IV all the rats used in series III were fed a diet containing 3 per cent sodium benzoate. The same grouping was maintained in order to study the residual effect of feeding small quantities of sodium benzoate and also of feeding glycine.

The composition of the diets used in each series is given in table 1. Waste by rats was prevented by mixing enough distilled water with the feed at feeding time to give the mixture the consistency of paste. Distilled water was supplied at all times in individual water fountains.

RESULTS

Comparisons of control rats with experimental rats showed that calcium

propionate, sodium propionate, and zephiran fed at the levels used in these trials did not decrease the amount of gain. Sodium benzoate fed at the rate of 3 per cent proved harmful: the amount of gain was much less than for the control group, and two rats out of eight died before the end of the trial.

TABLE 1

Composition of diets

Series and group	Constituents of each diet					
	Fox chow	Yeast	Cod-liver oil	Salt	Calcium lactate	Experimental substance
	%	%	%	%	%	%
Series Ia:						
Control	91.5	5.0	2.0	0.5	1.0	.....
Ca propionate	91.5	5.0	2.0	0.5	.....	1.0
Na propionate	91.5	5.0	2.0	0.5	.....	1.0
Series Ib:*						
Control	89.5	5.0	2.0	0.5	3.0	.....
Ca propionate	89.5	5.0	2.0	0.5	.....	3.0
Na propionate	89.5	5.0	2.0	0.5	.....	3.0
Series II:						
Control	89.5	5.0	2.0	0.5	3.0	.....
Na benzoate	89.5	5.0	2.0	0.5	.....	3.0
Zephiran	89.5	5.0	2.0	0.5	.....	3.0
Series III:						
Control	89.5	5.0	2.0	0.5	3.0	.....
Na benzoate	91.5	5.0	2.0	0.5	.....	1.0
Na benzoate plus glycine	89.5	5.0	2.0	0.5	.....	3.0‡
Series IV:†						
Na benzoate	89.5	5.0	2.0	0.5	.....	3.0

* Rats continued from series Ia.
† Rats continued from series III.
‡ One part of glycine was added for each part of sodium benzoate.

For the group of rats receiving 3 per cent sodium benzoate, the average amount of gain produced per 10 grams of feed consumed was 1.01 grams smaller than the average for the control group. This is considered a significant margin. The addition of glycine to the 3 per cent sodium benzoate diet reduced the toxic effect of the benzoic acid. The difference between the amount of gain produced per 10 grams of feed consumed when glycine was fed was only .24 gram in favor of the control group. This fact is probably significant, however, because the gain of the control individual over that of the rat receiving sodium benzoate plus glycine was consistent for all pairs tested. This result may indicate a limited capacity of the animal organism to synthesize glycine or to utilize dietary glycine for the detoxication of sodium benzoate.

TABLE 2

Grams of gain produced

Series and groups	Gain by triplicates								Total gain	Average	Difference†	S.D.	P. value	Odds	Gain/10 gms. feed
	1	2	3	4	5	6	7	8							
Series Ia (4 wks.)															
Control group	88	82	70	86	88	60	78	80	632	79.0					3.34
Ca propionate	90	82	66	87	91	62	82	80	640	80.0	+ 1.0	2.29	.1429	1: 7	3.38
Na propionate	85	84	67	86	87	67	80	82	638	79.8	+ .75	2.11	.1881	1: 5	3.37
Series Ib (3 wks.)															
Control group	50	26	30	50	43	20	33	36	288	36.0					1.74
Ca propionate	52	16	34	50	39	17	36	35	279	34.9	− 1.12	4.25	.2586	1: 4	1.68
Na propionate	53	17	35	51	36	25	43	33	293	36.6	+ .63	6.08	.3994	1: 3	1.77
Series II (4 wks.)															
Control group	63	70	65	74	69	65	74	77	577	69.6					3.24
Na benzoate (3%)	51	53	58	*	*	59	32	32	285	47.5	−21.5	15.98	.0148	1: 68	2.23
Zephiran (3%)	*	71	70	76	80	62	77	73	509	72.7	+ 2.1	4.67	.1525	1: 7	3.35
Series III (5 wks.)															
Control group	82	100	98	103	97	100	98	98	776	97.0					3.12
Na benzoate (1%)	87	96	98	97	95	97	97	102	769	96.1	− .88	3.55	.2666	1: 4	3.09
Na benzoate (3%) plus glycine	74	87	90	94	95	92	90	95	717	89.6	− 7.38	3.23	.0002	1: 5000	2.88
Series IV‡ (2 wks.)															
Group 1	18	22	*	23	19	26	28	26	162	23.1					1.33
Group 2	32	20	28	27	23	33	22	29	214	26.8	+ 3.43	5.90	.1033	1: 10	1.55
Group 3	32	24	29	*	25	32	30	22	194	27.7	+ 4.33	5.47	.0668	1: 15	1.61

* Omitted because of incomplete results.

† Mean difference between control group and experimental group.

‡ Rats of group 1 continued from control group of series III.
Rats of group 2 continued from Na benzoate (1%) group of series III.
Rats of group 3 continued from Na benzoate (3%) plus glycine group of series III.

At the termination of the tests in series III, all the rats of that trial were changed to a diet containing 3 per cent sodium benzoate. Results obtained from this diet were compared with those of previous diets fed, but the probable error was large. The control group which had never received any sodium benzoate was most seriously affected by the change in diet. This group consumed 7.49 grams of feed per gram of gain compared to 6.44 for the group which had previously received 1 per cent sodium benzoate and 6.20 for the group which had previously received 3 per cent sodium benzoate plus glycine.

These results indicate that the group of rats which had previously received glycine had more resistance to the toxic effect of sodium benzoate than any other group. The utilization of stored glycine may explain the increased resistance. However, it seems reasonable to assume that the glycine reserve of group 2, which had received previously sodium benzoate and no glycine, should have been depleted and that additional quantities of sodium benzoate should have been very toxic. Instead, this group of rats made a greater gain than group 1 and practically as much gain as group 3. This fact may indicate that with limited feeding of sodium benzoate a mechanism was set up which enabled the animals to more readily combat toxicity.

Series II gives further evidence that rats which consume sodium benzoate develop a resistance to its harmful effects. The symptoms of toxicity were evident and the deaths caused by it occurred 7 to 20 days after the start of the trial. The rats which lived longer than 20 days showed an increasing resistance to the toxic effects of sodium benzoate.

The toxicity of sodium benzoate was expressed by definite, characteristic symptoms. The animal first became irritable and rigid, responding to the slightest touch or disturbance by biting the cage or the handler. As the symptoms progressed, it lost its power of coordinated movements and had convulsions.

A summary of the grams of gain produced in each part of this experiment is presented in table 2.

SUMMARY

A study was made of the amount of gain produced in growing white rats which were fed diets containing chemical agents used in food products or as a sterilizing agent. The amount of gain produced was used as an indication of the toxicity of these chemical agents. It is recognized that the method of measuring toxicity by the amount of gain produced has a limited application.

Neither calcium propionate nor sodium propionate, when fed in quantities up to 3.0 per cent of the diet, decreased the amount of gain.

Zephiran, a disinfectant made up of high molecular alkyldimethylbenzylammonium chlorides, when included in the diet at the rate of 3.0 per cent,

did not cause any ill effect. In fact, the zephiran group made slightly greater gain than the control group; and out of seven pairs of rats finishing the trial, five of the rats receiving zephiran made greater gains than their paired members in the control group. The results of this study indicated that zephiran is not toxic, and since it is a germicide there is a possibility that it could be employed to help control the bacterial flora of the alimentary canal in experiments where that feature is desired.

Sodium benzoate fed at the rate of 1.0 per cent in the diet did not affect the amount of gain. When the rate was increased to 3.0 per cent, definite toxic effects were observed. Numerous investigations have indicated that benzoic acid in the animal organism is detoxified by combining with glycine to form hippuric acid. It has been suggested that the animal organism has a readily available supply of glycine which can be used for the detoxication of benzoic acid. This study indicates that the animal organism has only a limited capacity for detoxifying benzoic acid in the body. The fact that addition of glycine to the sodium benzoate diet increased the amount of gain indicates a decrease in toxicity. The small difference between the gains produced in this group and the control group is considered significant, however, because individual comparisons showed that the control animals made greater gains than the experimental animals in every case.

The animal organism may develop a tolerance for sodium benzoate. Three groups of rats, which had received, respectively, no sodium benzoate, 1.0 per cent sodium benzoate, and 3.0 per cent sodium benzoate plus glycine, were all placed on a diet containing 3.0 per cent sodium benzoate. The group which had not previously received any sodium benzoate made the smallest gain and required the most food per gram of gain. The development of a tolerance for sodium benzoate was indicated by this fact and by the evidence obtained in series II that the toxic effects are expressed during the first 20 days of feeding.

The paired-feeding method of controlling food intake is believed essential to a study of this nature. If the food intakes of the control and experimental animals had not been equal, observed differences in amount of gain could have resulted from the difference in amount of food consumed.

REFERENCES

(1) GRIFFITH, WENDELL H. Benzoylated Amino Acids in the Animal Organism. Jour. Biol. Chem., 82: 415–427. 1929.

(2) MITCHELL, H. H. The Paired-Feeding Method: Its Value and Limitation in Livestock Experimentation. Amer. Soc. Anim. Prod. Proc., 1930.

(3) MITCHELL, H. H., AND BEADLES, JESSIE R. The Paired-Feeding Method in Nutrition Experiments and Its Application to the Problem of Cystine Deficiencies in Food Proteins. Jour. Nutr., 2: No. 3. January, 1930.

(4) RITTENBERG AND SCHOENHEIMER. Formation of Hippuric Acid in the Animal Organism. Jour. Biol. Chem. 127: 329–331. 1939.

DISTRIBUTION OF DIACETYL AND ACETYLMETHYLCARBINOL BETWEEN FAT AND WATER, WITH SPECIAL REFERENCE TO BUTTER[1]

W. H. HOECKER AND B. W. HAMMER

Department of Dairy Industry, Iowa State College, Ames, Iowa

In butter made with butter culture, diacetyl and acetylmethylcarbinol are derived largely from the culture added to the cream and from the fermentation of citric acid during holding or ripening of the cream. Only small portions of these compounds present in the cream at churning appear in the finished butter. They are carried out in the buttermilk (2, 4, 5, 6, 8, 9, 15, 16, 17, 19) in relatively large amounts and also may be removed by the water used to wash the butter (6, 11, 13, 17).

Fat and water, the two constituents of butter which are present in large amounts, have very different solvent properties. The data reported herein deal with the distribution of diacetyl and acetylmethylcarbinol between fat and water and involve studies on (a) mixtures of "Wesson" oil and water or brine, (b) mixtures of butterfat and water or brine and (c) unsalted and salted butter.

ANALYTICAL PROCEDURES

Diacetyl was determined by the colorimetric method of Prill and Hammer (18), with minor modifications used by Hoecker and Hammer (9). Color intensities were obtained with a Klett-Summerson photoelectric colorimeter. Acetylmethylcarbinol also was determined colorimetrically, using the procedure described by Hoecker and Hammer (9) for its estimation in butter.

EXPERIMENTAL

Distribution of Diacetyl and Acetylmethylcarbinol in Mixtures of "Wesson" Oil and Water or Brine[2]

The distribution of diacetyl between "Wesson" oil and water or brine was studied (a) by adding various amounts of an oil solution of diacetyl to 100 ml. portions of oil and then adding 100 ml. of either water or brine to each portion and (b) by adding various amounts of a water solution of diacetyl to 100 ml. portions of either water or brine and then adding 100 ml. of oil to each portion. The mixtures were held 2 days at room temperature in closed containers, with frequent shaking. The oil and water or brine were separated by centrifuging, the oil was pipetted off and diacetyl contents of

Received for publication October 16, 1941.

1 Journal Paper No. J-713 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 127.

2 Brine regularly consisted of 14 gm. sodium chloride made up to 100 ml. with distilled water.

TABLE 1

Distribution of diacetyl and acetylmethylcarbinol in mixtures of "Wesson" oil and water or brine
Mixtures contained equal volumes of oil and water or brine and were held 2 days at room temperature

Series No.	Description of mixture		Diacetyl				Acetylmethylcarbinol			
			p.p.m. in mixture calc.*	p.p.m. in water	p.p.m. in oil	% in oil	p.p.m. in mixture calc.	p.p.m. in water	p.p.m. in oil	% in oil
1	100 ml. oil +	0.5 ml. soln. A† or B‡ + 100 ml. water	1.86	2.93	0.78	21.0	4.62	8.45	0.79	0.86
		1.0 ml. soln. A† or B‡ + 100 ml. water	3.54	5.75	1.33	18.8	8.79	16.70	0.88	0.51
		2.0 ml. soln. A† or B‡ + 100 ml. water	6.55	10.40	2.69	20.5	14.78	28.20	1.36	0.46
		3.0 ml. soln. A† or B‡ + 100 ml. water	10.38	16.40	4.35	21.0	22.56	43.30	1.82	0.40
2	100 ml. oil +	0.5 ml. soln. A or B + 100 ml. brine	1.41	1.98	0.83	29.5	3.87	7.04	0.69	0.89
		1.0 ml. soln. A or B + 100 ml. brine	3.07	4.19	1.95	31.8	8.83	16.40	1.26	0.71
		2.0 ml. soln. A or B + 100 ml. brine	5.75	7.73	3.77	32.8	15.62	29.27	1.96	0.63
		3.0 ml. soln. A or B + 100 ml. brine	9.34	12.50	6.18	33.1	23.10	43.13	3.07	0.66
3	100 ml. water +	0.5 ml. soln. C§ or D‖ + 100 ml. oil	1.85	3.00	0.70	18.9	3.92	6.87	0.96	0.12
		1.0 ml. soln. C§ or D‖ + 100 ml. oil	3.82	6.40	1.24	16.3	13.60	15.92	1.27	0.47
		2.0 ml. soln. C§ or D‖ + 100 ml. oil	7.78	12.92	2.64	17.0	16.71	31.80	1.62	0.48
		3.0 ml. soln. C§ or D‖ + 100 ml. oil	12.31	21.00	3.62	14.7	26.11	49.90	2.32	0.45
4	100 ml. brine +	0.5 ml. soln. C or D + 100 ml. oil	1.53	2.15	0.91	29.8	4.42	8.10	0.73	0.83
		1.0 ml. soln. C or D + 100 ml. oil	3.31	4.71	1.91	28.9	7.90	14.70	1.10	0.70
		2.0 ml. soln. C or D + 100 ml. oil	6.40	9.47	3.33	26.0	15.87	29.40	2.34	0.74
		3.0 ml. soln. C or D + 100 ml. oil	9.75	14.70	4.80	24.6	24.27	46.20	2.33	0.48

* Calculated from analyses of oil and water or brine.
† Soln. A = 100 ml. "Wesson" oil + 0.1 ml. diacetyl.
‡ Soln. B = 100 ml. "Wesson" oil + 0.2 gm. acetylmethylcarbinol.
§ Soln. C = 100 ml. water + 0.1 ml. diacetyl.
‖ Soln. D = 100 ml. water + 0.2 gm. acetylmethylcarbinol.

the oil and water or brine were determined. In the studies on acetylmethylcarbinol the same general procedures were used. Table 1 gives the details of the trials and also the results of the analyses.

In the mixtures, the water or brine regularly contained higher concentrations of diacetyl and acetylmethylcarbinol than the oil, the differences being greater with acetylmethylcarbinol than with diacetyl. The percentage of diacetyl in a mixture that was contained in the oil was increased by sodium chloride in the water. The concentration of diacetyl in a mixture apparently did not affect the percentage in the oil. The concentrations of acetylmethylcarbinol in the oil were very low, and the different concentrations in the mixtures gave essentially the same percentage in the oil.

In the oil-water mixtures, concentrations of diacetyl and acetylmethylcarbinol in water ranged from 2.93 to 21.00 p.p.m. and from 6.87 to 49.90 p.p.m., respectively, and those in the oil varied from 0.70 to 4.35 p.p.m. and from 0.79 to 2.32 p.p.m., respectively. Of the total diacetyl and acetylmethylcarbinol in the mixtures, from 14.7 to 21.0 per cent and from 0.12 to 0.86 per cent, respectively, were in the oil.

In the oil-brine mixtures, concentrations of diacetyl and acetylmethylcarbinol in the brine ranged from 1.98 to 14.70 p.p.m. and from 7.04 to 46.20 p.p.m., respectively, while those in the oil varied from 0.83 to 6.18 p.p.m. and from 0.69 to 3.07 p.p.m., respectively. The percentages of the total diacetyl and acetylmethylcarbinol in the mixtures that were in the oil ranged from 24.6 to 33.1 and from 0.48 to 0.89, respectively.

A series of oil-water mixtures, each containing 200 gm. of "Wesson" oil and 40 gm. of water, were prepared and different amounts of either diacetyl or acetylmethylcarbinol added. Additions of the various concentrations of diacetyl or acetylmethylcarbinol were made by using equal amounts of the compounds as oil and water solutions. The mixtures were then treated the same as those involving equal volumes of oil and water or brine. Data on the distribution of diacetyl and acetylmethylcarbinol in the mixtures are given in table 2.

As in the previous trials, the water regularly contained higher concentrations of diacetyl and acetylmethylcarbinol than the oil, and the differences were greater with the carbinol than with diacetyl. With both diacetyl and acetylmethylcarbinol, the percentages in the mixtures that were contained in the oil varied considerably, but with each compound the highest value was obtained with the lowest concentration.

In the mixtures, concentrations of diacetyl and acetylmethylcarbinol in the water ranged from 0.53 to 6.90 p.p.m. and from 10.92 to 118.00 p.p.m., respectively, while those in the oil varied from 0.24 to 2.19 p.p.m. and from 0.87 to 5.43 p.p.m., respectively. Of the total diacetyl and acetylmethylcarbinol in the mixtures, from 56.5 to 69.0 per cent and from 18.5 to 28.7 per cent, respectively, were in the oil.

TABLE 2

Distribution of diacetyl and acetylmethylcarbinol in mixtures of "Wesson" oil and water
Mixtures contained 200 gm. oil and 40 gm. water and were held 2 days at room temperature

Trial No.	Diacetyl				Acetylmethylcarbinol			
	p.p.m. in mixture calc.*	p.p.m. in water	p.p.m. in oil	% in oil	p.p.m. in mixture calc.	p.p.m. in water	p.p.m. in oil	% in oil
1	0.29	0.53	0.24	69.0	2.54	10.92	0.87	28.7
2	0.47	0.96	0.37	66.0	4.00	19.00	1.01	21.0
3	0.68	1.53	0.52	63.3	5.65	26.10	1.57	23.2
4	0.70	1.60	0.52	61.4	6.49	30.70	1.67	21.4
5	1.09	2.43	0.83	63.3	11.33	54.40	2.75	20.2
6	1.68	4.40	1.14	56.5	13.04	64.00	2.89	18.5
7	2.97	6.90	2.19	61.3	24.13	118.00	5.43	18.8

* Calculated from analyses of oil and water.

With about the same concentration of diacetyl or acetylmethylcarbinol in mixtures of equal volumes of oil and water and in mixtures of 200 gm. oil and 40 gm. water, the concentrations of the compounds in both the water and the oil were higher in the latter mixtures. Since in these mixtures the oil comprised such a large portion of the total weight, it contained larger percentages of the diacetyl and acetylmethylcarbinol than in mixtures of equal volumes of oil and water.

Distribution of Diacetyl and Acetylmethylcarbinol in Mixtures of Butterfat and Water or Brine

In studying the distribution of diacetyl between butterfat and water or brine, butterfat was obtained by melting sweet cream butter (made without butter culture), allowing the fat and serum to separate at 45° C. and then decanting and filtering the fat at 45° C. Mixtures of 84 per cent melted fat and 16 per cent water or brine were placed in quart jars and various amounts of diacetyl added, the additions consisting of equal amounts of diacetyl as "Wesson" oil and water solutions. The jars were closed and placed in a small experimental churn where the mixtures were agitated for 1 hour. After holding the mixtures at 4° C. for various periods, the fat and water or brine were separated by placing the mixtures at 45° C. until the fat had melted, centrifuging and then pipetting off the fat. Diacetyl concentrations in the fat and the water or brine were determined. In the trials with acetylmethylcarbinol, the same procedures were employed. Table 3 gives the data on one trial which is representative of the five carried out.

The diacetyl and acetylmethylcarbinol showed the same general distribution as in the mixtures involving "Wesson" oil, with the water or brine regularly containing higher concentrations of the compounds than the fat and the differences being greater with acetylmethylcarbinol than with diacetyl. Sodium chloride increased the percentages of the compounds in the

TABLE 3

Distribution of diacetyl and acetylmethylcarbinol in mixtures of butterfat and water or brine

Mixtures contained 84 per cent butterfat and 16 per cent water or brine and were held 7 and 30 days at 4° C.

Description of mixture	Days held at 4° C.	Diacetyl				Acetylmethylcarbinol			
		p.p.m. in mixture calc.*	p.p.m. in water	p.p.m. in oil	% in oil	p.p.m. in mixture calc.	p.p.m. in water	p.p.m. in oil	% in oil
Butterfat-water	7	1.11	2.23	0.90	68.0	2.81	12.50	0.97	28.9
		2.25	4.90	1.75	65.3	4.85	22.30	1.52	26.4
		4.06	8.60	3.19	66.0	8.34	38.00	2.70	27.1
		4.78	10.91	3.61	63.4	.....	.....	.....	.....
		6.15	13.59	4.74	64.7	12.81	53.00	5.15	33.7
		7.50	17.44	5.61	62.9	20.56	97.58	5.89	24.0
	30	0.86	1.87	0.67	65.2	.....	.....	.....	.....
		1.58	3.50	1.21	64.6	5.14	22.00	1.93	31.6
		3.38	7.60	2.56	63.7	8.67	40.00	2.71	26.2
		3.60	7.60	2.83	66.2	10.81	45.00	4.30	33.4
		4.93	10.60	3.84	65.5	14.83	65.50	5.27	29.8
		5.04	10.30	4.04	65.4	19.76	93.60	5.89	24.5
Butterfat-brine	7	0.81	1.08	0.76	78.7	3.31	10.00	2.04	51.7
		1.40	1.90	1.31	78.4	5.13	20.30	2.24	36.7
		2.67	3.92	2.43	76.5	8.85	35.00	3.88	36.7
		3.46	5.04	3.16	76.7	12.94	54.20	5.10	33.1
		5.07	8.08	4.50	74.5	18.70	77.60	7.48	33.6
		6.01	9.12	5.42	75.7	21.75	89.20	8.88	34.3
	30	0.62	0.80	0.59	79.0	3.34	11.80	1.73	43.4
		1.25	1.75	1.15	78.4	5.21	20.40	2.33	37.4
		2.14	3.11	1.95	75.3	9.47	37.30	4.16	37.0
		3.25	5.11	2.89	74.7	13.62	56.10	5.54	34.1
		3.85	6.46	3.35	73.3	18.66	76.70	7.60	34.2
		5.81	8.78	5.23	75.7	22.24	91.60	9.00	34.0

* Calculated from analyses of fat and water or brine.

mixtures that were contained in the fat. Mixtures held 7 days and 30 days showed essentially the same distribution of diacetyl and the carbinol.

In the butterfat-water mixtures, concentrations of diacetyl and acetylmethylcarbinol in the water ranged from 1.87 to 17.44 p.p.m. and from 12.50 to 97.58 p.p.m., respectively, and those in the fat varied from 0.67 to 5.61 p.p.m. and from 0.97 to 5.89 p.p.m., respectively. The fat contained from 62.9 to 68.0 per cent of the diacetyl and from 24.0 to 33.7 per cent of the acetylmethylcarbinol in the mixtures.

In the butterfat-brine mixtures, concentrations of diacetyl and acetylmethylcarbinol in the brine ranged from 0.80 to 9.12 p.p.m. and from 10.00 to 91.60 p.p.m., respectively, while those in the fat varied from 0.59 to 5.42 p.p.m. and from 1.73 to 9.00 p.p.m., respectively. The fat contained from 73.3 to 79.0 per cent of the diacetyl and from 33.1 to 51.7 per cent of the acetylmethylcarbinol in the mixtures.

The results on the five trials with butterfat and water or brine are summarized in table 4, the data being divided on the basis of the concentrations of diacetyl or acetylmethylcarbinol in the mixtures.

TABLE 4

Summary of the distribution of diacetyl and acetylmethylcarbinol in all the butterfat and water or brine mixtures

Mixtures contained 84 per cent butterfat and 16 per cent water or brine and were held various periods at 4° C.

Description of mixtures and groupings	p.p.m. in mixture calc.*	Number of mixtures	Average p.p.m. in		Average % in fat
			Water or brine	Fat	
Diacetyl					
Butterfat-water mixtures					
Group 1	0 to 1.50	13	1.60	0.64	71.8
Group 2	1.51 to 5.00	21	6.45	2.60	69.2
Group 3	above 5.00	17	12.01	5.85	71.5
Butterfat-brine mixtures					
Group 1	0 to 1.50	11	1.23	0.95	80.6
Group 2	1.51 to 5.00	18	4.08	2.96	78.9
Group 3	above 5.00	23	12.96	9.54	79.0
Acetylmethylcarbinol					
Butterfat-water mixtures					
Group 1	0 to 8.00	13	23.46	1.90	30.0
Group 2	8.01 to 24.00	18	73.86	4.93	26.4
Group 3	above 24.00	18	185.17	12.13	22.9
Butterfat-brine mixtures					
Group 1	0 to 8.00	13	20.26	2.47	40.3
Group 2	8.01 to 24.00	20	63.68	6.41	34.9
Group 3	above 24.00	18	149.30	14.54	33.9

* Calculated from analyses of fat and water or brine.

The average values in the table support the various points already noted. They also show that as the concentration of diacetyl in a mixture increased, the percentage in the fat did not change appreciably, while as the concentration of acetylmethylcarbinol in a mixture increased, the percentage in the fat decreased. These relationships are suggested by the data on the individual mixtures, but irregularities in the results tend to obscure them.

Distribution of Diacetyl and Acetylmethylcarbinol in Unsalted and Salted Butter

In the studies on the distribution of diacetyl and acetylmethylcarbinol between the fat and serum of unsalted and salted butter, the serum was separated from the fat (a) by subjecting chilled butter to high pressures and (b) by centrifuging melted butter. The unsalted butter was of the high-flavor type, being churned from cream that had been ripened with a butter culture to a relatively high acidity. The salted butter either was

churned from sweet cream held over night at about 4° C. after addition of 8 per cent butter culture or was churned from sweet cream (containing no culture) with addition of a solution of diacetyl or a distillate of butter culture during working of the butter.

For the separation of the serum and fat by pressing, the butter was held at approximately −18° C. for 24 hours, after which it was shredded and 400 gm. mixed with 900 gm. of fine sand. The mixture was then subjected to approximately 1200 lbs. pressure per square inch in a hydraulic press (12). The sand and the parts of the press coming in contact with the mixture were cooled to approximately 4° C. before use so that the temperature of the butter would not increase too rapidly. With the procedure employed, a portion of the butter serum was obtained. Also, a small amount of the mixture came through the filter cloth; this material was held at 45° C. and the fat recovered by centrifuging and pipetting. For the separation of the serum and fat by melting, the butter was held in a closed container at 45° C. until the fat had melted, and the mixture was then centrifuged and the fat pipetted off.

Diacetyl and acetylmethylcarbinol determinations were made on the original butter and on the fat and serum. The percentages of fat and water in the butter were determined by the Mojonnier method, and from these values and the analyses on the fat and serum the amounts of diacetyl and acetylmethylcarbinol in the butter were also calculated. Table 5 gives the data.

As with the mixtures of butterfat and water or brine, the serum of butter contained higher concentrations of diacetyl and acetylmethylcarbinol than the fat, with the greatest differences again involving the carbinol. The averages of the percentages of diacetyl and acetylmethylcarbinol contained in the fat were smaller in unsalted than in salted butter. The percentage of diacetyl contained in the fat apparently was independent of the concentration in the butter, whereas the percentage of acetylmethylcarbinol contained in the fat usually decreased somewhat as the concentration in the butter increased. Addition of a solution of diacetyl or a distillate of butter culture to salted butter resulted in essentially the same distribution of diacetyl as when the butter was made from cream containing butter culture. When the serum was separated by pressing the butter, the fat usually contained slightly higher percentages of diacetyl and acetylmethylcarbinol than when the serum was separated by melting the butter. The amounts of diacetyl and acetylmethylcarbinol in the butter, as calculated from its composition and analyses of the fat and serum, agree fairly closely with the determined amounts.

In the unsalted butter, diacetyl and acetylmethylcarbinol concentrations in the serum ranged from 0.25 to 3.55 p.p.m. and from 4.85 to 119.16 p.p.m., respectively, and those in the fat varied from 0.19 to 1.11 p.p.m. and from

TABLE 5

Distribution of diacetyl and acetylmethylcarbinol in unsalted and salted butter

Sample No.	Serum separated by	Diacetyl					Acetylmethylcarbinol				
		p.p.m. in butter		p.p.m. in serum	p.p.m. in fat	% in fat	p.p.m. in butter		p.p.m. in serum	p.p.m. in fat	% in fat
		detr.*	calc.†				detr.	calc.			
Unsalted											
1	pressing	1.16	0.96	2.88	0.61	53.2	19.75	17.41	78.65	6.20	29.8
2	pressing	0.92	0.81	2.27	0.45	44.4	.....	.....	.....	.....	.....
	pressing‡	0.24	0.20	0.25	0.19	75.0	.....	.....	.....	.....	.....
3	pressing	0.57	0.58	1.79	0.33	46.6	1.58	1.60	5.08	0.89	45.6
	melting	0.57	0.50	1.54	0.35	58.0	1.58	1.56	4.85	0.88	46.8
4	pressing	1.29	1.09	3.13	0.72	55.0	23.20	23.05	119.16	5.46	19.5
	melting	1.29	1.11	2.34	0.89	67.5	23.20	20.44	96.00	6.61	27.1
5	pressing	1.42	1.39	3.55	1.04	62.1	20.90	20.25	92.40	6.40	26.2
	melting	1.42	1.33	2.50	1.11	69.4	20.90	20.08	88.90	6.86	28.2
6	pressing	0.99	0.91	2.70	0.58	52.7	10.10	7.94	32.00	3.40	35.6
	melting	0.99	0.94	1.75	0.79	70.3	10.10	8.34	33.50	3.60	35.9
Salted											
7	pressing	0.16	0.19	0.44	0.14	63.2	4.56	4.23	18.53	1.76	34.2
8	pressing	0.08	0.09	0.20	0.07	66.1	3.18	2.69	12.30	0.91	27.5
9	pressing	0.11	0.11	0.26	0.09	61.3	3.00	3.03	13.00	1.09	29.0
10	pressing	0.10	0.10	0.21	0.08	63.2	2.40	2.69	11.00	1.04	30.8
	melting	0.10	0.09	0.14	0.09	78.4	2.40	2.58	8.66	1.25	43.4
11	pressing	0.05	0.03	0.07	0.02	65.5	0.54	0.50	1.72	0.29	46.0
	melting	0.05	0.03	0.11	0.02	48.5	0.54	0.54	1.93	0.30	44.4
12	pressing	0.69	0.71	1.55	0.55	61.8	13.85	13.50	59.00	4.00	23.6
	melting	0.69	0.73	1.15	0.66	72.3	13.85	11.83	45.40	4.87	32.8
13	pressing§	0.92	0.96	2.00	0.76	61.6	.....	.....	.....	.....	.....
	melting§	0.92	0.97	1.33	0.92	74.6	.....	.....	.....	.....	.....
14	pressing‖	0.50	0.44	0.73	0.39	70.5	.....	.....	.....	.....	.....
	melting‖	0.50	0.52	0.80	0.48	72.8	.....	.....	.....	.....	.....

* Determined.
† Calculated on basis of composition of butter and analyses of serum and fat.
‡ Butter held 2 weeks at 4° C.
§ Solution of diacetyl added to sweet cream butter.
‖ Distillate of butter culture added to sweet cream butter.

0.88 to 6.86 p.p.m., respectively. The fat contained from 44.4 to 75.0 per cent of the diacetyl and from 26.2 to 46.8 per cent of the acetylmethylcarbinol in the butter.

In the salted butter, diacetyl and acetylmethylcarbinol concentrations in the serum ranged from 0.07 to 2.00 p.p.m. and from 1.72 to 59.00 p.p.m., respectively, while those in the fat varied from 0.02 to 0.92 p.p.m. and from 0.29 to 4.87 p.p.m., respectively. Of the total diacetyl and acetylmethylcarbinol in the butter, the fat contained from 48.5 to 78.4 per cent and from 23.6 to 46.0 per cent, respectively.

DISCUSSION OF RESULTS

The presence of diacetyl and acetylmethylcarbinol in the fat of butter and of mixtures of fat and water or brine is in agreement with various investigations (3, 7, 8, 10, 15, 17). However, Makar'in (13, 14) found diacetyl (a trace) in the fat of only one of eight samples of butter, whereas the serum always contained diacetyl. He believed that the aroma of butter is influenced largely by the concentration of the aqueous constituents of the cream that are retained in the butter. On the basis of averages of the percentages of diacetyl and acetylmethylcarbinol in cream that were retained in butter, Barnicoat (1, 2) suggested that these compounds are present only in the serum. If this were the case, the percentages of the compounds in the cream that are retained in the butter should be the same, and actually a higher percentage of diacetyl than of acetylmethylcarbinol is retained (19).

Since large percentages of the diacetyl and acetylmethylcarbinol in cream at churning are removed with the buttermilk, higher concentrations of the compounds would be expected in the serum than in the fat of butter. Although the concentrations in the fat are relatively low, the percentages of the compounds in butter that are contained in the fat are comparatively high because butter contains approximately 80 per cent fat.

The difference in the partitioning of diacetyl and acetylmethylcarbinol between fat and serum of butter (or between fat and water or brine in the mixtures) is what would be expected from the chemical constitution of the compounds. Davies (8) stated that since the vapor pressure of diacetyl is much higher than that of acetylmethylcarbinol, a greater portion of diacetyl than of the carbinol would be expected in the fat. Apparently, the partitioning of diacetyl and carbinol between the serum and fat in butter reaches an equilibrium in a relatively short time.

The distribution of diacetyl in butter into which a solution of diacetyl or a distillate of butter culture has been worked should be essentially the same as in butter made from cream containing butter culture; diacetyl is produced by the organisms in the serum of cream (or butter) and therefore in both cases the partitioning of the diacetyl is from the serum to the fat.

The greater percentage of diacetyl and acetylmethylcarbinol in the fat

in mixtures of fat and brine than in mixtures of fat and water presumbly is due to the salting-out effect of the sodium chloride. Some of the older procedures for distilling diacetyl from solutions made use of this effect through the addition of sodium chloride to a solution before distillation.

Comparative solubilities in fat probably explain why with diacetyl the concentration in butter does not affect the percentage of the total that is retained in the fat, while with acetylmethylcarbinol an increase in the concentration in butter decreases the percentage of the total that is retained in the fat. The low solubility of acetylmethylcarbinol soon limits the amount taken up by the fat.

The variations among samples of butter in the percentages of the total diacetyl or acetylmethylcarbinol that is contained in the fat probably are due to several factors, such as the composition of the butter, the physical state of the fat, the churning procedure and the degree to which water is dispersed in the butter. Also, analytical errors involved in determining very small quantities of the compounds may be of minor significance.

SUMMARY

In unsalted and salted butter, both the serum and the fat contained diacetyl and also acetylmethylcarbinol. The serum contained higher concentrations of the compounds than the fat, the differences being greater with acetylmethylcarbinol than with diacetyl. In each type of butter, a larger percentage of the total diacetyl than of the total acetylmethylcarbinol was contained in the fat. Butter into which a solution of diacetyl or a distillate of butter culture had been worked showed the same general distribution of diacetyl as butter made from cream containing butter culture.

In general, the data obtained on mixtures of "Wesson" oil and water or brine and mixtures of butterfat and water or brine agree with the results obtained on butter. In such mixtures, and also in butter although the results were not as definite as with the mixtures, the addition of sodium chloride increased the percentage of diacetyl or acetylmethylcarbinol that was in the fat. The concentration of diacetyl in the mixtures or in butter apparently did not affect the percentage contained in the fat, but as the concentration of acetylmethylcarbinol increased the percentage contained in the fat decreased. Mixtures of butter fat and water or brine held at 4° C. showed essentially the same distribution of diacetyl and acetylmethylcarbinol after 30 days as after 7 days.

REFERENCES

(1) BARNICOAT, C. R. Diacetyl in Cold-stored Butters. Jour. Dairy Res., 6: 397–406. 1935.

(2) BARNICOAT, C. R. Diacetyl in Cold-stored Butters. II. Jour. Dairy Res., 8: 15–30. 1937.

(3) BOGDONOV, V. M. Ways of Increasing the Aroma of Butter. Molochnaya Prom., 4, No. 4: 5–9. 1937. Original not seen. Abstracted in Chem. Abs., 33: 7411. 1939.

(4) BRIOUX, CH., AND JOUIS, EDG. Le Diacétyle dans les Beurres Normands. Compt. Rend., 205: 526–528. 1937.

(5) BRIOUX, CH., AND JOUIS, EDG. Le Diacétyle dans les Beurres Normands. Le Lait, 18: 11–22. 1938.

(6) BÜNGER, H. Die Preussische Versuchs- und Forschungsanstalt für Milchwirtschaft in Kiel in Jahre 1936–37. Landw. Jahrb., 84: 887–927. 1937.

(7) DAVIES, W. L. Flavour and Aroma of Butter. Dairy Indus., 1: 165–167. 1936.

(8) DAVIES, W. L. The Development of Aroma in Butter. 11th World's Dairy Congr. Proc., Berlin, 2: 76–78. 1937.

(9) HOECKER, W. H., AND HAMMER, B. W. Flavor Development in Salted Butter by Pure Cultures of Bacteria: Preliminary Results. Iowa Agr. Expt. Sta., Res. Bul. 290. 1941.

(10) KING, N. Über die Einwerkung des Diacetyls auf das Butterfett. Milchw. Forsch., 12: 172–182. 1931.

(11) KRENN, JOSEF. Über die Bildung von Diacetyl bei der Reifung des Rahmes und dessen Schicksal bei der Butterung. 11th World's Dairy Congr. Proc., Berlin, 2: 78–80. 1937.

(12) LANÉ, C. B., AND HAMMER, B. W. Bacteriology of Cheese. I. Effect of Pasteurizing the Milk on the Nitrogenous Decomposition in Cheddar Cheese. Iowa Agr. Expt. Sta., Res. Bul. 183. 1935.

(13) MAKAR'IN, A. M. The Distribution of Biacetyl in the Process of Production of Butter Both in the Individual Products and in the Butter in the Various Phases of Production. Molochnaya Prom., 4, No. 5: 20–22. 1937. Original not seen. Abstracted in Chem. Abs., 33: 9467. 1939.

(14) MAKAR'IN, A. M. The Production of Aroma in Butter. Molochno-Maslodel'naya Prom., 5, No. 6: 10–13. 1938. Original not seen. Abstracted in Chem. Abs., 35: 2988. 1941.

(15) MICHAELIAN, M. B., AND HAMMER, B. W. Studies on Acetylmethylcarbinol and Diacetyl in Dairy Products. Iowa Agr. Expt. Sta., Res. Bul. 179. 1935.

(16) MOHLER, H., AND HERZFELD, E. Diacetyl in Milchprodukten. Mitt. aus dem Geb. der Lebensmtl. Untersuch. u. Hyg., 26: 34–41. 1935.

(17) MOHR, W., AND WELLM, J. Der Diacetylgehalt in deutscher Butter und Einfluss des Herstellungsverfahrens auf den Diacetylgehalt der Butter. 11th World's Dairy Congr. Proc., Berlin, 2: 89–97. 1937.

(18) PRILL, E. A., AND HAMMER, B. W. A Colorimetric Method for the Microdetermination of Diacetyl. Iowa State Col. Jour. Sci., 12: 385–395. 1938.

(19) PRILL, E. A., AND HAMMER, B. W. Changes in the Diacetyl and the Acetylmethylcarbinol Contents During the Manufacture of Butter. JOUR. DAIRY SCI., 22: 79–88. 1939.

GREETINGS FROM YOUR PRESIDENT

Certainly those of us who are considered too old to shoulder a rifle must consider ourselves fortunate to be associated with an industry so vital to the well-being of both soldier and civilian and hence to the defense of our country. Never was there a time when so great a service can be rendered by the dairy industry. "She who gives the most is the most highly esteemed" can well be said of the dairy cow upon whom we depend for our livelihood. Isn't this axiom a good one for us all to keep in mind in the days of toil that lie ahead?

It seems to me that the American Dairy Science Association is unique in that it has a membership that works together and members who give willingly and unstintingly of their time and talent by working on various committees. The response to my recent committee appointments has been splendid and is very much appreciated. I am sure it presages a successful year and a banner meeting in East Lansing next June.

Speaking of our annual meeting, I am sure we all appreciate the cordial invitation of President Hannah of Michigan State College to visit the campus of that University the week of June 21, 1942. While "business and education as usual" may not be possible in this war torn world we must keep on "operating the milking machine" and learning all we can about how to make the best use of the product. Let us, therefore, make our plans to attend our anual inspiration meeting in June. Professor Weaver and his staff have their plans for our entertainment well under way and the program committee assures us of the best program yet. The symposia, started last year, will continue to be a feature and it is hoped that this feature may help draw an ever increasing number to our meetings from the commercial field.

Don't forget to tell the girls and kiddies about this meeting. They will see that you go. The fact that the social side of our meetings seems like a big family party appeals to all, I am sure.

Just a closing word to our members who are wearing the uniform of Uncle Sam or who may have to don it before our meeting. Rest assured we are pulling for you. Keep the old chin up and keep your membership up. There will be times when you will want to see what the Journal has to say, and that, with the maturing influence of the Service will make you a valuable asset to the industry when you can change the khaki or blue for the white uniform once more.

H. F. JUDKINS

VOLUME XXV FEBRUARY, 1942 NUMBER 2

JOURNAL OF DAIRY SCIENCE

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION
R. B. STOLTZ, Sec.-Treas.
Ohio State University, Columbus, Ohio

ABSTRACTS OF LITERATURE

T. S. SUTTON, Editor
Columbus, Ohio

MILK AND MILK PRODUCTS

Published in cooperation with
INTERNATIONAL ASSOCIATION OF ICE CREAM MANUFACTURERS
R. C. HIBBEN, 1105 Barr Bldg., Washington, D. C., Exec. Sec.

INTERNATIONAL ASSOCIATION OF MILK DEALERS
R. E. LITTLE, 309 W. Jackson Blvd., Chicago, Illinois, Exec. Sec.

CONTENTS

THE SCIENCE PRESS PRINTING COMPANY LANCASTER, PA.

PUBLICATIONS AND ABSTRACTORS

EDITORS

Dahle, C. D., Dahlberg, A. C., Elliker, P. R., Petersen, W. E., Tracy, P. H. and Weckel, K. G.

ABSTRACTORS

Anderson, E. O.
Archibald, J. G.

Babcock, C. J.
Berggren, Ruth E.
Brueckner, H. J.
Burgwald, L. H.
Bushnell, L. D.

Cole, W. C.
Cone, J. F.
Coulter, S. T.

Doan, F. J.

Dorsey, L. M.
Downs, P. A.

Erb, J. H.
Ely, Fordyce
Espe, D. L.

Frazier, W. C.

Garrett, O. F.
Glick, D. P.
Goss, E. F.

Hansen, Arne
Huffman, C. F.

Irvine, O. R.

Josephson, D. V.

Knight, D.

Lucas, P. S.
Lush, J. L.

Mack, M. J.
Macy, H.
Marquardt, J. C.
Martin, W. H.
Mueller, W. S.

Price, W. V.

Reece, Ralph P.
Riddell, W. H.
Ritter, W.

Sheuring, J. J.
Stark, C. N.
Stebnitz, V. C.

Thomsen, L. C.
Trout, G. M.

Webb, B. H.
Weckel, K. G.
White, G. C.

Yale, M. W.

JOURNALS

American Butter Review
American Milk Review
American Journal of Diseases of Children
American Journal of Physiology
American Journal of Public Health
Archives of Pediatrics
Australian Journal of the Council for Scientific and Industrial Research

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Canadian Public Health Journal
Certified Milk
Cornell Veterinarian

Dairy Industries
Dairy World
Deutsche Molkerei Zeitung

Endocrinology

Food Industries
Food Manufacture
Food Research

Ice and Refrigeration
Ice Cream Field
Ice Cream Review
Ice Cream Trade Journal
Industrial and Engineering Chemistry

Journal of Agricultural Research
Journal of Agricultural Science
Journal of American Medical Association
Journal of American Veterinary Medical Association
Journal of Bacteriology
Journal of Biological Chemistry
Journal of Dairy Research
Journal of Dairy Science
Journal of Endocrinology
Journal of Experimental Medicine
Journal of General Physiology
Journal of Genetics
Journal of Heredity
Journal of Industrial and Engineering Chemistry
Journal of Infectious Diseases
Journal of Milk Technology
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry
Journal of Physiology
Journal of Veterinary Research

Kaeseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry
Milk Plant Monthly
Molkerei Zeitung
National Butter and Cheese Journal
New Zealand Journal of Science and Technology

Oil and Soap

Pacific Dairy Review
Proceedings of Society of Animal Production
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture

Tierernährung
Tierzüchter

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zeitschrift für Untersuchtung der Lebensmittel
Zeitschrift für Züchtung. Reihe B. Tierzuchtung und Zuchtungbiologie
Zentralblatt für Bacteriologie
Züchtungskunde

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment. Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

National Institute for Research in Dairying, Reading, England
New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

ADVANCE ABSTRACTS OF REPORTS ACCEPTED FOR PUBLICATION IN THE JOURNAL OF DAIRY SCIENCE

26. The Significance of Tannic Substances and Theobromine in Chocolate Milk. W. S. MUELLER, Massachusetts State College, Amherst, Mass.

The relative toxicity of pure theobromine, pure tannic acid and two cocoa powders varying in tannic substances content was determined by feeding these substances in a basal diet to white rats. Theobromine was non-toxic to albino rats when the ration contained 0.27 per cent of this alkaloid, and tannic acid was toxic when the ration contained 2 per cent of this substance. A cocoa powder containing 12.15 per cent of tannic substances was more toxic than a cocoa powder containing only 2.67 per cent of tannic substances, but was less toxic than pure crystalline tannic acid. A concentrated extract of cocoa was non-toxic to rats when the ration contained 8 per cent. The hemoglobin levels of the blood of rats fed theobromine, crystalline tannic acid, and cocoa powder containing varying amounts of tannic substances did not vary from the normal enough to be of any significance. Results from this study indicate that the toxicity from cocoa can be greatly reduced by selecting a cocoa or chocolate which is low in tannic substances, or preferably using an extract of cocoa as the flavoring material when feasible.

27. The Advantage of Grinding Atlas Sorghum Grain for Dairy Cows. F. W. ATKESON AND G. H. BECK. Contribution No. 140, Department of Dairy Husbandry, Kansas State College, Manhattan.

Feeding trials with dairy cows were conducted to determine the value of grinding of Atlas sorgo grain as measured by the amount of grain recovered in the feces. The sorgo grain was fed as whole grain representing a fineness modulus of about 4.5; as coarsely ground grain representing a fineness modulus of 3.65; and as finely ground grain of a fineness modulus of 2.44. A burr mill was used for the coarse grinding and a hammer mill for the fine grinding.

The cows were fed through three ten-day periods using in the first period whole grain, in the second coarse ground or cracked grain, and in the third finely ground grain. All feces voided during the last three days of each ten-day period were collected and the grain recovered.

The trial lots included cows receiving only Atlas sorgo grain and alfalfa; a comparison of the degree of utilization of sorgo grain by cows on a balanced ration and cows on a deficient ration; and the effect on utilization by cows receiving the sorgo grain in silage as compared to sorgo grain fed as a concentrate.

The results of all three groups were in accord with each other in that feeding whole grain resulted in excessive waste while coarse grinding was more satisfactory than fine grinding considering cost of grinding and consistency of feed, and both grindings decreased the waste remarkedly. The first lot receiving alfalfa and sorgo grain resulted in a recovery in the feces of 42.0 per cent of the grain when fed whole; 4.8 per cent when the grain was coarsely ground and 1.5 per cent when finely ground. In the group comparing deficient rations on utilization or sorgo grain the recovery results were in accord with the first group, but cows receiving deficient rations averaged a grain waste of five times greater than cows receiving normal rations. The trial group fed whole sorgo grain in silage showed a grain recovery in the feces of 10.7 per cent. However, the silage fed was immature, the grain content as fed being 1.3 per cent.

BACTERIOLOGY

28. Heat Resistant and Heat-Loving Bacteria. The Problem—Their Control. W. B. SARLES, Univ. Wisconsin. Milk Plant Monthly, *30,* No. 8: 3, 33, 42. 1941.

Heat-resistant and heat-loving bacteria may be classified into several main groups. Their presence in milk is undesirable because of subsequent spoilage and high counts in the pasteurized products. Improperly treated utensils and coat of the cow are the two chief sources of contamination. Control of thermophilic bacteria within the plant involves scrupulous cleaning and sterilization of all equipment; short runs with vat pasteurizers; use of air space heaters; avoiding repasteurization; and possibly employment of hot-short pasteurization. The methylene blue test at 122° to 125° F. may be used to detect thermophiles. G.M.T.

29. Control of Heat Resistant and Heat-Loving Bacteria. W. B. SARLES, Univ. Wisconsin, Madison. Natl. Butter and Cheese Jour., *32,* No. 10: 18. 1941.

For abstract see preceding abstract. W.V.P.

30. Behavior of Microorganisms at Subfreezing Temperatures. III. Influence of Sucrose and Hydrogen-Ion Concentrations. V. H. MCFARLAND, Bur. Agr. Chem. and Engin., U.S.D.A., Washington, D. C. Food Res., *6,* No. 5: 481. September–October, 1941.

Cells of a cold tolerant Saccharomyces and of *Esch. coli* were suspended in sucrose solutions varying from 1 to 50 per cent. Viability studies were made at pH 6.5, 5.0 and 3.6 to 3.7 when held at – 10° C. and at – 20° C.

It was found that viability did not always correlate with sucrose concentration except at the low pH level. High concentrations of sucrose

tended to retard destruction of the yeast cells although greater destruction occurred in the medium concentrations than in distilled water. On the other hand, *Esch. coli* was destroyed to a greater extent in distilled water than in any of the sucrose concentrations.

When pH was the only variable, the low pH levels (3.6–3.7) proved to be more destructive to both microorganisms than the higher levels. When temperature was the only variable greater kills were obtained at – 10° C. than at – 20° C. F.J.D.

BUTTER

31. Old and New Facts about Churns and Churning. F. H. ABBOTT, Univ. Calif., Davis. Natl. Butter and Cheese Jour., *32*, No. 11: 12. 1941.

Round fat globules are kept apart in milk and cream by the viscosity of the suspending medium, by an adsorbed layer of nitrogenous milk solids and lactose and by the negative charge on the fat globules. Agitation ruptures the adsorbed layer, the fat globules adhere to each other and when the butter "breaks" there is present a skimmilk-in-fat emulsion. New types of rollless churns are more sanitary; metal churns can be sterilized with hot water or steam and butter made in them rarely shows yeast or mold. W.V.P.

32. A Study of Some Factors Influencing the Phosphatase Reaction of Flash Pasteurized Cream and Butter Made from It. W. J. WILEY, F. S. J. NEWMAN, AND H. R. WHITEHEAD, Council Sci. Indus. Res., Victorian Dept. Agr. and Dairy Res. Inst. of N. Z., resp. Jour. Council Sci. Indus. Res., Australia, *14*, No. 2: 121–128. 1941.

When the Kay and Graham "long" phosphatase test was used on cream pasteurized in the vacreator and on serum from butter made therefrom, the butter gave much higher values than the cream from which it had been made. Addition of salt, galactose or sucrose to cream (or butter) produced no immediate effect on the test, but after several hours phosphatase values were considerably higher. Vacuum drying the cream at 40° C. caused a similar increase, and even storage of the flash pasteurized cream led to a slow increase in phosphatase values. The authors theorize that there apparently is "binding of a small and varying proportion of the enzyme in the cream in such a way that it escapes destruction during a very short heat treatment." It is supposed that salt, sugars and drying cause the release of this "bound" phosphatase. Tests on cream flash pasteurized in the laboratory gave similar results.

There was no evidence of the production of phenolic substances in the cream by bacteria. Plate counts showed that there was more destruction

of bacteria by the vacreator method than by the usual holding method, although lower phosphatase values were obtained from cream subjected to the holding method.

The authors conclude that "the phosphatase test therefore cannot be used on butter as a means of checking whether the initial cream has been properly flash pasteurized." W.C.F.

CHEESE

33. Pioneer Days in Cheese Making. E. L. ADERHOLD, Natl. Butter and Cheese Jour., *32,* No. 11: 16. 1941.

The Good (?) Old Days. A. T. BRUHN, Wisconsin Dept. Agr., Madison, Wis. Natl. Butter and Cheese Jour., *32,* No. 11: 22. 1941.

These two articles review the changes in the cheese industry, relative to the methods of payment for milk, starters, boards of trade, styles of cheese, buildings and equipment, boxes, utensils and inspection. W.V.P.

34. Bacteriology of Cheese. VI. Relationship of Fat Hydrolysis to the Ripening of Cheddar Cheese. C. B. LANE AND B. W. HAMMER. Iowa Agr. Expt. Sta. Res. Bul., 291. 1941.

The studies were carried out with four types of milk, (1) raw milk, (2) pasteurized milk, (3) skim milk (raw or pasteurized) plus homogenized cream (raw or pasteurized) and (4) pasteurized material containing lipolytic enzyme.

In some trials cheese made from raw homogenized cream plus raw or pasteurized skim milk was more satisfactory than that made from raw milk. Although cheese from the raw homogenzied cream plus raw or pasteurized skim milk commonly was characterized by a rancid flavor early in the ripening period, this rancidity tended to disappear, and when well ripened, the cheese was superior in flavor to that made from pasteurized milk or pasteurized homogenized cream plus pasteurized skim milk.

Addition of pancreatin to pasteurized milk resulted in an objectionable rancid flavor and in the ripened cheese this was in many cases accompanied by a pronounced bitter flavor.

The titratable acidities of cream-sugar mixtures increased when desiccated mammary tissues or liquid extracts of them were added and the mixtures incubated at 37° C. for 3 and 7 days. Tissue extracts produced less fat hydrolysis than the corresponding desiccated tissue.

Addition of desiccated mammary tissues or their extracts to pasteurized milk resulted in an increase in fat acidity and a slight increase in soluble nitrogen in the cheese. The flavor of cheese made from pasteurized milk was improved by addition of mammary tissue or its extract. In some trials

when spleen tissue or its extract were added to pasteurized milk, the flavor of the cheese was improved. Little improvement in flavor of cheese resulted when liver extracts were added to pasteurized milk. P.R.E.

35. **Cottage Cheese—a Healthful Food for the Lenten Season and the Year Round.** H. A. RUEHE, Univ. Illinois, Urbana, Ill. Milk Plant Monthly, *30,* No. 3: 27–28. 1941.

The market possibilities of cottage cheese together with methods of manufacture and causes of defects are presented in detail. The possible uses of cottage cheese include: appetizers, soups, salads, main dishes and sandwich fillings. The size and characteristics of cottage cheese curd may be varied to suit the consumer demand. Ten steps are given in making a flaky curd cottage cheese. Tough and rubbery curd is caused by: heating the curd too high or holding at the cooking temperature too long; cutting the coagulum before sufficient acidity has developed; and not using a sufficient amount of rennet extract. A soft, pasty curd is caused by: permitting too much acid development; using too much rennet extract; too low a cooking temperature or insufficient cooking time; and too high a pasteurization temperature. G.M.T.

36. **Danger Confronts the Dairy Industry.** RALPH AMMON, Director Wis. Dept. Agr., Madison. Natl. Butter and Cheese Jour., *32,* No. 11: 66. 1941.

Dangers listed are: possibility of over-expanded production after the current crisis; disorderly diversion; unfair legislation, particularly that pertaining to oleo; war-hysterical appeal for use of substitutes for butter; and regimentation and control of industry by Federal authorities. Suggestions to protect the industry are: co-operation in production for defense; co-operation between states to avoid adjustment shocks after crisis; fight for a fair deal by demanding repeal of oleo standard, demanding laws prohibiting fraudulent advertising of oleo in semblance of butter; abolishment of the Consumer Counsel Division of the U.S.D.A.; manufacture and advertising of highest quality butter; and the preservation of democracy by resistance to bureaucratic control and political subjugation. W.V.P.

37. **Leadership.** C. R. BARKER. Natl. Butter and Cheese Jour., *32,* No. 10: 14. 1941.

Leadership can be established in the cheese business on a quality rather than a volume-of-business basis. This must be done through intelligent sales efforts with emphasis on excellence, nutritive value and recognition of the responsibility of the manufacturer to the public. W.V.P.

CHEMISTRY

38. Composition of the Milk of the Monkey. G. VAN WAGENEN, H. E. HIMWICH, AND H. R. CATCHPOLE, Dept. Obstetrics and Gynecology, the Adolescence Study Unit, Yale Univ. Soc. Expt. Biol. and Med. Proc., *48:* 133. 1941.

Average values for 9 animals gave: protein 2.1 per cent; carbohydrate 5.9 per cent; fat 3.9 per cent; and ash 0.26 per cent. It is pointed out that in composition monkey's milk is similar to that of the human being and differs from cow's milk in having a lower percentage of protein and ash and a higher percentage of milk sugar. Milk samples were obtained between the 35th and 103rd day of lactation and no systematic changes were observed during this interval in the percentages of the principal milk constituents or in the calorific values ascribable to them. R.P.R.

39. Quantitative Determination of Dissolved Oxygen. Ascorbic Acid Oxidase Method. PAUL F. SHARP, DAVID B. HAND, AND E. S. GUTHRIE, Cornell Univ., Ithaca, N. Y. Indus. and Engin. Chem., Analyt. Ed., *13,* No. 9: 593. 1941.

This new method for the determination of the dissolved oxygen of fluids containing organic matter was developed especially for making determinations on milk. The determination was made several thousand times on milk, water, buffer solutions and bacteriological media, it being possible for one person to make 30 determinations in a half day. Since fresh milk contains only about 1/3 enough ascorbic acid to react with the dissolved oxygen, additional ascorbic acid is first added to each sample. The total ascorbic acid content of the milk is then determined by titration. A quantity of ascorbic acid oxidase which acts as a catalyst is added to the milk and the sample is allowed to stand 15 minutes during which time the enzyme causes all the dissolved oxygen to react with the reduced ascorbic acid. The enzyme is then inactivated by sulfuric acid and the ascorbic acid content of the sample is again determined by titration. The dissolved oxygen content of the sample is obtained by a simple calculation. Complete directions for preparing reagents and apparatus are given. A specially designed oxygen analysis tube which avoids transference of the liquid and protects it from air is used for the determinations. Ascorbic acid oxidase is prepared from the juice of green cucumbers. The method shows good agreement on water when compared with the Winkler method. The probable error is 0.1 to 0.2 part per million. B.H.W.

40. Instrumental Methods of Chemical Analysis. RALPH HOLCOMBE MÜLLER, Dept. Chemistry, New York Univ., Washington Square,

New York, N. Y. Indus. and Engin. Chem., Analyt. Ed., *13*, No. 10: 667. 1941.

This paper comprises the entire issue of this Journal. The use of instruments in analysis and testing is discussed and descriptions and illustrations of all the more important types of instruments used in chemical analysis are presented. B.H.W.

41. Polarographic Determination of Ascorbic Acid. MARY MANN KIRK, N. Y. State Agr. Expt. Sta., Geneva, N. Y. Indus. and Engin. Chem., Analyt. Ed., *13*, No. 9: 625. 1941.

The author reports the results of preliminary work on the use of the polarograph for the determination of ascorbic acid. No quantitative determinations were run but results were obtained which indicated that the method could be adapted for accurate quantitative analysis by comparing curves obtained when an unknown solution was used, with calibration curves. B.H.W.

42. The Colorimetric Determination of Lactic Acid in Biological Material. S. B. BARKER AND WILLIAM H. SUMMERSON, New York Hospital and Depts. of Medicine and Biochemistry, Cornell Univ. Medical College, New York City. Jour. Biol. Chem., *138*, No. 2: 535. 1941.

A method for the colorimetric determination of lactic acid in biological material is described in which the lactic acid is converted into acetaldehyde by treatment with concentrated sulfuric acid and the acetaldehyde determined by its color reaction with parahydroxydiphenyl in the presence of cupric ions. The color is read in a photoelectric colorimeter with a filter having a peak transmission at 560 mμ. V.C.S.

43. The Chemical Determination of Nicotinic Acid in Milk and Milk Derivatives. C. I. NOLL AND O. G. JENSEN, Borden Co. Res. Div., Biological and Chemical Labs., Bainbridge, N. Y. Jour. Biol. Chem., *140*, No. 3: 755. 1941.

The method of Melnick and Field appears to be well adapted to the estimation of nicotinic acid in milk. A discussion of the limitations of chemical methods for the determination of nicotinic acid, in respect to specificity of the reactions, the use of an appropriate blank, and the interference of colored solutions, is presented.

The nicotinic acid values reported for a group of dry skim milk samples, as determined by the method presented, varied from 14 to 28 gamma per gram (average 18.3) and are lower than most values reported in the literature. V.C.S.

44. Physical Properties of Sodium, Potassium and Ammonium Lactate Solutions. ALBERT A. DIETZ AND ED. F. DEGERING, Purdue Univ., Lafayette, Ind., AND H. H. SCHOPMEYER, American Maize-Products Co., Roby, Ind. Indus. and Engin. Chem., Indus. Ed., *33,* No. 11: 1444. 1941.

The density, index of refraction, viscosity, boiling and freezing points and surface tension of sodium, potassium, and ammonium lactate solutions are reported. These properties were determined for concentrations ranging from 1 to 90 per cent. The salts were prepared from very pure lactic acid. B.H.W.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

45. The Dry Milk Situation. ROUD MCCANN, Amer. Dry Milk Inst., Chicago, Ill. Natl. Butter and Cheese Jour., *32,* No. 11: 10. 1941.

The low price of butter has thrown too suddenly a high load value onto the non-fat solids of milk. Dry milk producers should try to retain home markets, to develop new markets and to increase production without building new plants. The American Dry Milk Institute is working for increased dry milk production by direct contact with manufacturers, and cooperation with federal and state agencies. The A.D.M.I. is helping train army chemists in dry milk grading and has loaned part of its personnel to the government for grading dry milk and dry eggs; it is educating the meat trade, improving production conditions to obtain more dry milk for human food and sponsoring research projects to develop new uses, improved foods and new packages for dry milk. W.V.P.

FOOD VALUE OF DAIRY PRODUCTS

46. The Utilization of the Calcium of Cauliflower and Broccoli. M. L. FINCKE, School of Home Economics, Oregon State College, Corvallis. Jour. Nutr., *22:* 477–482. 1941.

One group of 28-day-old rats was fed a basal diet in which practically all of the calcium was derived from dried milk. Two other groups were fed the basal diet in which one-half of calcium was supplied by dried broccoli or cauliflower. The rats were killed at 60 days of age and their bodies analyzed for calcium. The milk calcium was 87 per cent available, that of the broccoli plus milk was 79 per cent available, and that of the cauliflower plus milk only 69 per cent available. The author attributed the lower availability of the calcium of cauliflower and broccoli to the combined effect of their oxalic acid and high fiber content. C.F.H.

47. Maintaining Vitamin Values in Milk and Milk Products. K. G. WECKEL, Univ. Wisconsin, Madison. Milk Plant Monthly, *30,* No. 5: 48. 1941.

Maintaining certain vitamin values in milk is of more than passing interest to the consumer, as shown by the fact that milk is being fortified today in some sections with vitamins and marketed regularly. Vitamin assays have shown the effect of processing upon vitamins of milk. Improvement of flavor, color and storage qualities result from maintaining higher vitamin values. Attention is being focused at present upon the proper feeding of dairy cows in order that higher levels of vitamins might be had in the milk. Correct feeding of cows and improved milk handling techniques seem to be necessary for the maintenance and preservation of a high vitamin level in milk. G.M.T.

48. No Objection to Pasteurized Milk on Nutritional Basis. C. A. ELVEHJEM, Univ. Wisconsin. Milk Plant Monthly, *30*, No. 7: 26–29, 40. 1941.

Experimental evidence has shown fairly conclusively that the nutritional value of milk is not greatly harmed by pasteurization and that milk exhibits seasonal differences far greater than that resulting from pasteurization. Two nutritional factors which may be reduced in pasteurization are vitamin C and vitamin B_1, the loss of each being about 20 per cent or less when using proper precautions. Under average conditions these losses may be compensated by use in the diet of fruits, vegetables and fortified flour bread. Thus the author concludes he was unable to find on a nutritional basis any objection to the production and use of pasteurized milk.

G.M.T.

49. Manganese in Cow's Milk. J. G. ARCHIBALD, Massachusetts State College, Amherst. Milk Plant Monthly, *30*, No. 9: 36. 1941.

The manganese content of cow's milk was significantly increased by feeding manganous sulphate in an experiment involving two groups of four cows each over an extended period. Some evidence is presented indicating that manganese may be stored during the pasture season which becomes depleted during the winter season. Speculation as to correlation between lack of manganese and development of oxidized flavor is made.

G.M.T.

50. Nutritive Value of Agar and Irish Moss. H. W. NILSON AND J. W. SCHALLES, Div. of Fisheries, Fish and Wildlife Service, U. S. Dept. of the Interior, College Park, Md. Food Res., *6*, No. 5: 461. September–October, 1941.

Using rats as subjects it was determined that the apparent digestibility coefficient of the nitrogen free extract of agar is about 28 per cent and that

of Irish Moss about 50 per cent, irrespective of the level included in the diet. In general the animals grew very well except those receiving a diet containing 20 per cent Irish Moss, in which group there was a 50 per cent mortality. A progressive depression in the apparent digestibility of dry matter of the remainder of the diet was noted as the level of agar or Irish Moss was increased. This amounted to almost 10 per cent at the higher levels.

F.J.D.

51. The Presence of Free and Combined Thiamine in Milk. NELLIE HALLIDAY AND HARRY J. DEUEL, JR., Dept. Biochemistry, Univ. Southern California School of Medicine, Los Angeles. Jour. Biol. Chem., *140*, No. 2: 555. 1941.

The thiamine content of Certified Holstein milk was found to average 23.4 and 40.5 mg. respectively for the free and total thiamine. Only approximately 60 per cent of the thiamine in milk is present in a free state, the rest being broken down with phosphatase or with taka-diastase but only when a proteolytic enzyme such as papain is also used.

Methods for the determination of free and combined thiamine in milk are given. V.C.S.

ICE CREAM

52. Outline of Activities for the Year 1941. ROBERT C. HIBBEN. Special Bulletin, Internat. Assoc. Ice Cream Mfrs., Washington, D. C. November, 1941.

The association has cooperated with other food industries in getting preference ratings for materials for replacement and repairs of equipment. Work has been continued with the Federal Food and Drug division regarding the definitions and standards of identity for frozen desserts to be adopted under the Food, Drug and Cosmetic Act of 1937. Federal and state legislation affecting the ice cream industry has been followed, and such matters as the Federal Tax Bill, price control legislation, labor measures, highway and trucking bills, etc., have been studied.

Consumer education has received attention, and several booklets for consumers have been released. The association took an active part in the promotion of June Dairy Month. Inter-industry contacts have been maintained with a number of industrial groups and committees.

The statistical and accounting bureau of the I.A.I.C.M. published a new accounting system which has already been installed by a large number of ice cream manufacturers. The bureau has made ice cream "expense comparisons" and has made an analysis of equipment used by the industry. The sales index of ice cream for 1941 has also been compiled.

The activities of the Ice Cream Merchandising Institute are also included in the bulletin. Attendance at the 1941 Merchandising Short Courses was approximately 5,000 and plans are completed for the 1942 courses. There are many other activities of the institute, such as the publication of monthly booklets on selling ice cream, the preparation of monthly window poster service kits, and so on. M.J.M.

53. Ice Cream Sales Index. Special Bulletin. Statistical and Accounting Bureau, Internat. Assoc. Ice Cream Mfrs., Washington, D. C. December, 1941.

This bulletin contains an analysis of ice cream sales for 1941, compared with 1940. The sales are for the period of January 1 through August 31. For this period of 8 months, sales in the United States increased 18.3 per cent over the like period in 1940. In Canada the increase for the same period was 36.36 per cent, and for the Territories of the United States the increase was 52.46 per cent.

Every state in the United States reported increased sales for the first 8 months of 1941, with increases of more than 20 per cent for 14 states. The sales increase was greatest in the Southern states (24.9 per cent) and least in the Western states (14.2 per cent).

A supplement to the bulletin contains the preliminary production report for 1940 as compiled by the Agricultural Marketing Service. The total production of ice cream for 1940 is given as 316,236,000 gallons, which is an increase of 13 million gallons over 1939. The per capita production in quarts is given by states. In the District of Columbia the highest annual per capita production of 24.24 quarts was reported. The percentage of the total U. S. production is also given by states for the year 1940. Pennsylvania led with 13.29 per cent of the total production, New York was second with 12.5 per cent, and Illinois was third with 6.84 per cent of the total.

M.J.M.

54. Our New Army as a Market for Ice Cream. VINCENT M. RABUFFO. Ice Cream Trade Jour., *37*, No. 8: 6. 1941.

A survey was conducted by the author to obtain figures on the consumption of ice cream by the soldiers in the many army camps throughout the nation. The figures obtained showed that 565,000 men out of an estimated total of 1,448,600 consumed approximately 107,000 gallons of ice cream during the month of May. On this basis it was estimated that this amount would be equivalent to a yearly per capita consumption of 3.8 gallons which is considerably above the national average. The prices paid by the army for standard brands of ice cream compared very favorably with that paid by ice cream dealers. The army recognizes the wholesomeness of ice cream

and serves it from one to three times a week in the mess halls and in addition large quantities are consumed in the canteens, post exchanges and clubs. This new business has raised the value of products manufactured in states where large numbers of men are in army camps. W.H.M.

55. What is Happening to Product Costs. VINCENT M. RABUFFO. Ice Cream Trade Jour., *37*, No. 8: 10. 1941.

The cost of ingredients used in the manufacture of ice cream has increased about 20 per cent during the past year and has resulted in increasing the cost of manufacturing a gallon of ice cream from 10 to 16 cents per gallon. Labor and overhead costs have also gone up and as a result ice cream prices have generally advanced throughout the nation. In some instances price advances have not kept pace with increased costs, and in other cases manufacturers have been forced to reduce the fat content of their ice cream and amount sold in various packages and novelties to partially offset increased costs. In many instances retailers have increased the selling price of ice cream and items containing ice cream far more than the percentage increase in the cost of their product. If sales of ice cream are to continue at a satisfactory volume, close cooperation between the manufacturer and retailer will be necessary. W.H.M.

56. No Place Like Home for Greater Sales. OWEN M. RICHARDS. Ice Cream Trade Jour., *37*, No. 8: 14. August, 1941.

A survey conducted by the American Dairy Association in some of the large cities reveals that ice cream ranks first as a dessert in public eating places and in the home when guests are present, but it ranks far down the list at regular meal time in the home. Families with children and families of high and middle incomes had ice cream delivered to the home more frequently than those in the lower classifications and those without children. Most ice cream was purchased through drug stores although the percentage varied in different cities. W.H.M.

57. The Homogenization of Ice Cream Mix. B. I. MASUROVSKY. Ice Cream Trade Jour., *37*, No. 8: 22. 1941.

Faulty homogenization can be determined by diluting the homogenized ice cream mix with two parts of water to one part of mix and allow it to stand in a tall test tube at 50° F. for two or three hours. The degree of stratification of layers of ice cream and their density serves as an index of homogenization efficiency.

A new method of measuring homogenization efficiency has been worked out by the laboratory of the Creamery Package Manufacturing Company, Chicago, Illinois, which consists of microscopic examination of diluted prod-

ucts and a classification of the globules according to the size of the globules. From these figures an homogenization index can be calculated.

W.H.M.

58. **Our New Army.** Lt. Col. Paul P. Logan, Office of Quartermaster Corps, Chief, Subsistence Branch. Ice Cream Trade Jour., *37*, No. 9: 10. 1941.

This article explains how ice cream is bought for use by the U. S. armed forces in its mess halls, post exchanges, and service clubs. The use of ice cream on the menu is left to the discretion of the officers in charge of each organization mess and the frequency of its use depends largely upon the taste of the men comprised in the mess. The ice cream for this purpose is purchased on definite quantity contracts entered into on the basis of competitive bids. The contracts are usually made on monthly basis, but the Corps Area Commander may authorize contracts covering a period of three months.

Each of the 147 Army posts and camps in the continenal United States has one or more post exchanges. The army furnishes the building and equipment for these exchanges. In buying ice cream the PX officers are not required to make any contract for a period of time specified by the army or for any regulatory quantity of ice cream. This is left entirely up to the exchange in each individual case.

Recreational centers operated by the affiliated groups of the U.S.O. are separate from the army camp but each of these will have a fountain. Each will purchase its ice cream in a way similar to that used by the PX officers.

W.H.M.

59. **A Method of Testing Flavors.** B. I. Masurovsky, Research Editor. Ice Cream Trade Jour., *37*, No. 9: 27. 1941.

An economical and time-saving method of testing ice cream flavor and color is described. It consists of placing 8 to 16 oz. of ice cream mix, carrying the flavor to be tested in an aluminum container which has a syphon arrangement leading to the head where provision is made to connect a cartridge filled with nitrous oxide under pressure. The mix is charged with gas, shaken and placed in a quart container and hardened with dry ice. Colors can be tested in the same way. A table showing the amount of flavor required for 5 gallons of ice cream mix is presented. W.H.M.

60. **Production Costs Can Be Lowered.** Paul Vasterling, Dufold Sales Co., Racine, Wis. Ice Cream Trade Jour., *37*, No. 10: 32. 1941.

The ice cream manufacturer who may want to reduce the ingredient cost of his cream will be interested in this article in which the author suggests

increasing the serum solid content of the ice cream, thus making it possible to take a higher yield without any sacrifice in the weight of the finished product. W.H.M.

61. Equipping a Dairy Products Control Laboratory. PAUL H. TRACY, University of Illinois, Urbana. Ice Cream Trade Jour., *37*, No. 10: 62. 1941.

The author has listed the equipment necessary for a bacteriological control laboratory for a dairy products plant, and estimates that it will cost approximately $1000 to purchase and install the equipment. W.H.M.

62. Controlled Retail Stores, ANONYMOUS. Ice Cream Field, *38*, No. 4: 26. October, 1941.

It is stated that invariably merchandising conferences stress (1) store clean up; (2) display and advertising, and; (3) handling merchandise properly. It is claimed that such programs always meet with the following obstacles: (1) dealer resents implication that his store is in bad condition; (2) he fails to execute program as outlined at the conference, and; (3) he permits competitive lines to occupy all available space.

Several specific cases are cited in which ice cream sales had materially increased as a result of controlled retail stores. Although some manufacturers have failed in operating their own stores, it is pointed out that the failure is due largely to lack of properly controlled retail stores.

It is concluded that a well-designed and properly operated plant store or town store will serve as an effective permanent advertisement. It is also claimed that such stores when properly operated are not in competition with dealers but serve as proof of effective means of getting business. Develop your own distinctive merchandising program rather than match "competitive schemes" is the advice given. W.C.C.

63. Your Delivery Problem. B. P. FORTNEY, Warnsman-Fortney Body Co. Ice Cream Field, *38*, No. 4: 27. October, 1941.

It is stated that the operating costs of old bodies and chassis are often more than the depreciation and operating costs of new trucks and bodies, in addition the latter maintain more uniform temperature and are more convenient.

Good-looking modern trucks painted in pleasing colors with attractive sign work serve as effective advertising.

It is stated that the principal changes for 1942 will be those necessitated by substitution materials, such as aluminum and corkboard, occasioned by the defense program. The author recommends the purchase of refrigerator trucks from well-established manufacturers. W.C.C.

64. Now You Can Sell Peach Ice Cream. JAMES S. LAWLESS, Frosted Fruit Products, Los Angeles. Ice Cream Field, *38*, No. 4: 6. October, 1941.

Peach ice cream has been a disappointment to manufacturer, retailer, and consumer, it is stated, because the pleasing flavor of the peach itself is elusive. This is evident from the fact that in 1938 peach ice cream accounted for only 1.46 per cent of the national ice cream production.

The author points out that the nectarine, in reality a variety of peach, is superior to ordinary peach as a source of flavor for ice cream. The nectarine can be processed by quick-freezing methods and used satisfactorily throughout the year as a source of flavor in ice cream or as fruit sundae topping. For such purposes tree ripe fruit is essential. It should be precooled, pureed without air incorporation, packed with about 25 per cent sugar, and then frozen rapidly. W.C.C.

65. Food Value of Ice Cream. J. H. FRANDSEN, Mass. State College. Ice Cream Field, *38*, No. 4: 13. 1941.

Ice Cream: A Food—Not a Fat. T. R. FREEMAN, Univ. Florida. Ice Cream Field, *38*, No. 4: 10. 1941.

Ice Cream and Better Nutrition. J. HOFFMAN ERB, Ohio State Univ. Ice Cream Field, *38*, No. 4: 10. 1941.

Ice Cream and National Emergency. W. C. COLE, Univ. California. Ice Cream Field, *38*, No. 4: 10. 1941.

Ice Cream Food Value Is Important in Advertising. P. S. LUCAS, Michigan State College. Ice Cream Field, *38*, No. 4: 10. 1941.

This series of articles on the food value of ice cream brings out the following points:

1. Ice cream is an important food source of calcium, phosphorus and the vitamins.

2. Ice cream can furnish a part of the weight increasing, or reducing diet. When consumed in addition to the regular diet ice cream increases the caloric intake; or when used to replace rich desserts of high caloric value the net caloric intake is accordingly reduced.

3. The caloric value of one quart of vanilla ice cream is compared with several other foods in terms of the amount of each required to furnish the same amount of energy.

4. The proportions of the adult nutritive requirements supplied by a 3½ oz. serving of ice cream and an 8 oz. glass of milk are given in tabular form.

5. It is pointed out that ice cream contains about 4 times the calories, slightly more mineral and serum solids and 3 times as much vitamins A and D as an equal weight of fluid milk.

6. The place of ice cream along with other dairy products in a national nutrition program is stressed.

7. Ice cream can be effectively advertised on the basis of its nutritive value. W.C.C.

66. Putting False Faces on Formulas. W. R. VAN METER, Kingston Cake Co. Food Indus., No. 10: 41–42. 1941.

You can disguise a valuable formula so that competitors cannot steal it by using arbitrary units of measurements and adopting coined names for ingredients. In the dairy and baking industry this appears to have merit as the great turnover in employment affords opportunity to carry procedures from one company to another. J.C.M.

67. New Quick Freezer Tests Foods in South. EARLE MAUDLIN. Food Indus., No. 10: 46–47. 1941.

This article deals with the experiments in freezing fruits, berries, and poultry. The experiments were conducted in five states by the T.V.A. and Georgia Experiment Stations. Much of value to the ice cream industry is contained in this article. J.C.M.

68. Dehydration Looks Up. L. V. BURTON, Editor Food Indus. Food Indus., No. 9: 53–55. 1941.

For centuries man has dehydrated meats, fish and fruits with success, but never have they had any success with dehydrated vegetables until a few years ago.

The idea came from an experience frozen vegetable companies had, *i.e.*, that you must inactivate the enzymes or else the food will change flavor. Inactivation of enzymes is also a factor in preparing fruits for use by the ice cream industry. J.C.M.

MILK

69. Refrigeration Equipment in Dairies. H. O. ROBERTS, JR., Central Power and Light Co., Corpus Christi, Texas. Refrig. Engin., *42*, No. 5: 305. 1941.

Control of bacteria by methods of refrigeration as practiced by Texas dairymen. These methods include mechanical refrigeration by means of wet storage and dry storage applications, the latter frequently employing brine circulation outside the dry storage room for precooling milk. Manufactured ice is used where electric service is not available, and it is used by producer-retailers for icing bottled milk for delivery. It is stated that under Texas conditions 0.98 kw. hr. of electricity are required per 100 lb. milk cooled, and that where electric service is available, most dairies are using some form of mechanical refrigeration. The author states that the large

wholesale dairies largely use direct expansion coolers in combination with the insulated tank. For dry storage of bottled milk among the larger distributors the unit blower-cooler is noted along with the older direct expansion coil system. L.M.D.

70. **The Use of Flavored Milk Drinks in the Dairy Industry.** GIDEON HADARY, Madison, Wis. Milk Plant Monthly, *30*, No. 1: 29–31. 1941.

Chocolate milk is the outstanding flavored milk drink despite various sporadic attempts to sell fruit-flavored milk. The ratio of chocolate to plain milk consumed by high school students was found to be 2 to 1, whereas in junior college the ratio was about 50–50. As children grow older the tendency is to drink less milk. Industrial workers prefer chocolate milk. To overcome industrial fatigue many industrial plants are introducing milk service which promises to be a potential outlet for milk sales. Little has been done in this country toward promoting fruit-flavored milk, a product which has enjoyed widespread popularity in England. States vary widely in their legal standards and definitions for chocolate milk. G.M.T.

71. **Improving the Quality of Milk Supplies in Small Communities.** C. J. BABCOCK, U. S. Dept. Agr., Washington, D. C. Milk Plant Monthly, *30*, No. 2: 28–30. 1941.

A committee report. Lack of realization of necessity of adequate sanitary control of the milk supply as well as proper pasteurization, coupled with cost of milk inspection are believed to be the factors chiefly responsible for a lower quality milk supply in the smaller communities. Pasteurization has failed in many small communities because oxidized flavor, caused by copper contamination is considered typical of pasteurized milk. The cost of sanitary control in the average municipality having local control in 1936 was reported by U. S. Public Health Service to average 7.1 cents per capita and ranging from 8 cents in the smallest municipality to 5 cents in the largest. Apparently to secure satisfactory milk supply in a small community, consciousness to the need of improving the milk supply must be awakened and some method must be devised to keep the cost of adequate milk control from being excessive. The former must necessarily be accomplished through educational means whereas the area plan of milk control and leadership supplied by the state control officials offer a possible solution to the latter. G.M.T.

72. **Homogenized Milk Is Here to Stay and Is Well Past the Experimental Stage.** L. K. CROWE, Univ. Nebraska, Lincoln, Neb. Milk Plant Monthly, *30*, No. 2: 36, 38. 1941.

Highlights in research on homogenized milk and their importance

to commercial practice are presented. Homogenization lowers protein stability; lightens the color of milk; lessens the occurrence of oxidation; induces development of rancidity in raw milk; increased sedimentation; makes fat testing by accepted Babcock procedure difficult; breaks up bacterial clumps; makes utilization of returned milk a special problem. Homogenzied milk must always be pasteurized with no lag of time between homogenization and pasteurization to prevent rancidity. The problem of sedimentation is overcome by clarification. Returns may be used in ice cream mix, chocolate milk, standardizing milk for cream or for whole milk cheese, cottage cheese, and for standardizing cream. Thermoduric bacteria may be a problem when returns are used. G.M.T.

73. **Factors Influencing the Flavor of Milk.** PAUL F. SHARP, Cornell Univ., Ithaca, N. Y. Milk Plant Monthly, *30,* No. 2: 31–34. 1941.

Flavor, involving both odor and taste, is a very important commercial and dietetic property of milk, assuming a greater role each year. The author names many of the more current off-flavors in milk and suggests that the group can be classified on the basis of the following causes: 1. microbial growth and decomposition; 2. feed; 3. absorbed; 4. chemical composition of the milk; 5. processing and handling; 6. enzymatic and catalytic.

Each group is discussed separately and general remedies for its elimination or prevention in milk are given. The paper is an excellent, brief, survey of milk flavors and a current review of some of the trends in recent research in that field. G.M.T.

74. **Homogenization of Milk by Sonic Vibration.** EDWIN P. BROWN, Mgr. Louden Hills Farms, South Montrose, Pa. Milk Plant Monthly, *30,* No. 3: 52. 1941.

Commercial experience with a sonic oscillator for homogenizing milk was favorably reported. Laboratory findings on about 100 samples revealed bacterial counts ranging from 0 to 200 per ml. The highest curd tension was 10 grams, the lowest 5 grams, and the average for the period under study was 8.5 grams. Although stabilization of emulsion was reasonably satisfactory, extremes possible in pressure homogenization were not accomplished. It was claimed that in sonic homogenization, clarification was unnecessary. G.M.T.

75. **The Physical Structure of Milk.** E. L. JACK, Univ. California. Milk Plant Monthly, *30,* No. 3: 25, 26. 1941.

The various constituents of milk are discussed from the standpoint of their size and physical relationship to each other. Despite the relatively

high water content milk is a liquid because of the size and shape of its particles. The percentage solids of many common solid foodstuffs relatively high in water are given. The properties and conditions of the constituents affecting their action in milk such as wheying and creaming are given.

G.M.T.

76. **Cereal Milk.** WAYNE H. BABCOCK, Babcock Dairy Co., Toledo, Ohio, Milk Plant Monthly, *30*, No. 4: 1941.

Cereal milk, known also as cereal cream, 10 per cent, half and half, breakfast cream and by many trade names, contains approximately 10 per cent fat and may or may not have 1 per cent of S.N.F. added in the form of fresh condensed skim milk or skim milk powder. The product is pasteurized at 150° F. and homogenized at pressure ranging from 1500 to 2000 pounds. Milk intended for cereal milk was purchased at class II or cream price. Since its introduction in Toledo in January, 1939, the average equivalent pint unit daily sales have increased from 166 to 4,584 in November, 1940, with only a three per cent drop in cream sales, which could not be attributed alone to the sales of cereal milk. Whether sales of cereal milk has hurt milk sales is debatable. G.M.T.

77. **The Value of Laboratory Control.** D. E. NOFSINGER, Richmond Dairy Co., Richmond, Va. Milk Plant Monthly, *30*, No. 5: 50–52, 70. 1941.

A plant laboratory is an aid to the manufacturing departments of a plant in producing quality and preventing waste, as well as to the sales and advertising departments. Much information concerning the product may be obtained through laboratory control. Among possible tests are those on butterfat, acidity, uniformity, keeping quality, solids-not-fat, quality of raw material, sanitation, microscopic and standard plate count, phosphatase, organoleptic, and microscopic observation of homogenized products. Proper equipment and an adequately trained man with experience are essential for satisfactory laboratory control. G.M.T.

78. **Milk and Men.** J. C. NISBET, Ohio Dairy Products Assoc. Milk Plant Monthly, *30*, No. 5: 66–69. 1941.

The requirements of the human body and the part played by milk in human nutrition are discussed and somewhat dramatized. Comparisons between calcium content of milk and other foods are given. G.M.T.

79. **Some Factors Affecting Wheying-off of Cultured Buttermilk.** LYNN R. GLAZIER AND H. G. LINDQUIST, Massachusetts State College, Amherst. Milk Plant Monthly, *30*, No. 5: 27–30. 1941.

Of the three kinds of cultured milk sold in this country, acidophilus,

Bulgarian, and lactis, the latter is most popular. Wheying-off of finished produce during storage is one of its production problems. Factors affecting wheying-off are: purity of culture; fat content; salt balance; pasteurization temperature; ripening temperature; ripening acidity; method of breaking coagulum and the storage temperature.

It was found that the higher the developed acidity, the less was the curd separation and wheying-off during storage. At acidities of 0.68 per cent wheying-off occurred freely, it was less at 0.80, but at 0.87 to 0.93 per cent it occurred only after long periods of storage. Skim milk gave less desirable results than whole milk. From the standpoint of body and texture, a pasteurization temperature of 200° F. was found to be more desirable than 180° F. Lower temperatures of pasteurization should be avoided. Storage temperatures as high as 50° F. were unsatisfactory. More desirable results were secured at a storage temperature of 33° F. Wheying-off did not occur for some time. The turnover of cultured buttermilk should be as rapid as possible if wheying-off is to be a minor problem even under best production.

G.M.T.

80. Six-day Delivery from the Plant Angle. H. D. DRAIN, Peoples Dairy Co., Akron, Ohio. Milk Plant Monthly, *30,* No. 6: 26–27. 1941.

See JOURNAL OF DAIRY SCIENCE, abstract No. 448, Vol. *24,* Page A183, July 1941; also abstract No. 644, Vol. *24,* Page A261, September 1941.

G.M.T.

81. Homogenized Milk. J. H. FRANDSEN, Massachusetts State College, Amherst. Milk Plant Monthly, *30,* No. 6: 24–27. 1941.

Advantages of homogenization stressed are: first, even distribution of the fat throughout the milk; second, marked improvement in the palatability of the milk; and third, increased digestibility of the milk. Emphasis is placed upon the necessity of a good quality milk for homogenization. Sales of homogenized milk are reported to be on the increase and will likely continue, provided milk selected for that purpose is of high quality, good flavor, and of low bacterial count and that no lowering of the fat content occurs.

G.M.T.

82. Scientific Studies on Cooling Milk on the Farm. J. ROBERTS, Investigator, Washington Committee on Relation of Electricity to Agriculture. Milk Plant Monthly, *30,* No. 7: 36–40. 1941.

In a study of various methods of cooling milk, that by mechanical refrigeration was most satisfactory; cold air was practically worthless; water below 60° F. was satisfactory for meeting the temperature requirement of grade B milk; and proper use of ice maintained a milk of low bacteria count.

Agitation both of the milk and water in the mechanical wet storage method cooled milk from 94° F. to below 50° F. in 12 to 16 minutes. The ice requirement per 100 pounds of milk for four grade A producers during July and August was 107 pounds as contrasted to 41.6 pounds for grade B producers, the cost of cooling in the former case being 38 cents per hundred pounds of milk. Insulated tanks reduced the energy consumption by 50 per cent. G.M.T.

83. Cause and Prevention of Oxidized Flavor in Milk. C. D. DAHLE, Penn. State College, State College, Pa. Milk Plant Monthly, *30*, No. 9: 29–34. 1941.

Oxidized flavor, extremely prevalent in winter months and often attributed to pasteurization, is the most common and serious flavor defect in market milk today. The cause of this defect may be associated with individual cows, feeding practices, low bacterial count, metal contamination and sunlight. Prevention lies in rejection of offending milk, correct feeding practices, homogenization, high heat treatment, elimination of copper contamination and use of antioxidants. Data are presented as well as a brief review of the subject and research studies on the problem, listing 19 references. G.M.T.

84. What You Can Do with Colloidal Stabilizers. W. C. COLE, Univ. California. Food Indus., No. 9: 44–47. 1941.

Milk is a good example of a natural oil in water emulsion. The factors responsible for its stability are the same as in an artificial emulsion. The "membrane substance" that normally surrounds the fat globules in milk and thereby stabilizes the emulsion is different from any other substance in milk, but any one of several other milk constituents could likewise act as an emulsifying agent. Stable emulsions can readily be formed by homogenizing milk fat with skim milk or with solutions of any one of several proteins present in milk.

The author also discusses "Stabilizers of Foam." J.C.M.

PHYSIOLOGY

85. Action of Progesterone on the Genital Organs of the Unprimed Rhesus Monkey. CARL G. HARTMAN AND HAROLD SPEERT, Dept. Embryology, Carnegie Instit. of Washington and Dept. of Obstetrics, Johns Hopkins Hospital. Endocrinology, *29:* 639. 1941.

Development of the mammary gland with lobular proliferation of the acini was obtained following progesterone administration. The acini were greatly increased in number and the individual cells were larger and con-

tained increased amounts of cytoplasm and round vesicular nuclei. Numerous mitotic figures were seen. These changes were most marked after 32 days of treatment with 20 mg. of progesterone daily while similar but less striking growth effects were observed with 5 mg. daily for 32 days and 20 mg. daily for 27 days. R.P.R.

86. Thyrotropic Hormone Content of Rabbit Pituitary During Growth. A. J. BERGMAN AND C. W. TURNER, Dept. Dairy Husbandry, Univ. Missouri. Endocrinology, *29:* 313. 1941.

Results were presented concerning the amount of thyrotropic hormone in the pituitaries of male and female New Zealand White rabbits during growth. Animals were grouped at 500-gm. intervals and their pituitaries assayed in day-old White Leghorn male chicks. The average amount of thyrotropic hormone per pituitary and the concentration per gram of fresh pituitary tissue increased in groups of rabbits up to 2,500 gm. As the body weights increased above 2,500 gm. there was a decrease in pituitary thyrotropin content. The thyrotropin content of pituitaries from male and female rabbits was similar and this coincided with a similar growth rate in the male and female. R.P.R.

87. Effect of Thyroidectomy of Young Male Goats upon Certain A.P. Hormones. E. P. REINEKE, A. J. BERGMAN AND C. W. TURNER, Dept. Dairy Husbandry, Univ. Missouri. Endocrinology, *29:* 306. 1941.

Eight male kids were thyroidectomized between the ages of 5 and 24 days and killed after growth stasis had appeared (4 months). Pituitaries were removed and assayed for the lactogenic, thyrotropic, gonadotropic and sugar elevating factor. Similar assays were made on pituitaries from normal kids of the same weight (but younger) and from normal kids of the same age but of normal weight. Both the lactogenic and thyrotropic hormones were present in pituitaries of thyroidectomized kids in concentrations comparable to the normals of similar age. Gonadotropic hormone concentration was lowest in the pituitaries from thyroidectomized kids and the testes showed lack of stimulation. The sugar elevating principle concentration was lowest in pituitaries from thyroidectomized kids and their pancreas showed an abnormal histological picture. Liver weights were lowest in thyroidectomized kids. R.P.R.

88. Assay of Posterior Pituitary Factors Which Contract the Lactating Mammary Gland. C. W. TURNER AND W. D. COOPER, Dept. Dairy Husbandry, Univ. Missouri. Endocrinology, *29:* 320. 1941.

An assay method for the determination of the quantity of a factor present in the posterior lobe of the pituitary which causes the contraction of the

smooth muscles of the lactating mammary gland was described. A unit of the extract was defined as the minimal amount of substance which upon intravenous injection into an unnursed lactating rabbit would cause a minimal contraction of the mammary gland within 40 seconds. In commercial pituitrin a unit response was obtained with 0.001 U of the international standard of oxytocic hormone whereas in the pitocin reported to contain the same number of oxytocic units 0.00182 U were required. The assay of pitressin indicated a unit effect with 0.005 U of pressor hormone. It was suggested that either both oxytocic and vasopressin factors combine to cause the contraction of the mammary gland or a third factor is involved which is present in pitocin and pitressin in varying proportions. R.P.R.

89. **The Effect of Estrogens, Gonadotropins and Growth Hormone on the Mammary Glands of Hypophysectomized Rats.** RALPH P. REECE AND SAMUEL L. LEONARD, Dept. Dairy Husbandry, New Jersey Agr. Expt. Sta., and Dept. Zoology, Rutgers Univ. Endocrinology, *29:* 297. 1941.

Confirmatory evidence was presented which showed that injected estrogens would not induce mammary growth in hypophysectomized normal and castrated male, and castrated female rats. Endogenous estrogens produced by injecting pregnancy urine and menopause urine extracts or by hypophyseal follicle stimulating hormone likewise failed to stimulate the glands. In the latter group, the body weights increased slightly even though hypophysectomy was considered complete. Growth hormone alone was able to stimulate mammary growth to a slight extent in hypophysectomized males. Growth hormone injected simultaneously with estrogen resulted in mammary stimulation similar to that obtained with estrogen in normal males. In general there was a positive correlation between the increase in body weight and the degree of mammary stimulation when both hormones were injected. Sometimes the rats failed to grow but qualitatively the effects of estrogen were still manifested. It was suggested that either estrogen facilitates the action of the mammogenic factor contained in the growth hormone or that the growth hormone with its mammogenic factor facilitates the action of estrogen on the mammary glands. R.P.R.

90. **Biological Assay of the Mammogenic Lobule—Alveolar Growth Factor of the Anterior Pituitary.** JOHN P. MIXNER AND CHARLES W. TURNER, Dept. Dairy Husbandry, Univ. Missouri. Endocrinology, *29:* 324. 1941.

A technic was reported for the assay of the mammogenic lobule-alveolar growth factor of the anterior pituitary. A mouse unit of the lobule-alveolar growth factor was defined as the total amount of material required per mouse

when injected subcutaneously daily for 10 days to produce definite lobule-alveolar development in 50 ± 10 per cent of 10 or more castrate, nulliparous, female mice weighing between 12 and 18 gm. Increasing dosages of various cattle pituitary lots did not show strictly quantitative relationships. When progesterone, however, was assayed very good quantitative results were obtained. R.P.R.

91. Uterine Distention and Lactation. JAMES T. BRADBURY, Bureau of Dairy Industry, U.S.D.A. Endocrinology, *29:* 393. 1941.

Distention of the uterus with paraffin (melting point 42° C.) during the first 24 hours after normal delivery did not prevent lactation in the rat. It was believed that the operative technique was so hard on the mother that she neglected the new-born young until they did not have sufficient strength to suckle and died of starvation. When the postpartum rat was given a vigorous foster litter normal weight gains were observed. R.P.R.

92. The Effect of Glycolysis Inhibitors and of Certain Substrates on the Metabolism and Motility of Human Spermatozoa. JOHN MACLEOD, Dept. Anatomy, Cornell Univ. Med. College. Endocrinology, *29:* 583. 1941.

Monoiodoacetate and fluoride inhibited the aerobic and anaerobic glycolysis of human spermatozoa and had a correspondingly depressing effect upon motility. Motility was found dependent upon the energy derived from the breakdown of sugar to lactic acid. No other substrates were effective. When spermatozoa were suspended in glucose-free Ringer's solution at 38° C. initial glycolysis was low and ceased completely within 3 hours. The normal level of glycolysis and rate of motility could be restored if a utilizable sugar was added to the medium within 2 hours after deprivation of substrate. Under anaerobic conditions lactic acid production in the presence of glucose remained linear for 4 hours but under aerobic conditions lactic acid production tended to decrease with time. R.P.R.

93. Growth Response of Thyroidectomized Goats to Artificially Formed Thyroprotein. E. P. REINEKE AND C. W. TURNER, Dept. Dairy Husbandry, Univ. Missouri. Endocrinology, *29:* 667. 1941.

The effect of thyroidectomy on the growth and body conformation of young male goats together with evidence of alleviation of the symptoms by the oral administration of an artificial thyroprotein in small amounts was reported. Goats thyroidectomized during the first month of life reached a complete growth stasis one to two months after operation. Growth stasis was accompanied by typical symptoms of cretinism. The feeding of a thyroprotein, arrested the development of cretinism and stimulated nearly nor-

mal growth. Growth was roughly proportional to the amount of thyroprotein fed. R.P.R.

94. Annual Variation in the Response of Crop-Sacs and Viscera of Pigeons to Prolactin. ROBERT W. BATES AND OSCAR RIDDLE, Carnegie Instit. of Washington. Endocrinology, *29:* 702. 1941.

The crop-sacs of 24 groups of 10 young White Carneau pigeons injected at intervals over a period of 2 years showed a semi-annual cyclic variation in their weight response to a 2.0 mg. (28 I.U.) dosage of the same prolactin preparation. The prolactin dosage used increased body weight over that of the controls by 4 per cent. Weight of pancreas was increased by 26 per cent; liver by 29 per cent; and intestine by 36 per cent. Testicular, thyroid, adrenal, and heart weight were not significantly affected by the treatment with prolactin while adrenal and heart weight showed no obvious cyclical or seasonal change. R.P.R.

95. Failure to Find Sodium Pregnanediol Glucuronidate in Bull's Urine. HERBERT S. STRICKLER, M. EVELYN WALTON AND DONALD A. WILSON, Dept. Chem., Univ. Pittsburgh and the Endocrine Lab., Elizabeth Steel Magee Hospital. Soc. Expt. Biol. and Med. Proc., *48:* 37. 1941.

No sodium pregnanediol glucuronidate was found in the urine obtained from the bladders of 4 freshly slaughtered bulls and 2 steers when Venning's method was used. The volumes of urine (1360, 840, 320, 300, 480, and 1060 cc.) were judged sufficient for demonstration of this substance if it were present in the amount suggested by previous reports for pregnanediol 3a, 20a from hydrolyzed bull's urine. R.P.R.

96. Effect of Diethylstilbestrol Dipropionate on Mammary Development and Lactation. SHEPPARD M. WALKER AND ALLAN J. STANLEY, Dept. Zoology, Louisiana State Univ. Soc. Expt. Biol. and Med. Proc., *48:* 50. 1941.

A castrate Jersey heifer at 12 months of age was injected over a period of 9 months with a total of 1560 mg. of diethylstilbestrol dipropionate and 530 mg. of testosterone propionate. At the end of 9 months injections were withdrawn and daily milking was begun. Milk secretion increased gradually for the first 50 days and then leveled off. The peak daily production during the first 100 days was 8 lbs. The administration of diethystilbestrol dipropionate twice during the lactation period resulted in a sudden, slight increase in milk yield followed by a decrease and then an increase. Following the second treatment milk yield increased to 16 lbs. daily. A sterile 3-year-old heifer was injected with a total of 350 mg. of diethylstilbestrol

dipropionate over a 90-day period and milking then begun. Milk yield increased to 3.7 lbs. per day during the first 30 days. Diethylstilbestrol was then re-administered and milk yield eventually increased to 14 lbs. per day. The administration of diethylstilbestrol dipropionate to castrate and intact rats resulted finally in lactation suppression which was more pronounced in intact than in castrate animals. There was a premature opening of the vagina at 12 days of age of the young nursing treated rats which indicated that estrogen was secreted in the milk and also that the hormone was not readily attacked by any of the enzymes of the rat. R.P.R.

97. Effects of Estrone and Progesterone on Male Rabbit Mammary Glands. I. Varying Doses of Progesterone. WM. R. LYONS AND DANIEL A. MCGINTY, Div. Anatomy, Univ. California and Res. and Biol. Labs., Parke, Davis, and Co. Soc. Expt. Biol. and Med. Proc., *48:* 83. 1941.

Groups of immature male rabbits were injected with varying doses (0.25, 1.0, 4.0, and 8.0 I.U.) of crystalline progesterone simultaneously with 120 I.U. of estrons for 18 injection days (injections made Monday through Friday). Of these 4 levels of progesterone, the 1.0 I.U. dose synergized best with the 120 I.U. of estrone, although lobule—alveolar development was not maximal. The 4.0 and 8.0 I.U. doses of progesterone appeared to inhibit mammary gland growth. R.P.R.

98. Effects of Estrone and Progesterone on Male Rabbit Mammary Glands. II. Varying Doses of Estrone. GEORGE SCHARF AND WM. R. LYONS, Div. Anatomy, Univ. California. Soc. Expt. Biol. and Med. Proc., *48:* 86. 1941.

Six groups of immature male rabbits were injected 5 days weekly for 5 weeks with 30, 60, 120, 240, 480, and 960 I.U. of estrone respectively. The animals receiving 120 I.U. showed the best duct growth while the animals receiving 30 and 60 I.U. showed slightly less extensive duct systems and the higher levels caused cystic changes in the main ducts. The same 6 levels of estrone were injected into 6 other groups of male rabbits plus 1 I.U. of progesterone for a similar period. In every case lobule-alveolar growth of the mammary glands occurred and there was no tendency toward cyst formation even in the animals receiving the highest dosage of estrone. The best lobule-alveolar development was noted in the groups receiving 1 I.U. of progesterone plus 240 and 960 I.U. of estrone respectively. R.P.R.

99. Dietary Requirements for Fertility and Lactation. XXVIII. The Lactation-Promoting Properties of Cystine when Added to Casein Diets. B. SURE, Dept. Agr. Chem., Univ. Arkansas, Fayetteville. Jour. Nutr., *22:* 491–498. 1941.

The lactation-promoting properties of lard, butterfat, hydrogenated

cottonseed oil, olive oil, and hydrogenated cottonseed oil in combination with wheat germ oil incorporated to the extent of 15 per cent on two types of salt mixtures were studied. The diets contained 17.7 per cent purified casein and 3.7 per cent protein derived from dehydrated bakers yeast as sources of the vitamin B complex.

Regardless of the nature of the oils or fats, or the composition of the salt mixture such diets did not meet the demands for lactation. When the diets were fortified with 0.2 per cent cystine lactation proceeded successfully and the young were weaned, although the diets supplied about 0.6 per cent methionine. C.F.H.

100. Dietary Requirements for Fertility and Lactation. XXIX. The Existence of a New Dietary Factor Essential for Lactation. B. SURE, Dept. Agr. Chem., Univ. Arkansas, Fayetteville. Jour. Nutr., *22:* 499–514. 1941.

Diets adequate for normal growth of young rats may be deficient in factors required for reproduction and lactation. When diets supplemented by pure thiamine, riboflavin, pyridoxine, choline, pantothenic acid, nicotinic acid and "W" factor from liver extracts which did not support normal lactation were supplemented with Brewers' yeast, dried grass, liver extracts or rice bran extracts, efficient lactation resulted. When the rice bran extract was ashed no lactation activity was manifested which indicated that a new lactation factor was organic in nature. The author concluded that para-aminobenzoic acid or a related compound is a component of the new factor. Preliminary data suggest that inositol may also be a component. C.F.H.

101. Implantation Following Mating in Hypophysectomized Rats Injected with Lactogenic Hormone. EUGENE CUTULY, Dept. Anatomy, Wayne Univ. Soc. Expt. Biol. and Med. Proc., *48:* 315. 1941.

Fourteen rats which had been hypophysectomized 1 to 5 days following mating were injected daily with 1 to 3 mg. of lactogenic hormone. Implantation failed to occur in 4 animals. Of the remaining 10 animals 2 carried to term or beyond while pregnancy was interrupted in 8 rats after 6–17 days. The results seemed to indicate that the lactogenic hormone was capable of stimulating corpus luteum function. R.P.R.

MISCELLANEOUS

102. Desiccation of Products Stored at Low Temperatures. J. G. WOODROOF, Food Technologist, Georgia Agr. Expt. Sta. Refrig. Engin., *42,* No. 6: 383. 1941.

Desiccation, or drying out, of stored frozen products is a major problem

of the frozen foods industry. Warm air coming in contact with refrigerating coils in a room gives up a part of its moisture, depositing it as frost on the coils. This less-than-saturated air coming in contact with the walls of the room and the surfaces of the product stored in the room tends to absorb moisture. On rising to the coils, the cycle is complete with additional moisture frozen to the coils. Thus the slowly moving air is the means of constantly drying the product.

Desiccation can be prevented only by protecting the product against surface evaporation. The rate of evaporation varies directly with the temperature and inversely with the relative humidity. A widely fluctuating temperature is the biggest single cause of drying out of frozen products. When this prevails there is a constant migration of water from the warmer portion of the container to the colder side. This may occur in a hermetically-sealed glass jar or can be evidenced by deposits of ice crystals on one side or under the lid. Methods of preventing desiccation in frozen products may be considered as:

1. Plant design—provide ante-room between any two rooms carrying temperatures more than 30° F. apart.
2. Provide humidifiers, as supplementary equipment.
3. Maintain as nearly as possible a constant and uniform temperature—never use storage room for freezing products.
4. Carry very low temperature—minus 20° F. or lower.
5. Use impervious materials as packages—as tin, glass, latex, coated cellophane, coated parchment, and others.
6. Surface treat or "glaze" the product during or immediately after freezing.
7. Avoid alternate thawing and refreezing the product in any degree whatever.
8. Avoid excessive circulation of air in the storage room. Strawberries and peaches are very susceptible to desiccation. The author found the most efficient treatment to be immersion freezing in invert syrup. In the case of strawberries, the sweet acid taste of the syrup blends with that of the berries. Glycerine has been found suitable for both fruits and vegetables in developing a glaze, it being practically inert to taste and can be used either as an acid or alkaline solution.

L.M.D.

103. **Air Motion in Refrigerated Spaces.** V. Floyd Self, Anemostat Corporation of America, New York, N. Y. Refrig. Engin., *42*, No. 5: 291. 1941.

The author indicates the necessity for creating a turbulence to break up incoming air mass into the multiplicity of smaller masses or streams and to bring other small masses—or streams—of the room air between the masses

of the incoming air. In refigerating rooms the most practical method for obtaining intermingling or diffusion is to introduce the incoming cold air at the top of the room, enabling the force of gravitation to augment the static pressure which has replaced the energy of velocity, and to cause the conditioned air to flow down through the product, eliminating stratification. L.M.D.

104. Economic Operation of Batch Extractors. W. L. FAITH, W. J. PETERSON AND MORTON SMUTZ, Kansas State College. Food Indus., No. 10: 43–45. 1941.

In recent years the addition of small amounts of chemical substances to foods has been increasingly important. Examples of this are the addition of vitamins and removal of alkaloids. J.C.M.

105. Four Basic Factors in Detergency. FOSTER DEE-SUELL, Foster Dee-Suell, Inc. Food Indus., No. 10: 48–50. 1941.

Getting equipment and containers really clean is largely a matter of the correct choice and utilization of cleaners.

The known factors of detergency are: 1. Initial alkalinity or pH of the detergent solution. 2. Total alkalinity or buffer value of the detergent solution. 3. Effect in lowering of interfacial tension between the foreign matter and water. 4. Deflocculating and emulsifying power.

The author goes on to elaborate on these four points. J.C.M.

106. Why France Goes Hungry. SIDNEY JAFFE, New York, N. Y. Food Indus., No. 9: 39–40. 1941.

Before the fighting began in the fall of 1939, farm labor was mobilized. These men lying idle ate heavily into the existing food supply. Then came the battle which destroyed electric systems throughout the country and smashed dairy farms.

One of the main reasons why Paris isn't getting milk is because there is not enough fodder to keep the cattle alive, and also because the cattle are slaughtered for want of feed and food for human use. J.C.M.

107. How To Tell What Color It Is. GORDON W. MCBRIDE, Washington, D. C. Food Indus., No. 9: 41–44. 1941.

The spectrophotometer, as long as it is in calibration, gives reproducible data and thereby provides a means of longtime comparison. This instrument can detect the slightest variation in color. J.C.M.

108. Lend Lease and Defense Increase Food Demand. G. L. MONTGOMERY. Food Indus., No. 9: 62–63. 1941.

While increasing quantities of food are likely to be shipped to Great

Britain and other anti-axis countries, only certain products will be affected. Milk products will be in greatly increased demand, particularly butter, cheese and evaporated milk. Milk production in this country is the highest ever recorded. However, in spite of the favorable factors there is not going to be enough milk to supply the prospective demand. If milk is to be shipped abroad to meet the demand, consumption in this country will be restricted and dairy products processors will need to increase their manufacturing capacities. In spite of defense, it is likely that priorities will be granted for this purpose, considering the importance of dairy products among overseas food needs. J.C.M.

109. Reliability of Organoleptic Tests. J. W. CRIST AND H. L. SEATON, Michigan State College of Agr., East Lansing, Mich. Food Res., *6*, No. 5 : 529. September–October, 1941.

A mathematical consideration of the reliability of tasting and smelling which casts some doubt on the usefulness of "tasting panels." F.J.D.

AMERICAN DAIRY SCIENCE ASSOCIATION

INCORPORATED IN THE DISTRICT OF COLUMBIA

Officers

President ..... HENRY F. JUDKINS, New York, New York
Vice-President ..... HERBERT P. DAVIS, Lincoln, Nebraska
Secretary-Treasurer ..... R. B. STOLTZ, Columbus, Ohio
Editor ..... T. S. SUTTON, Columbus, Ohio
Director ..... G. MALCOLM TROUT, East Lansing, Michigan
Director ..... J. C. KNOTT, Pullman, Washington
Director ..... HOWARD B. ELLENBERGER, Burlington, Vermont
Director ..... ARTHUR C. DAHLBERG, Geneva, New York
Director ..... C. N. SHEPARDSON, College Station, Texas
Director ..... FORDYCE ELY, Lexington, Kentucky
Director ..... HARRY W. CAVE, Stillwater, Oklahoma

Officers of Sections

DAIRY PRODUCTION SECTION

Chairman ..... H. A. HERMAN, Columbia, Missouri
Vice-Chairman ..... K. L. TURK, College Park, Maryland
Secretary ..... DWIGHT L. ESPE, Ames, Iowa

DAIRY MANUFACTURING SECTION

Chairman ..... L. H. BURGWALD, Columbus, Ohio
Vice-Chairman ..... R. WHITAKER, Baltimore, Maryland
Secretary ..... KENNETH G. WECKEL, Madison, Wisconsin

DAIRY EXTENSION SECTION

Chairman ..... GLEN W. VERGERONT, Madison, Wisconsin
Vice-Chairman ..... J. F. KENDRICK, Washington, D. C.
Secretary ..... E. C. SCHEIDENHELM, East Lansing, Michigan

Officers of Divisions

SOUTHERN

Chairman ..... C. D. GRINNELLS, Raleigh, North Carolina
Vice-Chairman ..... R. B. BECKER, Gainesville, Florida
Secretary-Treasurer ..... J. P. LAMASTER, Clemson, South Carolina

EASTERN

Chairman ..... K. S. MORROW, Durham, New Hampshire
Vice-Chairman ..... H. C. MOORE, Durham, New Hampshire
Secretary-Treasurer ..... L. R. DOWD, Storrs, Connecticut

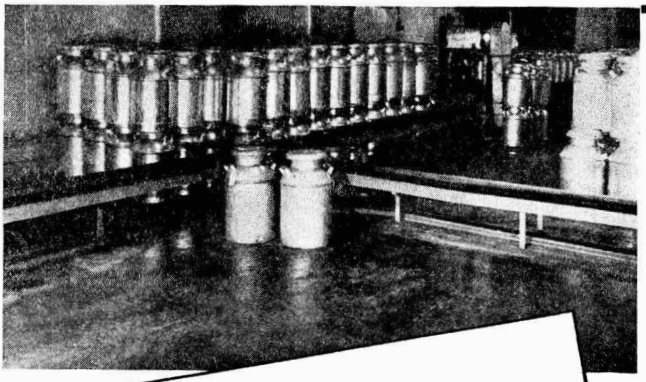
WESTERN

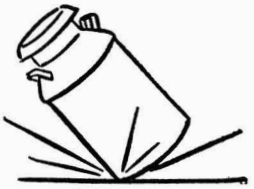
Chairman ..... D. L. FOURT, Moscow, Idaho
Vice-Chairman ..... N. S. GOLDING, Pullman, Washington
Secretary-Treasurer ..... H. P. EWALT, Corvallis, Oregon

The American Dairy Science Association was organized to advance the general welfare of the dairy industry, especially by the improvement of dairy instruction by the stimulation of scientific research in all phases of the subject and by improvement in methods of conducting extension work.

Membership. Any person is eligible to membership who is formally announced by an Agricultural College or Experiment Station, or by the Bureau of Dairy Industry of the United States Department of Agriculture or by the Canadian Department of Agriculture as an instructor, extension worker, investigator, or administrative officer connected with the dairy industry, or any person filling a position of responsibility connected with the dairy industry who has had a college or university training in technical science, or any person filling a responsible position in the dairy industry of a professional character requiring a technical knowledge of dairying of a high order. The membership fee is $5.00.

The dues are $5.00 a year, $3.00 of which is for a year's subscription to the *Journal of Dairy Science*. Correspondence regarding membership and dues should be addressed to R. B. Stoltz, Ohio State University, Columbus, Ohio.





Resists Abusive Impacts

Reduces Slipping Hazards

AT LAST ...THE PERFECT ANSWER TO THE PROBLEM OF Durable Non-Slip Dairy Floors

Low in cost . . . easy to install . . . attractive . . . EMERY AGGREGATE brings new safety and economy to dairies. Almost as hard as a diamond . . . EMERY AGGREGATE provides a hard, dense floor surface that can stand constant abusive impacts. A thousand cans a day are dropped on the floor shown above. Yet it shows no deterioration after more than a year of this smashing wear.

EMERY AGGREGATE floors provide a safe, non-slip working surface under all dairy operating conditions. EMERY AGGREGATE floors never wear smooth —moisture does not reduce gripping surface. They resist lactic acid solutions much longer than any other material comparable in cost, durability and safety.

EMERY AGGREGATE

HARD . . . DENSE . . . ACID-RESISTING

Scientifically graded EMERY AGGREGATE can be used effectively for Loading Platforms, Receiving Rooms, Truck Runways, Pasteurizing, Processing, Churn and Bottling Rooms. Attractive appearance recommends its use in Offices, Lobbies and Retail Store Rooms. Write for Bulletin.

THE CREAMERY PACKAGE MFG. COMPANY

1243 West Washington Boulevard, Chicago, Illinois

Branches: Atlanta — Boston — Buffalo — Chicago — Dallas — Denver — Kansas City — Los Angeles — Minneapolis — New York — Omaha — Philadelphia — Portland, Oregon — Salt Lake City — San Francisco — Seattle — Toledo — Waterloo, Iowa.

Creamery Package Mfg. Co. of Canada, Ltd.
267 King St., West, Toronto, Ont., Canada

The Creamery Package Mfg. Company, Ltd.,
Avery House, Clerkenwell Green, London, E. C. 1, England