JOURNAL OF DAIRY SCIENCE

Contents

Vol. XXXVIII, No. 8, August, 1955

Published by the

AMERICAN DAIRY SCIENCE ASSOCIATION

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION

P. H. TRACY, *Editor*
Editorial Office: Department of Food Technology, University of Illinois, Urbana, Ill.

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Printed by The Garrard Press, 119-123 West Park Avenue, Champaign, Illinois. Entered as second-class matter at the post office at Champaign, Illinois, under the act of March 3, 1879.

JOURNAL OF DAIRY SCIENCE

VOLUME XXXVIII August, 1955 NUMBER 8

A QUANTITATIVE PROCEDURE FOR THE DETERMINATION OF AN INHIBITORY SUBSTANCE IN MILK—PENICILLIN[1]

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During the past few years antibiotics have been successfully used for the treatment of bovine mastitis. A secondary phase of the use of antibiotics is concerned with the adverse effect of using the milk from antibiotic-treated cows in the manufacture of milk products requiring acid production. Doan *(2)*, Hansen *et al. (3)*, Jørgensen *(4)*, Krienke *(5)*, Petersen *(6)*, and Yahraes *(10)* have demonstrated the inhibition of *Streptococcus lactis* by the residual antibiotic.

Several qualitative methods for the detection of antibiotics in milk are available, but they require a great deal of time and do not always detect the lower concentration, which could prove detrimental to fermentative processes. Krienke *(5)* and Ruehe *(7)* used an active starter culture added to previously heated milk, and the degree of acid production was used to indicate the presence of antibiotics. Stoltz and Hankinson *(8)* used a measure of phosphatase activity as their criterion for the presence of antibiotics.

Vincent and Vincent's quantitative method *(9)* for blood analysis has been adapted to determine quantitatively the amount of antibiotics in milk *(1)*. This method utilizes the inhibiting effect of milk containing the antibiotic on *Bacillus subtilis*. A measure of a "haloed" zone is correlated with the concentration of the antibiotic. The method requires from 4 to 6 hours for completion.

The method herein described for the quantitative estimation of penicillin is based upon the ability of this antibiotic to inhibit the production of nitrite from nitrate by an actively growing culture of *Micrococcus pyogenes* var. *aureus*.[3] The decreased nitrite production, as compared to a control, can be measured colorimetrically following diasotization of sulfanilic acid and coupling with alpha naphthylamine hydrochloride. The test can be completed in 2 hours.

REAGENTS

20% sodium nitrate solution.

15% trichloroacetic acid solution.

Sulfanilic acid solution—1 g. of sulfanilic acid is dissolved in hot distilled

Received for publication July 1, 1954.

[1] A portion of these data was presented by the senior author in a thesis to the Graduate School, University of Connecticut, in partial fulfillment of the requirements for the Ph.D. degree, 1954.

[2] Present address: Whiting Milk Company, Boston, Mass.

[3] Culture ♯254 Department of Bacteriology, University of Connecticut.

nitrite-free water. The solution is cooled and made up to a volume of 100 ml. with distilled nitrite-free water.

Alpha naphthylamine hydrochloride solution—0.5 g. of the reagent is refluxed for 10 minutes with 100 ml. of water.

Nutrient agar slants—2.3% nutrient agar and 6% sodium chloride (reagent grade) are dissolved in water by heating. Five ml. of the resulting solution is placed in a 6 × 5/8 in. test tube, plugged with cotton, and sterilized in an autoclave at 121° C. for 10 minutes. The tubes are placed in an incline to form the slant.

Nutrient broth—2% Bacto Peptone (Difco standardized "Granular") and 6% sodium chloride (reagent grade) are dissolved in water. One hundred ml. of this solution is placed in a 250-ml. Erlenmeyer flask, plugged with cotton, and sterilized in an autoclave at 121° C. for 15 minutes.

Standard antibiotic solutions—3,000 ml. of fresh, antibiotic-free skimmilk was sterilized and then inoculated with 300,000 Oxford units of penicillin (sodium salt). This gives a concentration of 100 Oxford units per milliliter and serves as a stock solution. The various concentrations of penicillin used in this investigation were a dilution of this stock solution.

PROCEDURE

Nutrient agar slants were streaked with a culture of *M. pyogenes* var. *aureus* and incubated at 37° C. for 24 hours. Then approximately 5 ml. of the nutrient broth from a 250-ml. Erlenmeyer flask was poured into the incubated slant. All growth on the slant was cleared by means of a wire loop, and the growth was suspended in the broth. The broth was then poured into the original 250-ml. Erlenmeyer flask and incubated for 14 hours at 37° C. The resulting suspension served as the test organism used in the analysis.

Ten ml. of the suspected milk samples were accurately pipetted into a 6 × 5/8 in. test tube. Ten ml. of an antibiotic-free skimmilk were accurately pipetted into a second test tube. To this control and the suspected sample, 0.1 ml. of 20% sodium nitrate solution and 5 ml. of the suspension of organisms were added. After thorough shaking, the tubes were tempered to 37° C. and incubated for 90 minutes. After incubation, 1 ml. of 15% trichloroacetic acid solution was added. The tubes were shaken and allowed to stand for 1 minute. The contents of the tubes were then filtered through No. 40 Whatman filter paper. Five ml. of the filtrate and 5 ml. of nitrite-free distilled water were pipetted into a 6 × 5/8 in. test tube and placed in an ice-water bath. One ml. of the sulfanilic acid solution was added to each tube and allowed to stand for 5 minutes. One ml. of the alpha naphthylamine hydrochloride solution was added to each tube and allowed to stand for 5 minutes. The color intensity was measured by a Klett-Summerson photoelectric colorimeter using Filter No. 56.

The Klett-Summerson colorimeter readings were used to obtain a standardized value as shown in the following formula:

$$\frac{\text{Colorimeter reading of suspected sample}}{\text{Colorimeter reading of control}} \times 100 = \text{standardized value}$$

METHODS

A series of skimmilk samples was prepared by diluting the standard stock solution of penicillin-treated skimmilk with fresh, antibiotic-free skimmilk. The concentrations of penicillin varied in an arithmetic progression from 0 to 3 Oxford units per milliliter and differed from each other by 0.1 Oxford unit per milliliter. Seven replications of the above procedure were performed.

The standardized values for each concentration were averaged arithmetically, and a regression line was calculated by the method of least squares, using the logarithmic values of the concentration of penicillin and mean standardized values.

The inhibitory effect of penicillin on acid production by *S. lactis* was determined with the method proposed by Krienke *(5)*. The data are the average of seven replications, which were carried out simultaneously with the determination for the presence of penicillin.

TABLE 1

The effect of the concentration of penicillin on the standardized colorimeter value

Concentration of penicillin	Mean Klett-Summerson colorimeter reading	Mean standardized value	Logarithm of the concentration of penicillin	Logarithm of the mean standardized value
(Oxford units per ml.)				
0.0	292	100.0	———	———
0.1	286	98.1	−1.0000	1.9917
0.2	249	85.4	−0.7990	1.9315
0.3	227	77.7	−0.5119	1.8904
0.4	218	74.5	−0.3979	1.8722
0.5	211	72.4	−0.3010	1.8597
0.6	206	70.5	−0.2219	1.8482
0.7	201	68.8	−0.1549	1.8376
0.8	194	66.5	−0.0969	1.8228
0.9	192	65.7	−0.0458	1.8176
1.0	189	64.8	0.0000	1.8116
1.1	188	64.4	0.0414	1.8089
1.2	185	63.4	0.0792	1.8021
1.3	183	62.6	0.1139	1.7966
1.4	181	62.1	0.1461	1.7931
1.5	181	61.9	0.1761	1.7917
1.6	180	61.7	0.2041	1.7903
1.7	179	61.2	0.2305	1.7868
1.8	178	61.0	0.2553	1.7853
1.9	176	60.8	0.2788	1.7839
2.0	177	60.5	0.3010	1.7818
2.1	176	60.4	0.3222	1.7810
2.2	175	60.0	0.3424	1.7782
2.3	175	59.9	0.3617	1.7774
2.4	175	59.9	0.3802	1.7774
2.5	175	59.9	0.3979	1.7774
2.6	174	59.7	0.4150	1.7760
2.7	174	59.6	0.4314	1.7753
2.8	173	59.4	0.4472	1.7738
2.9	173	59.2	0.4624	1.7723
3.0	173	59.1	0.4771	1.7716

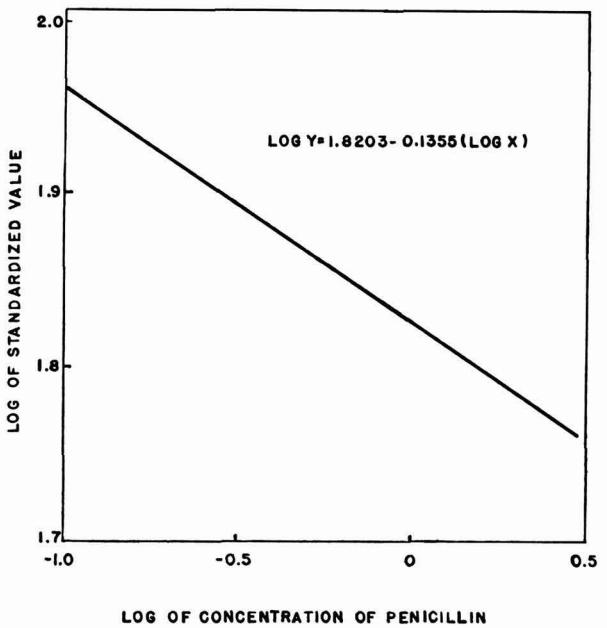

FIG. 1. The logarithmic relationship between the standardized value and the concentration of penicillin.

RESULTS

The mean standardized values from the 31 concentrations of penicillin-treated milk are given in Table 1. These are based on the seven replications performed on each sample. The mean Klett-Summerson colorimeter reading, the logarithm of the concentration of penicillin, and the logarithm of the mean standardized value also are shown in Table 1.

The regression line calculated by the method of least squares with the data in Table 1 is shown in Figure 1. The logarithm of the mean standardized value was considered the dependent variable and the logarithm of the concentration was considered as the independent variable. The regression line fitted to the data has the equation: $\log Y = 1.8203 - 0.1355 \log X$, where Y is the mean standardized value and X is the concentration of penicillin in Oxford units per milliliter. This logarithmic type curve was chosen to represent the data instead of the usual polynomial type curve to facilitate ease in the calculation of the concentration of penicillin from the standardized value. By using the logarithmic type curve, a straight line was obtained. With a straight line, a given amount of change in X always brings a constant amount of change in Y.

To calculate the concentration of penicillin from the standardized value Y, substitute the logarithm of the standardized value ($\log X$) in the following equation: $\log X = \dfrac{1.8203 - \log Y}{0.1355}$. Then by finding the antilog for the value

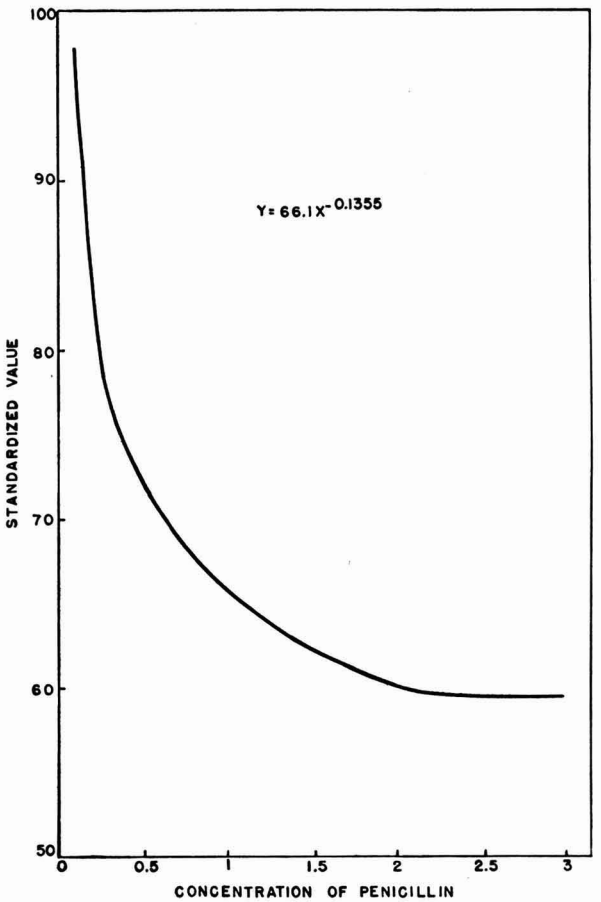

FIG. 2. The standard curve for the determination of penicillin in milk.

calculation (log X), the concentration of penicillin in Oxford units per milliliter is obtained directly. The equation for the regression line can alternately be written: $Y = 66.1X - 0.1355$. The regression curve for this equation can be seen in Figure 2.

The value, X is equal to 0, was not embraced in the calculation of the regression line, since the standardized value should be equal to 100, and a value for the log X, when X is equal to 0, is minus ∞. Therefore, the equation does not hold true for this value. It should be assumed in this case that the penicillin concentration is equal to 0, and the standardized value is equal to 100.

The inhibitory effect of penicillin on acid production by *S. lactis* may be noted in Table 2. Lactic acid production was completely inhibited by 0.5 Oxford units per milliliter. The test is applicable for this range. However, for concentrations higher than 1.0 Oxford units per milliliter the precision of the proposed determination slowly decreases.

TABLE 2
The effect on acid production on adding penicillin to milk

Oxford units per ml.	Increase in acidity[a]		
	2 hours	at 3 hours	4 hours
0.0	0.04	0.10	0.22
0.1	0.04	0.09	0.20
0.2	0.02	0.07	0.17
0.3	0.02	0.06	0.12
0.4	0.01	0.02	0.06
0.5	0.01	0.01	0.01
0.6 to 3.0	0.00	0.00	0.00

[a] Acidity of the control at 0 hours was 0.18%.

SUMMARY

A quantitative determination for penicillin in milk has been described. The test is accurate for concentrations less than 1.0 Oxford unit of penicillin per milliliter. In concentrations higher than 1.0 Oxford unit per milliliter the precision of the test slowly diminishes. The presence of 0.5 Oxford unit of penicillin per milliliter resulted in complete inhibition of acid production. As little as 0.1 Oxford unit per milliliter caused partial inhibition. The test is applicable for the critical range of penicillin in milk (0-0.5 Oxford unit per milliliter).

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FAT EXTRACTION FROM MILKER RUBBER WITH LYE SOLUTIONS

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Milking machine rubber parts, especially inflations, are known to gain weight and to increase in size with use. These changes are brought about largely through fat absorption and subsequent oxidation. Moir *(3)* found that discarded rubber inflations usually contain 10% by weight of butterfat and in certain portions as much as 30%. Investigators agree that fat absorption is not prevented by normal cleaning practices. Whittlestone *(4)* and Gardner and Berridge *(1)* concluded that absorbed fat could be removed practically only by saponification. This, according to Whittlestone, "requires impractical temperatures, times, and concentration of chemicals."

Moir *(3)*, first to recommend hot lye solutions for the removal of fat from rubber, directed that inflations be held in solutions of about 4% strength and at 190-200° F. for a 3- to 5-hour period. Either metasilicate of soda or a soda mixture was used in the solution to soften the water. Popular recomendations propose periodic boiling of used inflations in about a 1% lye solution for 10 to 15 minutes. Jensen *(2)* recommended weekly boiling of rubber parts for 15 minutes in a 2% lye solution.

This study was made for the purpose of determining the practicability of extracting absorbed butterfat from rubber with varying concentrations of cold and boiling lye solutions.

EXPERIMENTAL PROCEDURE

Four basic unused rubbers were used in these studies: *(a)* latex, designated as A; *(b)* a composite of latex and synthetic rubber, B; *(c)* Buna-N, C; and *(d)* neoprene, D. Five varieties of B were used, designated as Ba, Bb, Bc, Bd, and Be, and two kinds of C, designated as Ca and Cb. Rubbers A and D were available for study only in the pure form.

The rubber was cut into pieces approximately ¼ in. square. These pieces were weighed, then soaked in freshly prepared butter oil for periods of 3 to 7 days. The rubber was washed to remove all surface-adhering fat and dried on moisture-absorbent paper, with a 10-minute finish-drying in a 100° C. oven at 24-25 in. vacuum. The rubber was then reweighed. The percentage of fat in the rubber was determined by dividing the net gain in weight by the weight of the fat-treated rubber. All increase in weight was attributed to fat absorption, since preliminary tests showed that only a minute increase in weight resulted from storing or by boiling new or fat-absorbed rubber in a lye or detergent solution.

Extraction of fat from the fat-treated rubber was made by boiling or by 7-day soaking in cold lye solution, 70° F., of various concentrations as indicated.

Received for publication December 8, 1954.

The extracted product is referred to as soap, since it possessed all the characteristics of that product. Extraction of fat was made first on large quantities of fat-treated rubber. Later, studies were made on 10-g. lots of rubber soaked in butter oil. The percentage of fat absorption was determined as previously mentioned. Lewis lye was used for all extractions. Solutions of 5, 7.5, and 10% concentration gave Baumé readings at 60° F. of 7.30, 10.40, and 13.2, respectively. Extractions of fat by boiling were made in Erlenmeyer flasks equipped with vapor condensers in order to maintain boiling without increasing the concentration of lye.

After the extraction treatments, soap and lye were washed from the rubber pieces with the aid of a Waring blendor. Distilled water was used for washing and rinsing to prevent the formation of insoluble soap curd. The rubber pieces were again dried on absorbent paper and in the vacuum oven at 100° C., cooled, and weighed.

RESULTS

Fat extraction with boiling lye solutions. Data in Table 1 show the amount of butterfat extracted from 6-day, fat-soaked rubber when boiled in lye solutions of various concentrations for different periods. These results are from one trial, typical of several runs.

TABLE 1

Amount of butterfat extracted from rubber Ba containing 30.7% butterfat when boiled in lye solutions

Concentration of lye	Fat extracted by boiling the fat-soaked rubber for			
	15 min.		60 min.	
(%)	*(g.)*	*(%)*	*(g.)*	*(%)*
1	0.00	0.00	0.10	3.25
2	0.05	1.60	0.26	9.47
5	0.10	3.25	0.60	19.54
10	0.26	9.47	1.25	40.39
15	0.44	14.33	1.65	53.74
20	0.36	11.72	1.55	50.49

Only a small amount of fat was removed by boiling the rubber for 15 minutes regardless of the concentration of the lye. Also, only relatively small proportions of fat were removed when lye concentrations of 5% or less were used, even with extended boiling. The highest extraction of fat, 53.74%, was secured when the rubber was boiled in a 15% lye solution for 60 minutes. Less fat was extracted by a 20% lye concentration than by a 15%.

Fat extraction with cold lye solution. Fat-soaked rubber was stored for 7 days in cold lye solutions ranging in concentration from 1.0 to 20%. The results obtained under these conditions are presented in Table 2. The data show that the percentage of fat removed from rubbers Bc and Be, containing 20.6% and 16.44% of absorbed fat, respectively, varied markedly with the rubber and with the concentration of lye. Nevertheless, relatively high extraction values were secured from both rubbers when the lye concentration ranged from 2 to 15%.

TABLE 2

Percentage of fat extraction from 2 lots of fat-soaked, composite latex-synthetic rubber, with different concentrations of cold lye during a 7-day treatment

Rubber	Fat absorbed by rubber	Extract[a] removed from rubber in lye solutions of various concentrations						
		1	2	5	7.5	10	15	20
	(%)	*(%)*	*(%)*	*(%)*	*(%)*	*(%)*	*(%)*	*(%)*
Bc	20.6	31	70	88	88	88	67	40
Be	16.44	0[b]	92	111	114	111	109	54

[a] Possibly includes fat and rubber constituents.
[b] Very slight but insignificant gain.

Some significant differences resulted relative to total extraction and to extractions secured at different concentrations. The Be rubber yielded extraction values in excess of the fat absorbed, as shown by 109 to 114% extractions with 5 to 15% lye solutions. A 1.0% lye solution produced a fat extraction of 31% from the Bc fat-soaked rubber, but no extraction from the Be fat-soaked rubber. The Bc lot showed a marked reduction in fat extraction when lye concentration increased from 10 to 15%. The Be lot did not show a significant reduction in fat extraction with 15% lye solution. The 20% lye solution extracted less than half as much fat as the 5 to 10% solutions on both lots of rubber. Highest fat extraction was secured from these rubbers with 5, 7.5, and 10% lye concentrations. Fat extraction in those solutions was much higher than with the boiling procedures.

With 5 to 7.5% concentration the density was sufficiently low that the fat-soaked rubber submerged, either immediately or after 3 or 4 days of soaking. In higher concentrations the pieces floated on the surface. It is not believed, however, that this condition materially affected the results.

Interesting different soap formations were observed (Figure 1). With less than 5.0% lye solutions flocculent soap formed, which upon chilling produced a soap gel. Clear liquid appeared in all 5 to 20% solutions with soap adhering

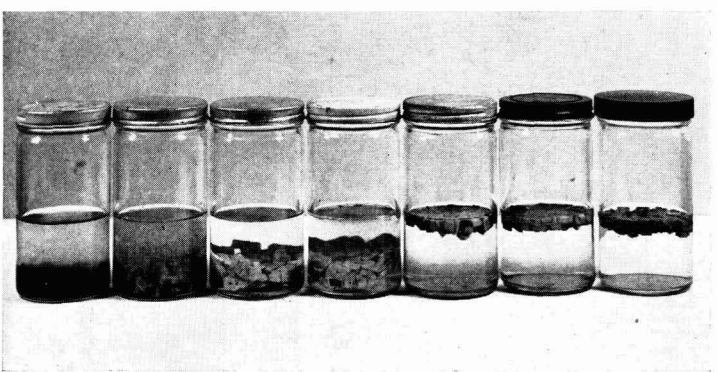

FIG. 1. Showing the appearance of fat-saturated rubber and lye solutions after 7 days storage in cold lye of 1, 2, 5, 7.5, 10, 15, and 20% concentrations, pictured from left to right, respectively. (The position of the rubber in the solutions is influenced by the lye concentration.)

firmly to the rubber pieces. However, noticeably less soap was formed in the 20% solution.

Variation in butterfat absorption and extraction in milker inflation rubber. Data in Table 3 show the amount of fat absorption by 10-g. portions of rubber after 3-, 5-, and 7-day soaking in butter oil and the lye-fat extraction after 7 and 14 days soaking in cold 7.5% lye solution. Nine different milker inflation rubbers were used.

TABLE 3

Variation in butterfat absorption and extraction of 9 lots of rubber, soaked 3, 5, and 7 days in butter oil, then 7 days in 7.5% lye solution

Rubber	Fat soaking	Fat absorption		Fat extraction	
				7 days	14 days
	(days)	*(g.)*	*(%)*	*(%)*	*(%)*
A	3	14.74	32	77	86
	5	15.85	37	70	77
	7	18.07	45	65	81
Ba	3	13.31	25	84	98
	5	14.34	30	84	91
	7	15.27	34	84	86
Bb	3	13.32	25	82	
	5	14.42	33	77	
	7	15.34	35	83	95
Bc	3	13.50	26	84	
	5	14.58	31	84	
	7	15.48	35	83	95
Bd	3	13.10	24	83	
	5	14.37	30	85	94
	7	14.98	33	81	
Be	3	11.63	14	124	
	5	12.10	17	110	
	7	12.46	20	110	128
Ca	3	9.88	−1.2	3.7	
	5	9.83	−1.2	3.1	
	7	9.80	−2.0	3.0	
Cb	3	9.73	−2.7	2.67	
	5	9.50	−5.0	2.1	
	7	9.59	−4.1	2.6	
D	3	10.3	2.91	−4.37 (gain)	
	5	10.42	4.03	−4.1 (gain)	
	7	10.42	4.03	−0.38 (gain)	

Rubber A, pure latex, absorbed the highest percentage of butterfat of all rubber tested during the 3-, 5-, and 7-day soaking periods—32%, 37%, and 45%, respectively—and yielded lower fat extraction values than did the B rubbers after the 7- and 14-day extraction periods. The latex rubber therefore retained more fat than did the latex-synthetic rubber.

Excluding lot Be, the composite latex-synthetic group gave practically identical absorption and extraction values. The extraction values closely approached, but never exceeded, the 100% value. Lot Be, however, gave consistent extraction

values in excess of 100%, with a high value of 128% after 14 days extraction. Additional data on fat extraction from Be rubber is shown in Table 5.

The data relative to lots Ca and Cb also are very nearly alike. Both lost weight in the 3-, 5-, and 7-day period of soaking in butter oil, yet both lost further weight through fat extraction. Abundant suds were formed when the soap was washed from the rubber pieces. The Cb rubber lost more weight in butter oil than the Ca rubber but also lost less fat upon lye extraction.

Lot D, neoprene from one manufacturer, absorbed only a very small amount of butterfat, 2.91% and 4.03%. However, sufficient soap was produced during lye soaking to cover the neoprene pieces and to cause abundant sudsing. The neoprene increased in weight through the action of the lye solution. The 3-, 5-, and 7-day fat-soaked portions assumed increases of 4.37, 4.10, and 0.38%, respectively. Later data show the influence of lower concentrations of lye solution.

Effect of lye solutions on rubber. Three control studies were made to determine the effect of lye solution on rubber only. In one of these trials, with rubber Be, cold lye solutions were used in concentrations ranging from 1 to 20%. No significant change in weight occurred when 10-g. lots were soaked in the various solutions during a 7-day period. In the second trial, the nine lots of rubber used in the study were soaked 7 days in cold 7.5% lye solution. Again no significant change in weight occurred, except with a 10-g. portion of neoprene, which increased in weight by 0.8 g. Also, the lye-treated neoprene produced a stain on moisture absorbent drying-paper, indicating a chemical breakdown of the neoprene. A third study was made with neoprene only with 1, 2, 3, and 4% cold lye concentrations and a 7-day soaking period. Increase in weight ranged from 0.43 to 0.57 g. per 10-g. lot. The data are presented in Table 4.

Fat extraction from neoprene. Lye solutions of 1, 2, 3, and 4% strength were tried for the removal of small quantities of fat from neoprene. Three lots of similar quality neoprene were used; one lot contained no fat, the second lot contained 0.32 g. fat per 10 g. neoprene after 3 days soaking in butter oil, and the third lot contained 0.42 g. fat per 10 g. neoprene after 7 days soaking in butter oil (Table 4).

All the 10-g. portions of neoprene gained from 0.43 to 0.57 g. when soaked 7 days in 1, 2, 3, and 4% lye solutions, indicating that lye solutions in the lower range of concentration also attacked neoprene. Apparently no soap formed around the neoprene pieces in the 1% lye solution, and all portions stored in 1% lye solutions increased in weight. Soap definitely formed in all other lye

TABLE 4

Effect of cold lye of less than 5% strength on neoprene containing small quantities of fat

Fat absorbed (g/10 g. neoprene)	Wt. of neoprene after soaking 7 days in lye solutions of various concentrations			
	1%	2%	3%	4%
(g.)	*(g.)*	*(g.)*	*(g.)*	*(g.)*
None (control)	10.45	10.45	10.43	10.57
0.32	10.82	10.41	10.64	10.94
0.42	10.65	10.19	10.87	10.88

solutions from the fat soaked pieces of neoprene. The soap clung to and covered the neoprene pieces. Lowest final weights resulted when fat-soaked neoprene was soaked in 2% lye solution. This solution produced the best extraction when the fat content was 0.42 g. per 10 g. neoprene.

Rubber solvent extraction by fat. Results secured when extracting the absorbed fat from rubbers Be, Ca, and Cb established that those inflation materials were partly composed of a fat-soluble ingredient that was drawn out of them by butterfat. This conclusion was substantiated by the fact that the lye solutions used failed to account for loss in weight in the rubber products. Fat soaking alone caused weight loss in the Buna-N "rubber." Data in Table 5 show the result of practically complete exhaustion of butterfat from triplicate Be portions. These data show that Be rubber lost approximately 9% of rubber ingredient in butter oil that was believed to be a nonfixed rubber solvent.

TABLE 5

Quantities of fat-soluble rubber ingredient extracted by butter oil from Be rubber during 7-day soaking periods

Wt. of 10 g. rubber after soaking in butter oil	Wt. and wt. loss after three 7-day extraction periods						Fat extracted rubber constituent	
	7 days		14 days		21 days			
	Wt.	Total loss	Wt.	Total loss	Wt.	Total loss		
(g.)	*(g.)*	*(g.)*	*(g.)*	*(g.)*	*(g.)*	*(g.)*	*(g.)*	*(%)*
12.28	9.57	2.71	9.22	3.06	9.12	3.16	0.88	8.8
12.27	9.54	2.73	9.25	3.02	9.12	3.16	0.88	8.8
12.27	9.61	2.66	9.32	2.95	9.18	3.09	0.82	8.2

DISCUSSION

This study of milking machine rubber and its response to fat-soaking treatment and subsequent lye saponification was made at the outset for the purpose of determining the effectiveness of the usually recommended lye solutions for removing fat from rubber. Since it was not possible otherwise to know the fat content of used milker rubber, unused rubber was soaked in butter oil and its fat content was calculated.

The results revealed that low concentrations of lye solution possessed very low fat extraction qualities when a 15-minute boiling period was used. Even with boiling increased to 60 minutes, fat extraction remained low with low lye concentrations. Promising extraction was secured when the lye strength was increased to 10 to 20% with 60 minutes of boiling. That method is time consuming and somewhat dangerous to the operator and requires additional heat and frequent make-up of fresh lye solutions, since with the boiling method the soap that forms remains in the lye solution.

Cold lye solutions, with a 7-day soaking period, were very effective for fat extraction from rubber. The most practical concentrations appeared to be 5 to 7.5%, for at those levels the extractions were normally highest and the soap that was produced adhered firmly to the rubber and was removed with it. Lye solu-

tions of 5 to 10% concentration should be usable for several months. When the 1 or 2% lye solutions were used, much of the soap remained in the solutions, making frequent changes necessary.

The different qualities of inflation products produced some interesting results. Latex rubber absorbed highest amounts of fat. The composite latex-synthetic rubber absorbed considerably less fat than the pure latex rubber and released fat more effectively with cold lye soaking methods. Buna-N rubber actually lost weight while soaking in butter oil, indicating that a solvent of the rubber was extracted by the butter oil. Additional loss of weight occurred when this rubber was subsequently soaked in cold lye. It was therefore obvious that as butterfat extracted a solvent from Buna-N, the rubber absorbed butterfat from the butter oil. A similar result was demonstrated with rubber Be. This rubber, however, absorbed much more fat than Buna-N rubber; the difference was attributed to the latex content of the rubber. Another important ingredient in Be rubber was believed to be Buna-N. Because of that combination of ingredients it was possible to secure extraction in excess of 100%, resulting apparently from absorption of butterfat.

The two Buna-N rubbers, Ca and Cb, were similar in yielding small amounts of rubber solvent and absorbing small amounts of fat. However, Ca yielded distinctly less loss of rubber solvent and more butterfat absorption than the Cb rubber. This difference, though small, may influence the flexing and lasting quality of rubber.

Neoprene inflation pieces absorbed only a small amount of butterfat when compared with the latex and composite latex-synthetic rubbers. The neoprene used in this study was to some extent hydrolyzable by lye solutions. The effects of lye were most noticeable in nonfat-treated neoprene pieces. A 2% lye solution caused sufficient saponification to extract fat from neoprene without damage. It was believed that soapy films which surrounded the neoprene pieces protected them against breakdown. When stronger lye solutions were used, hydrolysis of the neoprene increased. Thus, the 2% lye solution appeared to be best for use in extracting fat from neoprene of the quality used in this study.

SUMMARY AND CONCLUSIONS

Butterfat extractions were made from fat-saturated portions of milking machine inflations by using both hot and cold lye solutions. Cold lye solutions used over a 7-day period were highly effective for fat extraction when lye concentrations of 2 to 15% were used. Concentrations in the range of 5 to 10% were most effective for latex type rubber.

Boiling-lye solutions in generally accepted concentrations were practically useless for extracting rubber-absorbed fat. However, boiling-lye solutions of 10 to 20% concentration extracted from 40 to 50% of the absorbed fat from composite latex-synthetic rubber with 60 minutes boiling time. By way of contrast, cold lye solution of 7.5% concentration extracted 84% fat from a similar quality rubber during a 7-day extraction period.

The quality of inflation rubber greatly affected fat absorption by the rubber and the subsequent fat extraction. Latex rubber absorbed the highest amount of butterfat—32, 37, and 45% in 3-, 5-, and 7-day fat soaking periods. The extraction of fat with 7.5% solution in a 7-day treatment yielded 77, 70, and 60%, respectively. Composite latex synthetic rubber absorbed approximately 25, 30, and 35% fat in respective 3-, 5-, and 7-day periods. The 7.5% lye solution extracted 84% of the absorbed fat.

One composite latex-synthetic rubber yielded extraction values in excess of amounts absorbed. Two lots of Buna-N inflation pieces gave negative absorption values when soaked in butter oil. Both kinds of inflations yielded losses of rubber solvent in butterfat while simultaneously absorbing butterfat. The neoprene tested absorbed very small quantities of butterfat. Fat from neoprene was best extracted with 2% lye solution.

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COMPOSITION OF THE CASEIN-CONTAINING PARTICLES IN MILK[1]

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It is well known that casein exists in milk in large aggregates. The purpose of this paper is to provide data on the chemical composition of these aggregates in relation to their size. Separation was achieved by centrifugation. The following chemical determinations were carried out on the separated material and on the residual liquids: total nitrogen, casein nitrogen, calcium, total phosphorus, trichloracetic-acid-soluble phosphorus, lactose, fat, and total solids.

EXPERIMENTAL PROCEDURE

Centrifuges, centrifugal velocities, and centrifuging times. Three centrifuges were used: a laboratory centrifuge having the cups provided with metal inserts to immobilize the liquid (Figure 1); various air-driven bowl rotors of 3.7 cm. diameter and 2 ml. to 2.7 ml. capacity, and a 12.4-cm. diameter, 50-ml. capacity, air-driven bowl rotor. One of the small bowl rotors and the 50-ml. bowl rotor are shown in Figure 2. The immobilizing inserts used with the laboratory centrifuge are an adaptation of a device introduced by Elford *(4)*. The bowl rotors are of the Henriot and Huguenard type *(8)* and were used without immobilizing devices.

FIG. 1. One type of immobilizing insert used with the laboratory centrifuge. Length of holes, 1.24 cm.; diameter, 0.231 cm.

The laboratory centrifuge was run at about 3,000 r.p.m., giving a centrifugal force at the midpoints of the immobilized columns of about 2,300 times gravity. The 2 ml. to 2.7 ml. capacity rotors were run at 510 and 800 r.p.s., giving effective centrifugal forces of about 13,000 and 33,000 times gravity. The 50-ml. capacity rotor was run at 416 r.p.s., giving an effective centrifugal force of about 28,500 times gravity.

Received for publication December 22, 1954.

[1] This work was done in part with Bankhead-Jones special research funds.

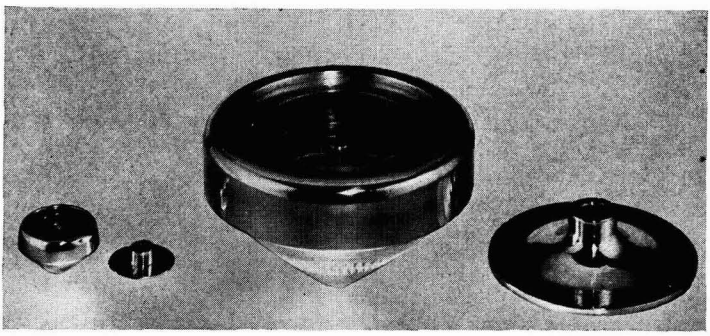

FIG. 2. Air-driven bowl rotors. Small rotor: 3.7 cm. diameter; 2.7 ml. capacity; inside and outside radii of annulus, 0.969 cm. and 1.454 cm. Large rotor: 12.4 cm. diameter, 50 ml. capacity, inside and outside radii of annulus, 3.49 cm. and 4.76 cm.

As a rule, with the small bowl rotors at 800 r.p.s., for example, roughly 14 minutes was required to remove 90-95% of the casein colloids; and with the 50-ml. rotor at 416 r.p.s. about 38 minutes was required. Although much longer times were used, up to 92 hours with the laboratory centrifuge and up to 16 hours with the bowl rotors, the final 5-10% of casein colloids was never completely removed. Some acid-precipitable protein always remained in even the clearest liquid samples.

Centrifugal techniques. Two techniques were used. With the laboratory centrifuge and with the small bowl rotors, many portions of each milk sample were centrifuged, each for a longer time than the preceding one. With the 50-ml. capacity rotor, in some experiments, the partially depleted liquid from one centrifugation was used to prepare the liquid and deposit in the next. The first of these techniques gives a Sven Odén type of depletion, i.e., for any single particle size the plot of concentration against centrifuging time follows a definite curve, which is almost a straight line. Sedimentation constants can be calculated from such plots *(5)*. The second technique gives results which are more difficult to interpret in terms of particle size but permits a sharper separation of fractions.

With the laboratory centrifuge only liquid samples were obtained. With the bowl rotors both liquid samples and deposits could be recovered. With the laboratory centrifuge the liquid samples were thrown out of the inserts into clean cups; with the bowl rotors the liquids were removed with hypodermic syringes or with pipettes, and the deposits were collected on celluloid liners fitted against the wall of the annulus.

Two of the laboratory centrifuge experiments were run at 17° C.; most of the other separations were at 19.5° C., although some were at temperatures as high as 25° C.

Milk samples. Effects of residual fat. Whole milk was obtained from the U. S. Department of Agriculture farm at Beltsville, Md. Both Jersey and mixed herd milks were used. No preservatives were added. All samples were stored at 4° C.

Skimmilk was prepared usually by gravity separation. It was siphoned from 3-l. flasks about two-thirds filled with whole milk, after 24 hours standing at 4° C. Twenty-four-hour gravity skimmilk obtained in this way contained roughly 0.3 to 0.7% fat. Gravity skimmilk was used primarily to insure the inclusion of large casein colloid particles but in part also to avoid even the slight heating and additional handling involved in mechanical separation. For some experiments the 24-hour gravity skimmilk was submitted to further separation by centrifuging for short times in the 50-ml. bowl rotor, at 416 r.p.s., especially for the purpose of removing the large particles and lowering the fat content. The initial fat content could be thus lowered to 0.07 to 0.08%. After even the most prolonged centrifugation, skimmilks always contain some fat.

As the data are presented here, any inaccuracies due to included fat are largely eliminated since the data are employed as ratios, as of calcium to nitrogen, or phosphorus to nitrogen, and in each case the analyses for these various elements were all on the same samples.

METHODS OF ANALYSIS

Nitrogen was determined by a semi-micro Kjeldahl method with mercuric oxide and sodium sulfate as catalysts. With the liquid samples casein was precipitated with 1 to 9 acetic acid and, after holding the samples for 15 minutes, sodium acetate buffer was added, giving a final pH of 4.6. For the determination of casein nitrogen on air-dried deposits, samples were weighed into 15-ml. centrifuge tubes, water was added, and the samples were allowed to swell. The resulting gelatinous material was then made into a suspension by adding dilute sodium hydroxide, keeping the pH below 8.0. Casein was precipitated from these redispersed samples, as from original liquid samples, with acetic acid, sodium acetate buffer was added to bring the pH to 4.6, and nitrogen was determined on the washed precipitate in the usual way.

Calcium was determined on the ash according to the micro-titration method of Tisdall and Kramer *(11)*. The Clark and Collip washing technique was used *(2)*. Total phosphorus and trichloracetic-acid-soluble phosphorus were determined by the volumetric method described in the official methods of the A.O.A.C. *(1)*. Lactose was determined by the A.O.A.C. gravimetric method. Fat was determined by the Röse-Gottlieb method.[2] The Mojonnier tester was used in place of the Röhrig tube. Total solids were obtained by transferring the samples to weighing bottles partly filled with sand and heating them in a vacuum at 98-100° C. to constant weight.

RESULTS AND CALCULATIONS

Relationship between casein nitrogen and total nitrogen. Figure 3 shows plots of per cent casein nitrogen against per cent total nitrogen in the liquids as the casein-containing colloids are progressively removed by centrifuging for

[2] Described on p. 272, 5th ed. of Official Methods of A.O.A.C.

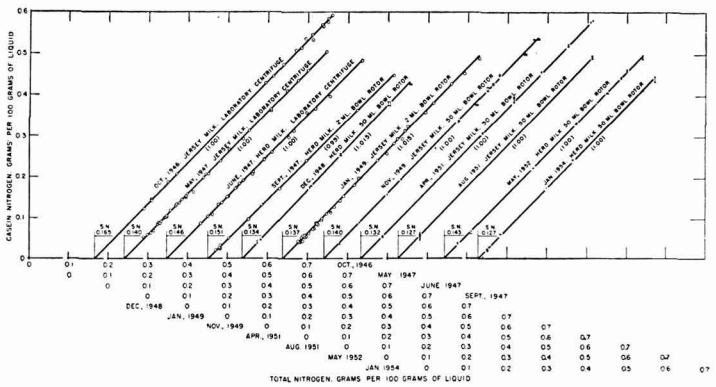

FIG. 3. Relationship of casein nitrogen to total nitrogen for skimmilk samples centrifuged for different lengths of time. Cirles represent single determinations or averages of duplicate determinations; crossed lines show limits of duplicate determinations. S.N. = serum nitrogen. Eleven plots are shown here, and each consecutive plot has its own abscissa values.

eleven milks. Since the data indicate essentially straight line relationships, there is here no evidence for differences in absorbed or otherwise associated noncasein proteins based on particle size, as might have been expected.

The large scale plot from which Figure 3 is reduced gives the following ratios between the decrease in casein nitrogen content and the decrease in total nitrogen content as the colloids are removed: 1.00, 1.00, 1.00, 0.99, 1.015, 1.015, 1.00, 1.00, 1.00, 1.00, and 1.00. These ratios are simply the slopes of the lines. It is seen that as a practical matter the casein nitrogen removed is essentially equal to the observed decrease in total nitrogen.

If casein nitrogen were the only nitrogen removed, the slopes of these lines should actually be greater than 1.00. This is because the original total nitrogen content represents grams per 100 g. of skimmilk, and the final total nitrogen content on the depleted samples represents grams per 100 g. of casein-free serum. For a typical milk containing 0.500% casein nitrogen and 0.642% total nitrogen, calculations give 1.016 for the theoretical slope of the line, assuming casein nitrogen to be the only nitrogen removed. The calculations involve a factor, 6.89, based on analyses, for conversion of casein nitrogen to dry lactose-free colloid; and a value for hydration of 0.52 g. of bound water per gram of dry colloid, or 0.55 g. per gram of casein, due to de Kadt and van Minnen (cf. ref. 3). That the actual slopes of the lines of Figure 3 are in many cases significantly less than 1.016 means that noncasein or serum proteins as well as casein are removed by the centrifugation. The amount, although small, is several times as great as the amount of albumin and globulin which would theoretically be independently sedimented in the centrifuging times used.

In general, total nitrogen determinations are more reliable than casein nitrogens. In 32 sets of duplicate total nitrogen determinations representing five complete centrifugal fractionations over a 3-year period, the average deviation of the duplicates from the mean values was $\pm 0.29\%$; for the corresponding

duplicate casein nitrogens the average deviation was ±0.88%. Therefore, casein nitrogen is referred to total nitrogen in Figure 3, and for the same reason calcium, total phosphorus, and acid-soluble phosphorus are referred to total nitrogen in subsequent plots.

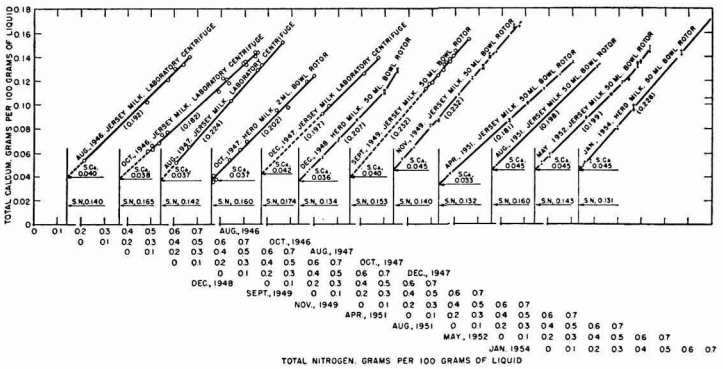

FIG. 4. Relationship of total calcium to total nitrogen for skimmilk samples centrifuged for different lengths of time. Circles represent single determinations or averages of duplicate determinations; crossed lines show limits of duplicate determinations. S.N. = serum nitrogen. S.Ca = serum calcium. Twelve plots are shown here, and each consecutive plot has its own abscissa values.

Calcium:casein-nitrogen ratios. Figure 4 shows plots, for 12 milks, of total calcium against total nitrogen as the colloids are progressively removed. Single straight lines are drawn through the sets of points except for December, 1948, and May, 1952, where a break in the region of large particles seems apparent.

For these 12 milks the extreme ratios of calcium removed to casein nitrogen removed are 0.181 and 0.232. The average is 0.206. In calculating these ratios, the serum calcium in the original skimmilks was found by proportioning the extrapolated value for the calcium in 100 g. of casein-free serum to the calculated weight of such serum in 100 g. of the skimmilk. Here, as before, the numerical constants 6.89 and 0.52 were used. For these plots, therefore, unlike the casein nitrogen:total nitrogen plots, the ratios given are not exactly the slopes of the lines.

Total phosphorus:casein-nitrogen ratios. Here again (Figure 5) single straight lines are drawn, with one exception. In this case, May, 1952, a deviation is indicated in the same region in which a deviation in calcium is shown in Figure 4. The five total phosphorus:casein-nitrogen ratios given by the lines as drawn are 0.125, 0.145, 0.119, 0.122, and 0.128. These ratios were calculated in the same way as the calcium:casein-nitrogen ratios.

Acid-soluble phosphorus:casein-nitrogen ratios. Since the calcium and total phosphorus plots are linear with only two exceptions, they indicate at least approximately constant composition for the casein colloids removed over the whole range or almost the whole range of sizes. The acid-soluble phosphorus plots of

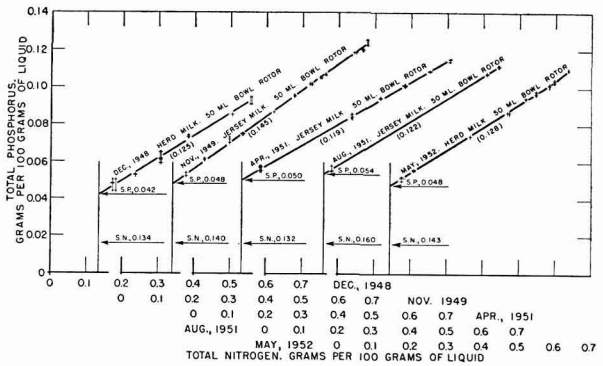

FIG. 5. Relationship of total phosphorus to total nitrogen for skimmilk samples centrifuged for different lengths of time. Crossed lines show limits of duplicate determinations. S.N. = serum nitrogen. S.P. = serum phosphorus. Five plots are shown here, and each consecutive plot has its own abscissa values.

Figure 6, however, seem to show a break in homogeneity in the region of the largest sizes.

The November, 1949, milk sample (cf. Figure 6) was 24-hour gravity skim and therefore contained all of the large particles originally present. The April, 1951, milk sample was partially depleted of large particles, and the August, 1951, and May, 1952, samples were very nearly or completely depleted of large particles, by preliminary centrifugation, before the experiments were started. The plots for the last two milks disclose no deviation from a straight line relationship.

The acid-soluble phosphorus : casein-nitrogen ratios shown in Figure 6, 0.088, 0.063, 0.067, and 0.071, are based on the major straight lines and were calculated in the same way as those for calcium and total phosphorus.

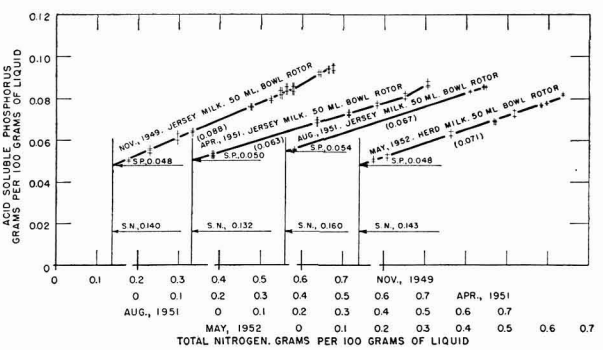

FIG. 6. Relationship of acid-soluble phosphorus to total nitrogen for skimmilk samples centrifuged for different lengths of time. Crossed lines show limits of duplicate determinations. S.N. = serum nitrogen. S.P. = serum phosphorus. Four plots are shown here, and each consecutive plot has its own abscissa values.

The plots of casein nitrogen and total nitrogen against centrifuging time for November, 1949, i.e., the depletion plots for this experiment, show that about 15% of the casein-containing colloid consisting of large particles must have differed in composition from the rest to give a break in the acid-soluble phosphorus plot at the point indicated. Other depletion experiments on gravity skimmilks in which acid-soluble phosphorus was not determined give proportions of particles in this size range not over, and usually less than, 15% of the total. Sometimes these large particles appear to be entirely absent.

Composition of casein in milk as indicated by the analysis of liquid samples. In the calculations to be outlined it is assumed that the total phosphorus content of a sample less the acid-soluble phosphorus represents organic phosphorus.

Considering only the analyses of the original skimmilks and of the casein-free serums as given by extrapolation (cf. Figures 5 and 6), the ratios of organic phosphorus to casein nitrogen found are 0.053, 0.052, 0.055, and 0.057. These ratios are for whole casein in the native state. The variation is about the same as in analyses of purified casein prepared by different methods. Linderstrøm-Lang *(7)* lists seven analyses by various authors; the phosphorus:nitrogen ratios calculated from these analyses are 0.054, 0.054, 0.056, 0.045, 0.051, 0.053, and 0.050.

TABLE 1

Summary of results of analyses of liquid samples, and calculation of the organic phosphorus:nitrogen weight ratio for the main component of native casein in milk

1	2	3	4	5
Date of milking	Ca/C.N.[a]	T.P./C.N.[a]	A.S.P./C.N.[a]	O.P./C.N.[a]
	(g/g)	*(g/g)*	*(g/g)*	*(g/g)*
Dec., 1948	0.207	0.125	——	——
Nov., 1949	0.232	0.145	0.088	0.057
Apr., 1951	0.181	0.119	0.063	0.056
Aug., 1951	0.198	0.122	0.067	0.055
May, 1952	0.199	0.128	0.071	0.057

[a] C.N. = casein nitrogen; T.P. = total phosphorus; A.S.P. = acid-soluble phosphorus; O.P. = organic phosphorus.

Table 1 lists the various weight ratios taken from Figures 4, 5, and 6. These ratios refer not to the total casein but to that part contained in the group of particles in the broad intermediate size range, which represents about 80% of the total. Here, the organic phosphorus:nitrogen ratios obtained by subtracting the acid-soluble phosphorus ratios from the total phosphorus ratios are 0.057, 0.056, 0.055, and 0.057. These ratios vary much less than those given above for the total casein. The average is 0.056.

The present data are insufficient to draw any detailed conclusions as to composition in the range of large particles. It can be said at least that the over-all organic-phosphorus:nitrogen ratio is appreciably less than that given above. These large particles are complex. Deviations in lactose:nitrogen plots show that they contain lactose or are deposited with lactose in excess of that associated

TABLE 2

Various mol ratios for the colloid containing the main component of native casein, based on analyses of liquid samples

1	2	3	4	5	6
Date of milking	Mols Ca[a] / Mols C.N.	Mols T.P.[a] / Mols C.N.	Mols A.S.P.[a] / Mols C.N.	Mols O.P.[a] / Mols C.N.	Mols Ca-Mols O.P. / Mols A.S.P.
Dec., 1948	0.0714	0.0565	(0.0312)	(0.0253)	1.48
Nov., 1949	0.0811	0.0655	0.0398	0.0258	1.39
Apr., 1951	0.0633	0.0538	0.0285	0.0253	1.33
Aug., 1951	0.0692	0.0552	0.0303	0.0249	1.46
May, 1952	0.0696	0.0578	0.0321	0.0258	1.36

[a] C.N. = casein nitrogen; T.P. = total phosphorus; A.S.P. = acid-soluble phosphorus; O.P. = organic phosphorus.

with the solvate liquid. They also appear to contain citric acid (cf. Ref. *3*). They contain fat, probably vitamins, and certainly also leucocytes, fragments of cells, and other foreign matter.

In Table 2 the data of Table 1 are presented in terms of mol ratios. For the December, 1948, experiment the organic phosphorus : nitrogen weight ratio 0.056 has been assumed. In the last column of the table, column 6, the mols of calcium, per mol of casein nitrogen, have been arbitrarily diminished by amounts equivalent to the organic phosphorus, and these differences divided by the mols of acid-soluble phosphorus. The average of the resulting ratios, 1.40, is close to the mol ratio of calcium to phosphorus in tricalcium phosphate.

Composition as indicated by analyses of deposits. Results of analyses of deposits, or sediments, are given in Tables 3 and 4. The 50-ml. rotor was used for these experiments, and each of the successive deposits was made from the previously partially depleted liquid by longer centrifuging. Most of the deposits were washed, as indicated in the tables. This was done by redispersing them in distilled water and recentrifuging. By such washing the lactose content is reduced to a negligible value, but some serum protein is always retained even after repeated washing. It is assumed that the soluble serum salts are removed with the lactose.

In the August, 1951, experiment only two fractions were prepared, one composed predominantly of the largest particles present and one composed of particles of small and intermediate sizes. This was not a separation of those largest particles that might differ in composition from the rest. These had been removed in the preparation of the milk sample. It was a separation of the major, apparently homogeneous component, into two size groups.

The purpose of Table 3 is to present the analytical data and to find the ratio of organic phosphorus to nitrogen in the deposits. These ratios are given in the last column. The average of all the values is 0.0563. This is in satisfactory agreement with the ratio 0.056 for the phosphoprotein of the main component found by the analyses of liquid samples.

The purpose of the calculations indicated in Table 4 is to find the mol ratio of calcium not equivalent to organic phosphorus to acid-soluble phosphorus in the colloids removed. This calculation requires that the calcium and phosphorus

TABLE 3

Summary of results of analyses of centrifugally deposited colloids and calculations of the organic phosphorus: nitrogen ratio for the main component of native casein

	1			2	3	4	5	6	7	8	9	10
		Sample		H_2O[b] (In wet deposit)	T.N.	C.N.	S.N.	T.P.	A.S.P.	O.P.	Ca	O.P./C.N.
No.	Centrifuging time at 28,500 × G	Treatment[a]	Approximate per cent of total colloid		*(g. per 100 g. vacuum dry solids)*							
	(min.)				January, 1951. Jersey 24-hr. gravity skimmilk							
A-1	2	One water wash	7	—	14.45	13.67	0.78	1.661	0.886	0.775	2.81	0.0567
A-2	4	"	10	—	14.15	13.05	1.10	1.654	0.914	0.740	2.83	0.0567
A-3	8	"	20	—	14.36	13.18	1.18	1.610	0.868	0.742	2.68	0.0563
A-4	60	"	50	—	14.60	12.70	1.90	1.54	0.83	0.71	—	0.056
					April, 1951. Jersey centrifugally skimmed milk							
B-1	½	Not washed	2	230	12.55	11.74	0.81	1.55	0.89	0.66	2.60	0.056
B-2	1	"	3	239	12.75	11.97	0.78	1.62	0.94	0.68	2.60	0.057
B-3	2	"	3	255	12.50	12.05	0.45	1.562	0.88	0.68	2.48	0.056
B-4	3	"	3	247	12.63	12.02	0.61	1.564	0.88	0.68	2.45	0.0565
B-5	30	"	70	237	12.70	12.30	0.40	1.52	0.83	0.69	2.42	0.056
					August, 1951. Jersey centrifugally skimmed milk							
C-1	½	Serum washed	2	(230)	12.59	11.64	0.95	1.67	1.02	0.65	2.65	0.056
C-2	30	Not washed	80	(237)	12.92	12.20	0.72	1.62	0.94	0.68	2.62	0.056
C-3	30	Water washed	80	—	14.55	13.74	0.81	1.700	0.93	0.77	2.75	0.056

[a] Details of the methods of preparation of the deposits for analysis are given in the text.

[b] Water content based on total solids determinations on the wet deposits.

TABLE 4

Calculations of various mol ratios for the colloid containing the main component of native casein

1	2	3	4	5	6	7	8	9	10	11
No.	Approx. serum H_2O in deposit	S.N. proportional to approx. serum H_2O	S.N. deposited	Serum H_2O corrected	Ca not serum Ca	A.S.P. not serum P	Mols Ca assigned to colloid per mol C.N.	Mols A.S.P. assigned to colloid per mol C.N.	Mols O.P. per mol C.N.	Mols inorganic Ca per mol A.S.P. assigned to colloid
					(g. per 100 g. vacuum dry solids)					
					January, 1951. Jersey 24-hr. gravity skimmilk					
A-1	—	—	—	—	2.81	0.886	0.0718	0.0293	0.0256	1.58
A-2	—	—	—	—	2.83	0.914	0.0758	0.0316	0.0256	1.59
A-3	—	—	—	—	2.68	0.868	0.0711	0.0297	0.0254	1.54
A-4	—	—	—	—	—	0.83	—	0.0295	0.0253	—
					April, 1951. Jersey centrifugally skimmed milk[a]					
B-1	188	0.27	0.54	186	2.53	0.79	0.0754	0.0304	0.0254	1.64
B-2	196	0.28	0.50	194	2.53	0.84	0.0739	0.0317	0.0256	1.52
B-3	212	0.30	0.15	211	2.41	0.77	0.0699	0.0288	0.0255	1.54
B-4	204	0.29	0.32	203	2.38	0.77	0.0692	0.0289	0.0255	1.51
B-5	193	0.27	0.13	193	2.35	0.73	0.0668	0.0268	0.0253	1.55
					August, 1951. Jersey centrifugally skimmed milk[b]					
C-1	(188)	0.26	0.69	186	2.56	0.91	0.0770	0.0353	0.0252	1.47
C-2	(193)	0.26	0.46	191	2.53	0.83	0.0725	0.0307	0.0252	1.54
C-3	—	—	—	—	2.75	0.93	0.0700	0.0306	0.0253	1.46

[a] The April, 1951, casein-free serum contained 0.132% S.N., 0.033% Ca, 0.050% P, 6.4% total solids, and 5.53% lactose.

[b] The August, 1951, casein-free serum contained 0.127% S.N., 0.045% Ca, and 0.0535% P. 6.4% total solids is assumed.

Column 2. Total water less C.N. times 6.89 and times 0.52, the colloid : N factor and the assumed hydration. Total water from Col. 2, Table 3, and C.N. from Col. 4, Table 3.

Column 3. Figures in Col. 2 divided by 100 and times 0.132/(1-0.064) = 0.141, for April; and times 0.127/(1-0.064) = 0.136, for August. Cf. notes *a* and *b* above.

Column 4. Figures in Col. 5, Table 3, less figures in Col. 3, this table. This serum nitrogen could be in part centrifugally deposited, in part trapped in the deposited jelly.

Column 5. Approximate serum water from Col. 2 less serum nitrogen deposited times 6.38 and times 0.52, the serum protein : N factor and an assumed hydration for the serum proteins.

Column 6. Total Ca from Col. 9, Table 3, less Ca proportional to serum water; i.e., less serum water from Col. 5 divided by 100 and times 0.033/(1-0.064) = 0.035, for April, and times 0.045/(1-0.064) = 0.048, for August. Cf. notes *a* and *b* above.

Column 7. A.S.P. from Col. 7, Table 3, less P proportional to serum water; i.e., less serum water from Col. 5 divided by 100 and times 0.050/(1-0.064) = 0.053, for April, and times 0.0535/(1-0.064) = 0.057, for August. Cf. notes *a* and *b* above.

Columns 8, 9, and 10. Ca and A.S.P. from Cols. 6 and 7 divided by C.N. from Col. 4, Table 3, and O.P./C.N. from Col. 10, Table 3, all expressed as mol ratios.

Column 11. Mols Ca per mol C.N. from Col. 8 less mols O.P. per mol C.N. from Col. 10, divided by mols A.S.P. per mol C.N. from Col. 9.

contained in the liquid part of the unwashed deposits be subtracted from the total calcuim and phosphorus. To this end certain assumptions are made: that the serum protein that may be considered a part of the liquid phase in the deposit is proportional to the total water less hydrate water; that the hydration of the casein colloid, and of the serum protein also, is 0.52 g. of hydrate water per gram of dry material; and that the amounts of calcium and phosphorus not part of the casein colloid are proportional to the free or serum water in the concentrations in which these elements are found in the casein-free serum. Details of the methods of calculation are given in the footnotes to the table. The several values for the calculated mol ratio of inorganic calcium to inorganic phosphorus are given in the last column. The average of all of these is 1.54. The average, omitting the first value for April, 1951, for the largest particles, is 1.52.

DISCUSSION

Comparisons with results of similar centrifugal analyses by others. De Kadt and van Minnen *(3)*, using the Sharples supercentrifuge, obtained variously depleted liquid samples and deposits. In the cases in which more than two liquid fractions were obtained, plots of calcium and total phosphorus against casein nitrogen constructed from their data are straight lines. The ratios of calcium removed to casein nitrogen removed range from 0.188 to 0.212, and the average is 0.202 as compared with the average ratio 0.206 given by the plots of Figure 4. The ratios of total phosphorus to casein nitrogen range from 0.122 to 0.128, and the average is 0.125 as compared with 0.128 given by Figure 5. Their average calcium:total phosphorus weight ratio for liquids is therefore 1.62; the present data give 1.61.

From analyses of their unwashed deposits by calculations similar to those used here, de Kadt and van Minnen obtain an average mol ratio of calcium less calcium equivalent to organic phosphorus, to inorganic phosphorus, of 1.53. These authors did not determine acid-soluble or inorganic phosphorus. They assumed a weight ratio of organic phosphorus to casein nitrogen of 0.053.

Von Hostettler *et al. (12, 13)*, using an angle centrifuge, separated two-thirds to three-fourths of the casein colloids from milk in fractions. Their analyses of deposits show a decrease in the calcium and total phosphorus content from the largest particles to the smallest. This result is in agreement with the present data (cf. Table 3), but their over-all decrease is greater. This could be because they started with whole milk, which would have contained all of the very largest particles. De Kadt and van Minnen, who, like Hostettler *et al.*, base their conclusions on their analyses of deposits, state (loc. cit.) that the fractions exhibit practically no differences in composition, but they leave open the possibility that slightly more calcium phosphate may be associated with the large particles than with the smaller particles. This indefinite result could be attributed to appreciable removal of large particles in the preparation of their skimmilks. Their original casein contents are all low, averaging 2.61%; the average original casein content of the skimmilks used here was 3.23%.

Ramsdell and Whittier *(10)* also separated and analyzed the casein-containing colloids from milk, thoroughly washing the deposits with water. They did not separate the colloids in fractions, and their samples probably contained a high proportion of very large particles. The organic phosphorus:nitrogen ratio given by their data is quite low, 0.051, which can probably be attributed to the inclusion of these large particles.

The very large and very small particles. More refined separations and more elaborate analyses than here attempted are required definitely to establish the compositions of the particles at both extreme ends of the size range.

In the region of very large particle sizes the low organic phosphorus indicated suggests the existence of a phosphoprotein which differs in composition from that in the particles of the broad intermediate size range, but it is not proof. This requires assurance that the large particles may not be merely aggregates of smaller ones with inclusion of such noncasein proteinaceous substances as would lower the organic phosphorus:nitrogen ratio.

In the region of very small particles the last 5 to 10% not removed is, of course, not included in the present analysis. These particles may or may not contain the same phosphoprotein as found in the main component. They also may not be associated with calcium phosphate, or at least not in the same way.

Composition of the main component of native casein in terms of α-, β-, and γ-caseins. Perfect linearity of both the total phosphorus and acid-soluble phosphorus plots over all or part of their length would require a perfectly constant organic phosphorus:nitrogen ratio for all of the casein complex particles over the range of linearity. Within the accuracy of the present data, such linearity is indicated over most of the size range. As a first approximation the plots show the existence of a native casein of constant composition in these particles. This conclusion is supported by the analyses of deposits.

The data on liquids give an average phosphorus:nitrogen ratio of 0.056, and the data on deposits give the ratio 0.0563. If this ratio is correct, then the native casein represented cannot be α-, β-, or γ-casein alone. These have the phosphorus:nitrogen ratios 0.0637, 0.0398 and about 0.0032 *(6, 9)*. The ratio found could, however, result from the presence of all three of these particular caseins in definite proportions.

Warner *(14)* originally reported the proportions of α- and β-casein in acid-precipitated casein as about 4:1, and electrophoresis and analyses indicate that γ-casein cannot amount to more than 5% of the total *(9)*. These figures suggest over-all proportions of α-: β-: γ-caseins of about 16:4:1. In such a combination the ratio of phosphorus to nitrogen would be 0.0563. The agreement with the experimental values 0.056 and 0.0563 is strong evidence for the existence in milk of such a definite mixture or combination of simpler phosphoproteins.

The implication is that each individual particle contains α-, β-, and γ-caseins in the proportions indicated. An alternative possibility, which is not ruled out by the data, is that α-, β-, and γ-caseins exist in separate particles and that the α-particles, β-particles, and γ-particles have comparable or identical size distributions.

Correction of the inorganic calcium:phosphorus ratio for magnesium in the casein colloid, and for a possible error in hydration. De Kadt and van Minnen *(3)* found magnesium to be removed with the casein colloids. Experiments not here reported confirm this, and give a mol ratio of magnesium to calcium removed of about 1 to 15. If the inorganic calcium:inorganic phosphorus ratios, 1.40 for liquids, and 1.52 for deposits, are increased by 1/15, they become 1.49 and 1.62, respectively.

The calculations for the liquid samples and for the unwashed deposits and the one serum-washed deposit, but not for the water-washed deposits, involve the factor 0.52 g. per gram, for hydration. This numerical value, due to de Kadt and van Minnen, is based on analyses of deposits, on the assumption that lactose is proportional to serum water, i.e., that it is not removed with the particles except as a part of the solvate liquid. Actually, as has been stated, excess lactose is removed with the large particles, and it is therefore not a valid reference substance, at least for these particles. Although de Kadt and van Minnen's deposits were perhaps free of large particles, still the possibility is suggested that the smaller particle-size fractions also might contain some lactose in excess of that in the solvate liquid. The necessary correction for inclusion of even a small amount of such nonsolvate lactose would give a hydration appreciably greater than 0.52 g. per gram. Any increase in the hydration would tend to lower the combined calcium-magnesium:acid-soluble phosphorus mol ratios. If the hydration were 1.00 g. per gram, for example, the average ratios corrected for both magnesium and hydration would be, for the liquid samples, 1.47; for all of the deposits omitting the largest particle size fraction for April, 1951, 1.50.

Relationship between calcium phosphate and particle size. The analyses of deposits (Tables 3 and 4) show a decrease in calcium and acid-soluble phosphorus, i.e., a decrease in calcium phosphate, with decreasing particle size. As has been stated, this is in agreement with results by Hostettler *et al. (12, 13)*.

The drift in calcium phosphate content with particle size, for the main casein-homogeneous component, is at first sight inconsistent with the linear plots of Figures 5 and 6. For some of these figures, slightly sagging lines might have been drawn, and more accurate data possibly would justify such curved lines. It seems likely, however, that usually, over appreciable distances at least, the lines should in fact be straight and represent single size classes of constant, or essentially constant, composition. For some of these milks the depletion plots disclose very few different particle sizes. It is to be noted also that with liquid samples the influence of the smaller particles predominates, since large amounts of these are included in all the fractions analyzed.

There is, in addition to the drift noted for individual milks, an over-all relationship between the calcium, i.e., calcium phosphate, content and particle size. For the August, 1946, milk, for which Figure 5 gives the calcium:nitrogen ratio 0.192, the depletion plot shows that less than 13% of the colloid was present as particles having sedimentation constants greater than 470×10^{-13}; and for the August, 1947, milk, for which the calcium:nitrogen ratio is 0.224, the depletion

plot shows that 50% of the colloid was present as particles having sedimentation constants greater than 470×10^{-13}.

Nature and condition of the inorganic phosphate in the casein-containing particles. Since the inorganic phosphate is removed with the casein in essentially constant proportions over most of the particle size range, it is unlikely that it exists to any appreciable extent as a separate colloid in fresh untreated milk. It must be present in all the particles as molecules combined in some way with calcium caseinate as a complex. This conclusion is the same as that of de Kadt and van Minnen and of Ramsdell and Whittier.

In Tables 2 and 4 the arbitrary assumption that the organic calcium is equivalent to the organic phosphorus is the same assumption made by de Kadt and van Minnen. As pointed out by these authors, this simplification is consistent with results of various more or less direct determinations of the combining power of casein for calcium. Ramsdell and Whittier used a value for organic calcium obtained from pH-calcium plots, but the end result is the same; and the conclusion by both de Kadt and van Minnen and Ramsdell and Whittier that the so-called inorganic phosphate is tricalcium phosphate is supported by the present data—with the important reservation that these data apply only to the particles in the intermediate size range, and not to the very largest nor the smallest particles.

The data given here indicate mol proportions of calcium to organic phosphorus to acid-soluble phosphorus, in the size fractions analyzed, of 5:2:2. This ratio is approached very closely when the calcium content is low and for the smallest particles (cf. columns 2, 4, and 5 of Table 2 and columns 8, 9, and 10 of Table 4). It may be considered to represent the mol relationships in a unit particle of the casein colloid, or complex, from which larger particles are formed by aggregation. The ratio suggests a combination of two mols of calcium caseinate with one mol of tricalcium phosphate.

SUMMARY

1. Roughly 75 to 90% of the casein in fresh untreated skimmilk appears to exist as a single phosphoprotein, which is probably a definite mixture or combination of α-, β-, and γ-caseins. The organic phosphorus:nitrogen ratio for this phosphoprotein is in close agreement with that for a mixture of these caseins in the proportions 16:4:1. This phosphoprotein is presumed to be contained in all the colloidal particles comprising the broad intermediate size range. An alternative assumption, that these individual caseins exist in separate particles having comparable or identical size ranges, is possible, however.

2. In the range of sizes referred to, the phosphoprotein may be considered to be combined with calcium and tricalcium phosphate as a complex. The proportion of inorganic phosphorus is variable as between milks and decreases with decreasing particle size. For milks of low calcium content, however, and for the smallest particles removed, a definite minimum proportion of inorganic phosphorus is indicated, such that the mol proportion of calcium to organic phosphorus to inorganic phosphorus is approximately 5:2:2.

3. The very largest casein-containing particles in skimmilk, which are not included in the size range above referred to, differ in composition. They appear to contain less organic phosphorus, but they also contain nonproteinaceous substances, and more refined analyses are required to characterize either the phosphoprotein or the inorganic components.

4. A residual fraction of the casein-containing particles, representing from 5 to 10% of the total casein, was not removed in the centrifuging times used.

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NATURAL VARIATION OF MILK SERUM PROTEINS AS A LIMITATION OF THEIR USE IN EVALUATING THE HEAT TREATMENT OF MILK

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Denaturation of the serum proteins may be used as an index of the extent of heat treatment of milk and its dry products *(4)*. Usually the index is reported either as the percentage denaturation of the original serum protein content or as the amount of undenatured serum protein remaining in the product. If the percentage denaturation is high, as for example in nonfat dry milk solids manufactured for baking purposes *(3, 7)*, direct determination of the amount of undenatured serum protein remaining is probably sufficient. For "low-heat" nonfat dry milk solids, however, the actual amount denatured may be of more significance than the percentage *(10)*. Since there are no direct methods for estimating the denatured serum proteins, the amount of heat denatured protein can only be calculated as the difference between the original and the final value. Unfortunately, except where it is used in control procedures in manufacture *(4)*, the serum protein content of the original milk is seldom known. It is, therefore, often necessary to assume an average value for the original serum protein content of a milk product of unknown history in order to evaluate its previous heat treatment. Consequently, the usefulness of serum proteins as an index of heat treatment is limited by the amount of variation in the content of these substances in milk. This is especially true for low-heat products.

The purpose of the experiments reported in this paper was to determine the extent of natural variations in serum protein content that might be encountered in commercial operations.

MATERIALS AND METHODS

Samples of bulked raw milk were obtained in each of three successive weeks during the winter (February and March), spring (early June), and fall (October) seasons from a single plant in each of ten widely separated milk sheds located throughout the United States. Eighty-one samples were collected. The samples were shipped to the laboratory via air express in precooled 1-qt. stainless steel vacuum bottles. Any samples having a low pH (below 6.5) or abnormally low heat stability were discarded. After determination of fat and total solids, the samples were separated by centrifugation and the total, noncasein, and nonprotein nitrogen was estimated in the skimmilk according to the Kjeldahl method of Rowland *(9)*. The serum protein nitrogen was also determined by the turbidimetric method essentially as proposed by Harland and Ashworth *(3)*.

Received for publication January 28, 1955.

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The heat denaturable serum protein nitrogen by both methods was calculated as the difference between the "noncasein" nitrogen content of the skimmilk before and after heating for 20 minutes in a boiling water bath. The total sulfhydryl content of the samples was estimated by the iodimetric method of Larson and Jenness *(5, 6)*.

After a closely controlled heat treatment of the milk at 165° F. for 30 minutes as described by Harland *et al. (4)*, the remaining undenatured serum protein N was determined by the Kjeldahl *(9)* and turbidimetric *(3)* methods, and the thiamine disulfide reducing substances were estimated by the method proposed by Harland and Ashworth *(1)*.

To explain some of the variability encountered in the 81 samples in the survey, data are included for samples of milk secured from individual cows as well as for successive samples of raw milk secured from a single bulked supply. Some data are presented to show the effect of copper contamination on the total sulfhydryl content of milk both before and after heat treatment. In such cases, the sample was milked directly into a Pyrex container, and appropriate amounts of copper as copper sulfate solution were added to portions of it.

A sample of comparatively low-heat nonfat dry milk solids was used as a control on the methods for the duration of these experiments.

RESULTS

A. *Variability in the original milk.* The variability, as per cent frequency, of the content of solids-not-fat, total protein nitrogen, casein nitrogen, and serum protein nitrogen is shown in Figure 1. The ranges, means, and standard deviations for these components as well as for total nitrogen, nonprotein nitrogen, heat-labile serum protein nitrogen, and sulfhydryl content are presented in

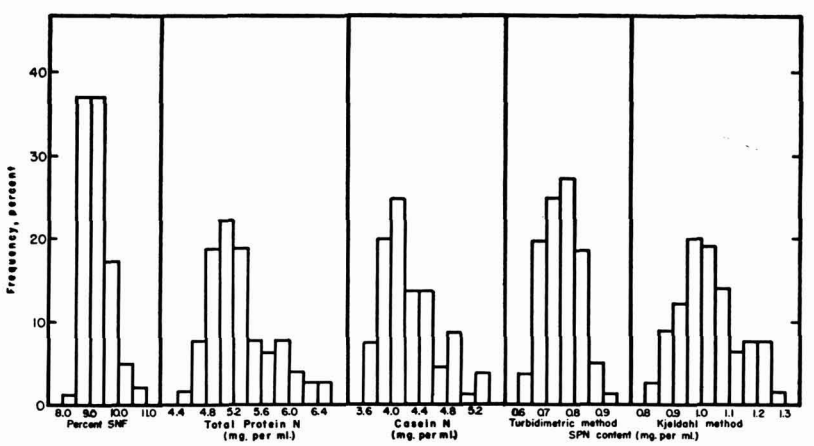

FIG. 1. Frequency distribution of solids-not-fat, total protein nitrogen, casein nitrogen, and serum protein nitrogen in 81 samples of raw skimmilk. (Data for two samples with high protein contents are omitted from the histograms for total protein nitrogen, casein nitrogen, and Kjeldahl serum protein nitrogen).

TABLE 1

Variations in the contents of several components in 81 samples of commercial bulked milk

Component[a]	Range	Mean	S.D.[b]
Solids-not-fat *(%)*	8.11 – 10.55	9.25	0.47
Total nitrogen *(mg/ml)*	4.82 – 7.70	5.66	0.56
Total protein *N (mg/ml)*	4.52 – 7.28	5.35	0.54
Nonprotein *N (mg/ml)*	0.23 – 0.42	0.31	0.04
Casein *N (mg/ml)*	3.49 – 6.02	4.31	0.47
Serum Protein N (Rowland Method)			
Total *(mg/ml)*	0.82 – 1.48	1.04	0.12
Heat labile *(mg/ml)*	0.60 – 1.10	0.76	0.08
Serum Protein N (Harland-Ashworth Method)			
Total *(mg/ml)*	0.62 – 0.91	0.76	0.06
Heat labile *(mg/ml)*	0.55 – 0.85	0.66	0.06
Sulfhydryl *(Iodosobenzoate—meq/l)*	0.19 – 0.44	0.30	0.16

[a] All data on the basis of skimmilk.
[b] Standard deviation of single determination.

Table 1. The serum protein contents of the samples varied considerably from plant to plant (Tables 2 and 3). Undoubtedly these variations resulted in part from differences in the breed compositions of the cattle contributing to the samples. For example, the samples from Plant 2, in a Holstein area, had the lowest average serum protein content (Rowland method), whereas those from Plant 8 in a region where Jerseys predominate, had the highest. The data do not permit speculation as to other possible causes for the regional variation.

TABLE 2

Variation of serum protein content of raw skimmilk with season and region

			Serum protein N content					
			Rowland method				Harland-Ashworth method	
			Content		As per cent of Total protein N		Content	
Plant	State	No. of samples	Mean	S.D.[a]	Mean	S.D.[a]	Mean	S.D.[a]
			(mg/ml)	*(mg/ml)*	*(%)*	*(%)*	*(mg/ml)*	*(mg/ml)*
			All seasons					
1	Wis.	7	0.97	0.06	19.6	1.4	0.71	0.04
2	Minn.	9	0.94	0.06	18.6	0.9	0.74	0.05
3	N. C.	9	0.99	0.06	20.1	1.3	0.72	0.06
4	N. Y.	8	0.97	0.13	19.7	2.6	0.72	0.06
5	Neb.	8	0.98	0.08	18.9	1.7	0.74	0.03
6	Ohio	9	1.10	0.17	17.8	1.2	0.81	0.05
7	Calif.	7	1.00	0.04	19.8	1.2	0.72	0.04
8	La.	8	1.23	0.10	22.1	1.7	0.80	0.03
9	Wash.	7	1.00	0.07	17.9	1.1	0.77	0.04
10	Fla.	9	1.15	0.05	19.6	1.2	0.83	0.03
Season					All plants			
Fall		29	1.07	0.14	19.2	1.4	0.75	0.07
Winter		26	0.95	0.11	18.2	1.2	0.74	0.06
Spring		26	1.08	0.08	20.7	2.0	0.78	0.05
All samples		81	1.04	0.12	19.4	1.5	0.76	0.06
Control[b]	10 determinations		0.84	0.02	—	—	0.64	0.02

[a] Standard deviation of single determination.
[b] Sample of low-heat nonfat dry milk solids analyzed concomitantly with the samples surveyed (three times in the spring, three in the fall, and four in the winter).

TABLE 3

Distribution of serum protein content of raw skimmilk with season and region

Serum protein N content	Plant and location									
	1 Wis.	2 Minn.	3 N. C.	4 N. Y.	5 Neb.	6 Ohio	7 Calif.	8 La.	9 Wash.	10 Fla.
(mg/ml)										
				Rowland method						
0.81 – 0.85	W[a]			W						
0.86 – 0.90		WWW	W	WW	WW				W	
0.91 – 0.95	W	FF	WF		W	W	W		W	
0.96 – 1.00	SSF	SF	WF	FFF	FFF	WS	WFF		F	
1.01 – 1.05	SF	SS	SS	S		WF	SSF	W	SFF	
1.06 – 1.10			SF		SS			F	S	W
1.11 – 1.15						SS		WSS		WSSF
1.16 – 1.20						F		F		WF
1.21 – 1.25				S				S		SF
1.26 – 1.30										
1.31 – 1.35										
1.36 – 1.40										
1.41 – 1.45								F		
1.46 – 1.50						F				
				Harland-Ashworth method						
0.56 – 0.60	W									
0.61 – 0.65	F		W	W			F			
0.66 – 0.70	S	WFF	WFF	WFF			WF		W	
0.71 – 0.75	W	WWF	WS	WSF	WWFF	W	SSF	S	WF	
0.76 – 0.80	SSF	SS	SF		WSF	WWSF	W	WSSF	SF	
0.81 – 0.85		S	S		S	SS		FF	SF	WWSS FFF
0.86 – 0.90				S		F		W		WS
0.91 – 0.95						F				

[a] Each letter represents one sample: W = winter sample, S = spring sample, F = fall sample.

The seasonal variations in serum protein content were relatively small. The mean content by the Rowland method was significantly lower (at the 1% level) in the winter samples than in those secured in the fall or spring; the means in the latter two seasons did not differ significantly. In the Harland-Ashworth data the only significant difference was between the winter and spring means. In any event seasonal variations in serum protein content appear to be much less important than geographical variations. In some plants (e.g., No. 6 and 8) wide fluctuations occurred within a single season.

The relationship between the serum protein contents of the raw samples as determined by the two methods, shown in Figure 2, reveals a significant statistical correlation, $r = +0.71$ (at the 1% point with 79 degrees of freedom $r = 0.283$). The average content of the fraction precipitated by salt but not by acid (difference between the results of the two methods for raw skimmilk) was 0.28 mg. N per milliliter, which is identical to the average value for the "proteose" fraction determined by the Rowland method (total serum protein N—heat labile serum protein N). Furthermore, a high correlation coefficient of +0.82 was found between the content of "proteose" and of the salt precipitable nonacid precipitable fraction.

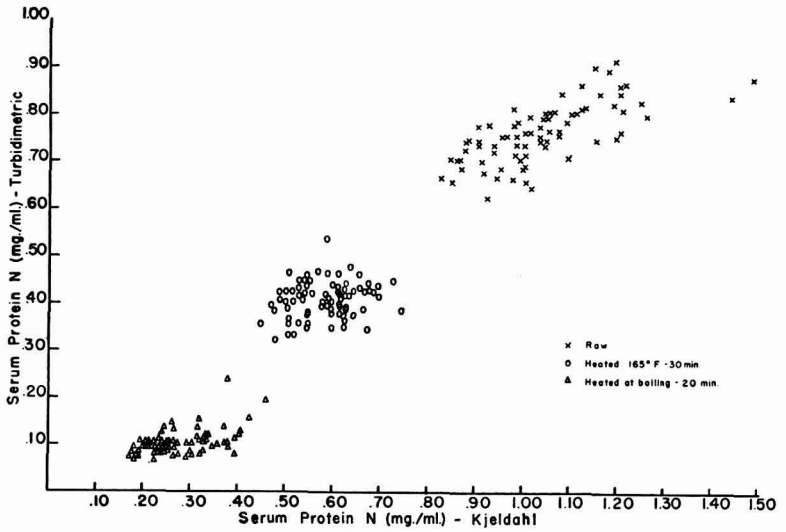

FIG. 2. Relation between Kjeldahl (Rowland) and turbidimetric (Harland-Ashworth) serum protein nitrogen values for 81 samples of skimmilk with and without heat treatment.

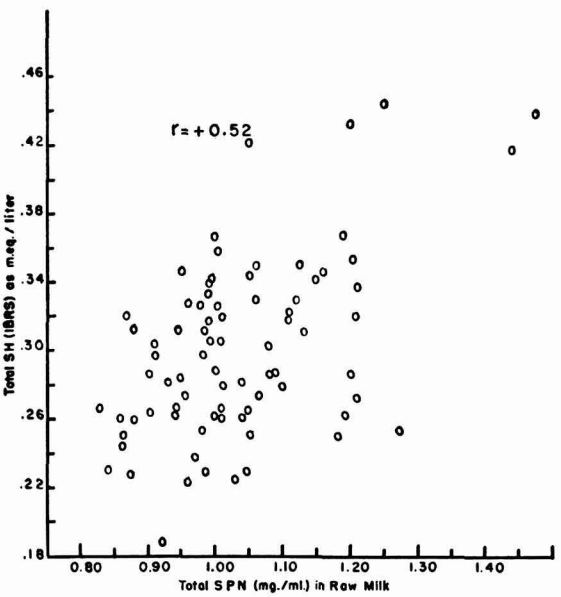

FIG. 3. Relation between sulfhydryl content (IBRS) and serum protein nitrogen content (Kjeldahl) for 81 samples of raw skimmilk.

The total serum protein N (Kjeldahl) was highly correlated with both the heat labile serum protein N ($r = +0.87$) and the "proteose" fraction ($r = +0.81$). Thus, high values for total serum protein represent high values for both its heat-labile and heat-stable fractions.

Figure 3 shows the relationship between total serum protein nitrogen and the sulfhydryl content as determined by the iodimetric method. The relatively low correlation coefficient of +0.52 between these variables re-emphasizes the fact that milk samples vary considerably in sulfhydryl content per unit of serum protein *(6)*.

B. *Variability in the effect of heat treatment at 165° F. for 30 minutes. Precipitability of serum proteins.* The 81 samples of skimmilk varied widely in the extent of precipitability of the serum proteins produced by treatment at 165° F. for 30 minutes. Figures 2 and 4 show the variation in the amounts

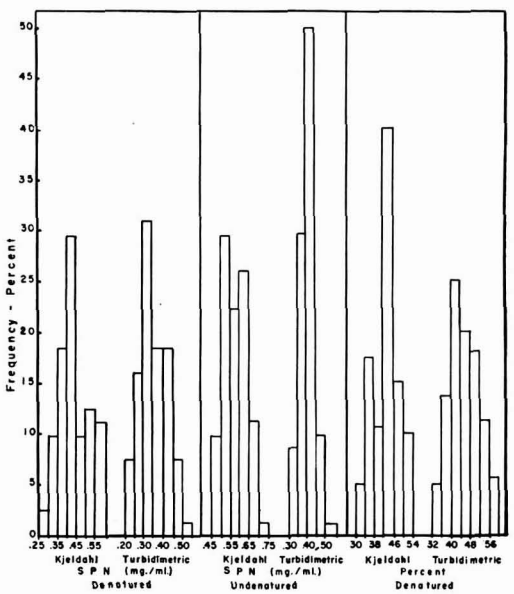

FIG. 4. Frequency distribution of amounts of serum protein denatured and undenatured and percentage denatured in 81 samples of skimmilk by heating at 165° F. for 30 minutes. (Data for five scattered samples with high amounts denatured omitted from histogram for amount denatured-Kjeldahl, data for one sample with low percentage denatured omitted from histogram for turbidimetric and for two samples with high percentages from that for Kjeldahl).

denatured and remaining undenatured after this treatment. The amount denatured was closely related to the total content of serum protein, as may be seen from Figure 5 and the correlation coefficients in Table 4. On the other hand, the amount remaining undenatured tended to be more constant. The percentage denaturation varied widely (Figure 4) but was much less closely correlated with total serum protein content than was the absolute amount denatured (Table 4).

Four samples taken at intervals during a period of 3 weeks from the bulked

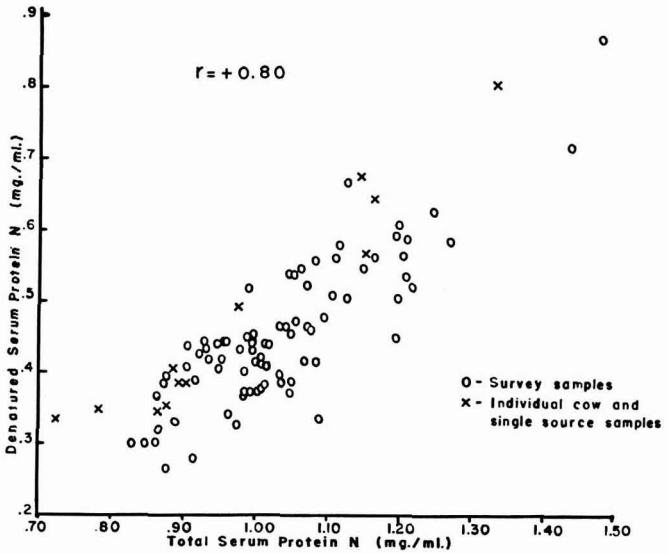

FIG. 5. Relation between serum protein nitrogen content (Kjeldahl) and amount denatured by heating at 165° F. for 30 minutes in 81 samples of mixed skimmilk, 8 samples from individual cows, and 4 samples from a single source.

milk supply of the University Milk Plant varied but little in serum protein content and in extent of denaturation by the 165° F.-30 minutes heat treatment (Table 5). On the other hand, samples from eight individual cows in the University herd exhibited considerable variability in serum protein content and in susceptibility to heat treatment (Table 6). These data have been included in Figure 5 to show that the relation between serum protein content and denaturation for these samples is similar to that for the 81 samples in the survey.

Thiamin disulfide reducing substances (TDRS). If milk is heated to temperatures above 160° F., protein –SH groups are made available for the reduction of thiamine disulfide *(1)*. The content of these TDRS in the 81 samples of milk that had been heated to 165° F. for 30 minutes varied from about 0.01 to 0.19 meq. per liter.

TABLE 4

Correlation coefficients relating serum protein content and denaturation by heating at 165° F. for 30 minutes

	Correlation coefficients[a]			
	Rowland method		Harland-Ashworth method	
	Total serum protein N	Heat labile serum protein N	Total serum protein N	Heat labile serum protein N
Amount denatured	+0.80	+0.88	+0.85	+0.84
Per cent denatured	+0.50	+0.72	+0.62	+0.57

[a] All of the coefficients in this table are considerably greater than the value of 0.283 required for significance at the 1% level with 79 degrees of freedom.

TABLE 5

Serum protein content and heat denaturability in four samples of skimmilk taken at weekly intervals from a single source of supply

Sample No.	Solids-not-fat	Rowland method		Harland-Ashworth method	
		Serum protein N	Denaturation[a]	Serum protein N	Denaturation[a]
	(%)	*(mg/ml)*	*(%)*	*(mg/ml)*	*(%)*
1	8.80	0.86	40.0	0.67	40.6
2	8.96	0.90	42.8	0.69	40.3
3	8.80	0.89	43.1	0.67	39.2
4	8.89	0.88	39.8	0.68	39.8
Average	8.86	0.88	41.4	0.67	40.0

[a] 165° F. for 30 minutes.

TABLE 6

Serum protein content and heat denaturability of skimmilk samples from individual cows

Cow No.	Solids-not-fat	Rowland method		Harland-Ashworth method	
		Serum protein N	Denaturation[a]	Serum protein N	Denaturation[a]
	(%)	*(mg/ml)*	*(%)*	*(mg/ml)*	*(%)*
T63	8.96	1.16	55.5	0.79	55.7
705	9.07	0.72	46.3	0.59	49.3
T66	9.22	0.88	46.2	0.71	46.8
T42	9.29	0.78	44.7	0.58	37.3
T46	9.32	1.15	49.2	0.86	47.8
706	10.04	0.98	51.0	0.78	56.2
707	10.10	1.15	58.9	0.78	54.4

[a] 165° F. for 30 minutes.

Since the total sulfhydryl content of the milk serum proteins may be estimated by the *o*-iodosobenzoate method *(5, 6)*, it was of interest to learn whether there was a relationship between the level of TDRS in the heated milk and the sulfhydryl content of the original milk. These data are shown in Figure 6. The relationship is not especially close ($r = +0.67$), but the content of TDRS in the heated milk does tend to increase with the –SH content of the raw milk.

C. *Influence of the age and copper content on –SH titer of raw and heated milk.* During this survey usually 2 or 3 days elapsed between the time the milk samples were collected at the various plants and the completion of the analytical work. Furthermore, it appeared unlikely that the amount of copper contamination would be the same in all samples. Accordingly, an experiment was planned to learn whether either of these factors was associated with the highly variable sulfhydryl data obtained for the 81 milk samples (Figures 3 and 6). Two cows were hand milked into carefully cleaned Pyrex flasks. The cream was separated from the skimmilk without delay by batch centrifugation, and each sample of skimmilk was divided into two portions. To one portion copper sulfate solution was added to give a copper content of 0.5 p.p.m. The total capacity of the skimmilk to reduce *o*-iodosobenzoate was determined on the fresh skimmilk both before and immediately after the addition of the copper. Secondly, the capacity of both the untreated and copper-treated samples to reduce *o*-iodosobenzoate and

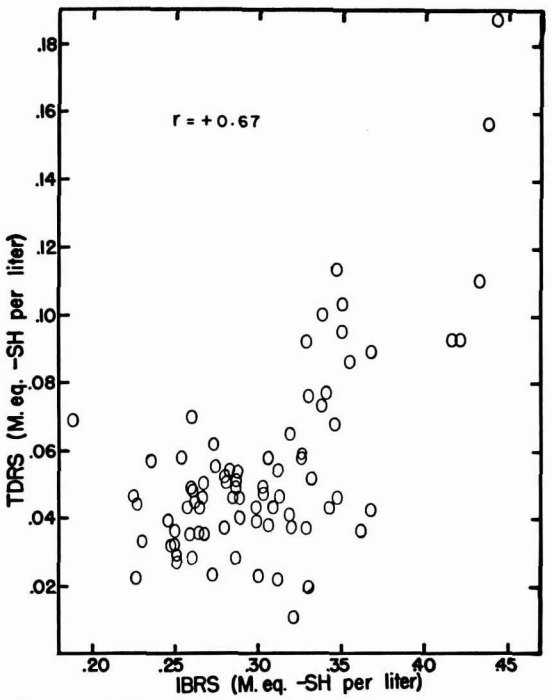

FIG. 6. Relation between total sulfhydryl content of 81 samples of raw skimmilk (IBRS) and active sulfhydryl content (TDRS) produced by heating at 165° F. for 30 minutes.

thiamine disulfide was estimated after heat treatment for 30 minutes at 165° F. Finally, these determinations and heat treatments were repeated after storage of the samples for 2 and 5 days at 34° F. The *o*-iodosobenzoate reducing titers are equilibrium values; that is, the samples were held at 34° F. for at least 48 hours after heating to allow time for oxidation of the "heat-activated" –SH groups. However, the thiamine disulfide analyses were performed immediately after heating.

The influence of the age of the sample and the addition of copper on the *o*-iodosobenzoate titer (IBRS) of skimmilk is shown by the bar graph of Figure 7. Aging or the addition of 0.5 p.p.m. of copper only slightly affected the IBRS content of the raw milk from cow No. 1 but considerably depressed that of the milk from cow No. 2. The final level of IBRS in the samples heated in the presence of copper appeared to be largely independent of the age of the milk and was comparable for both cows.

Table 7 shows that both copper contamination and aging depressed the content of thiamine disulfide reducing substances (TDRS) produced by heat treatment of both samples.

DISCUSSION

The variability in solids-not-fat, total nitrogen, and serum proteins among the samples surveyed is rather large when one considers that each sample repre-

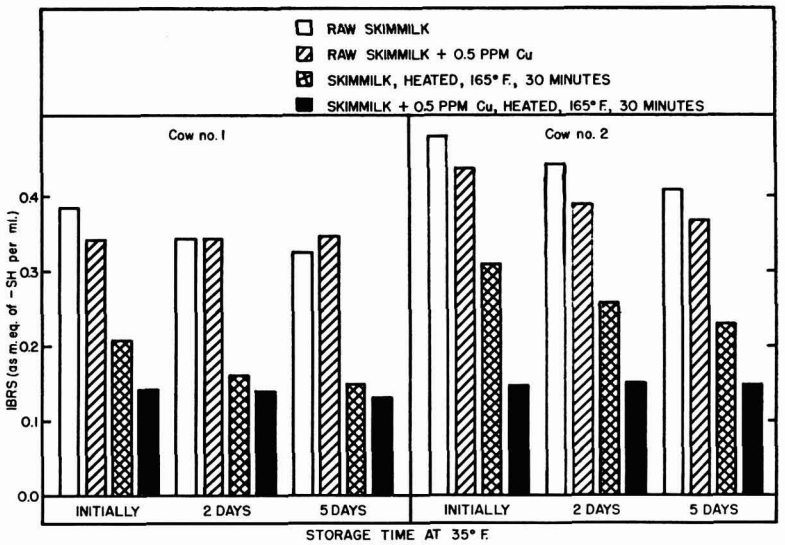

FIG. 7. Influence of age of sample, addition of copper, and heating at 165° F. for 30 minutes on the sulfhydryl content (IBRS) of two samples of skimmilk.

sents bulked milk from many cows. The differences are undoubtedly real, however, since the methods of analysis gave highly reproducible results for the control sample (Table 2). It was not the purpose of this survey to determine the underlying physiological causes for the variations in composition, and the only speculation that seems justified from the data is that the regional differences probably arise principally from differences in the predominant breed of dairy cattle.

As expected, the Harland-Ashworth method always gave a lower result than the Rowland, presumably because salt precipitates a protein fraction that acid does not. The fact that the difference between results by the two methods averages the same as, and is highly correlated with, the amount of heat stable "proteose" fraction is at least circumstantial evidence for the identity of the "proteose" with the fraction precipitated by salt but not by acid. However, if these frac-

TABLE 7

The influence of the age of the sample and the addition of copper on the thiamine disulfide titer (TDRS) of milk heated at 165° F. for 30 minutes

	Thiamine disulfide reducing capacity			
	Cow No. 1		Cow No. 2	
Age of milk	No Cu	0.5 p.p.m. Cu	No Cu	0.5 p.p.m. Cu
(days)	*(meq/l)*	*(meq/l)*	*(meq/l)*	*(meq/l)*
0	0.074	0.033	0.131	0.026
2	0.046	0.035	0.095	0.029
5	0.042	0.027	0.057	0.022

tions are identical, one would expect that no protein would remain in the salt filtrate of boiled milk or, in other words, that all of the serum protein determined by the Harland-Ashworth method would be heat labile. In this study an average of about 13% of the Harland-Ashworth serum protein seemed not to be heat labile. This is a somewhat greater proportion than previously reported *(2)*.

The natural variability in serum protein content seriously limits the value of serum protein determinations for assessing low-heat nonfat dry milk solids. In this case it is often desired to know the content of denatured serum protein, but this can only be calculated as the difference between the total and the undenatured serum protein. No great difficulty arises within an individual plant, where the serum protein content of the original raw milk can be determined. Indeed, in some plants, such as No. 10, the total serum protein content seems to be sufficiently constant to justify use of an average value throughout the year as a basis for calculation. In other plants, such as No. 6, the variability would make it unwise to use such an average. Certainly the geographic variability in serum protein content precludes accurate estimation of the amount of denatured serum protein in a sample of unknown origin and heat history by taking the difference between some "average" total serum protein content and the determined amount of undenatured serum protein. For example, if each of the 81 samples in the survey had been heated sufficiently to denature an amount of serum protein equivalent to 0.1 mg. of N per milliliter and then had been analyzed by the Harland-Ashworth method, the amount of denatured protein calculated by subtracting the undenatured from the average total of 0.76 mg. N per milliliter would range from –0.05 to +0.25 mg. N per milliliter, 45 of the samples falling from +0.05 to +0.15 and 71 from 0.00 to +0.20 mg. N per milliliter.

If the individual serum proteins were all denatured at the same rate and in accordance with first order kinetics, the absolute amount denatured in a given time at a given temperature would be proportional to the initial concentration and the per cent denatured would be constant. This would be true even though the individual proteins have different denaturation rates *(8)*, provided they were always present in constant proportions in the original raw milk. The data obtained with a heat treatment of 165° F. for 30 minutes exhibit a tendency toward this idealized situation in that the absolute amount of serum protein denatured is much more closely correlated with the total serum protein content than is the percentage denaturation. The variability in percentage denaturation doubtless is attributable to such factors as variations in proportions of the individual serum proteins in the mixture, variations in the ionic constituents which would affect denaturation rates, and the effects of one protein on the denaturation of another. In any event the determination of undenatured serum protein in a sample of unknown history does not constitute a very sensitive index of the heat treatment that it has received.

The variation in total sulfhydryl content is similar in extent to that reported by Larson and Jenness *(6)* for commercial mixed milk samples. Considerable variability is evident even on the basis of –SH per unit of serum protein (see Figure 3). Part of this variation may be due to differences in the proportions

of the individual serum protein components, but it now appears that some of it must be attributed to loss of sulfhydryls during aging, probably by oxidation.

SUMMARY

Eighty-one samples of fresh bulked milk, collected in ten regions of the United States in winter, spring, and fall seasons, were analyzed for nitrogen distribution, sulfhydryl content, and susceptibility of the serum proteins to heat denaturation. The variability in content of serum proteins and in their heat denaturability imposes serious limitations on the use of serum protein analyses for assessing dry milks of unknown history for specific uses. The sulfhydryl content not only exhibits a natural variability but is further affected by aging of the milk and contamination with copper.

ACKNOWLEDGMENTS

This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces and has been assigned No. 534 in the series of papers approved for publication. The views or conclusions in this report are those of the authors. They are not to be construed as necessarily reflecting the views or endorsement of the Department of the Army.

The financial support of the Minnesota Institute of Research is gratefully acknowledged. The authors wish to acknowledge also the help of the several individuals and organizations that collected and shipped the samples.

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THE EFFECT OF ARTIFICIAL LIGHT ON MILK IN COLD STORAGE

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The fact that sunlight exposure of bottled milk results in increased ascorbic acid oxidation and greater incidence and degree of oxidized and/or activated flavor development has been well established *(1, 4)*. Apparently, no experimental data have been published regarding the effect of incandescent or fluorescent light, at intensities normally found in market milk storage coolers, on bottled whole milk. However, Weckel and Chicoye *(5)* have noted a slight change of flavor in bottled skimmilk within 12-24 hours exposure to fluorescent light.

The objective of this study was to determine the effect of incandescent and fluorescent light, at light intensities normally found in market milk storage coolers, on ascorbic acid retention and oxidized flavor development in homogenized and cream-line milk.

EXPERIMENTAL PROCEDURE

Evening and morning mixed herd milk was obtained from the University dairy herd during December, 1953, and January, 1954. The milk was pasteurized by the high-temperature short-time method at processing temperatures used by many dairy plant operators. Some of the milk was homogenized at 2,000 p.s.i. and pasteurized at 170° F. for 19 seconds. Similarly, cream-line milk was pasteurized at 162° F. for 19 seconds. Both milks were cooled to 35° F. by means of a plate type cooler and bottled in half-pint clear glass bottles. The bottles were sealed with Seal-Hood caps. Approximately 1 hour elapsed between the end of the morning's milking and the completion of the bottling process.

Equal numbers of half-pint samples of pasteurized cream-line and homogenized milk were randomly placed in half-pint milk cases and stored at 40° F. in each of three milk storage rooms containing, respectively, no light, a 100-w. frosted white incandescent light, and two 40-w. cool white fluorescent lights. A sufficient number of samples were prepared so that each milk was exposed to no light or to 6, 12, or 18 ft-c. of incandescent or fluorescent light for 0-, 1-, 2-, and 4-day periods. The milk cases containing the samples to be exposed to the various intensities of light were placed on top of other cases at such a level that the light source from above was at the desired intensity when measured by means of a light meter. The light intensity was measured at the top of each sample case and at a point level with the top of the milk bottles. As each sample was removed for analysis, another half-pint sample was added in its place so that each case was filled at all times. The samples were removed at random at the end of each storage period and randomized prior to their analysis.

The criteria used to determine the effect of light on the bottled milk were ascorbic acid content and the degree of oxidized flavor development. Ascorbic

Received for publication February 18, 1955.

acid expressed as milligrams per liter was determined by the method of Woessner *et al. (6)*. This method was modified so as to permit the use of a Klett-Summerson photoelectric colorimeter. Flavor scores from four individual judgments were totaled and used to indicate the degree of oxidized flavor. The intensity of oxidized flavor was expressed as follows: absent (0), slight (1), distinct (2), and strong (3). The character of the flavor reported in this study is referred to as oxidized since it was more typically an oxidized than an activated flavor.

The analysis of variance of the ascorbic acid concentration and oxidized flavor scores included variability between types of milk, between sources of light, among levels of light intensity, and among days in storage, as well as the interactions of these four main effects. In addition, trends among the levels of light intensity and among days in storage were explored *(3)*. The total scores representing the degree of oxidized flavor were transformed into the square root of the total value plus 0.5 because of the preponderance of zero values *(3)*.

RESULTS

The effects of days in cold storage during the winter months and varying intensities of incandescent and fluorescent light on ascorbic acid levels in homogenized and cream-line milk are shown in Table 1.

The analysis of variance of the ascorbic acid levels indicated that exposure of homogenized and cream-line milk to incandescent and fluorescent light at inten-

TABLE 1

Effect of days in storage under varying intensities of incandescent and fluorescent light on ascorbic acid levels in homogenized and cream-line milk

Source of light	Light intensity	Days in storage			
		0	1	2	4
	(ft-c.)	Ascorbic acid *(mg/l)*			
		Homogenized milk[b]			
Incandescent	0	19.0[a]	17.7	15.9	11.2
	6	19.2	17.4	11.7	7.0
	12	18.9	16.3	10.5	4.5
	18	19.0	16.0	9.0	2.4
Fluorescent	0	18.9	17.4	15.7	11.2
	6	18.8	16.8	10.9	3.7
	12	18.9	15.6	8.7	1.8
	18	18.9	15.0	6.1	0.6
		Cream-line milk[b]			
Incandescent	0	18.3	14.6	9.8	3.7
	6	18.3	14.2	7.7	2.1
	12	18.3	13.1	6.6	0.6
	18	18.3	12.4	6.1	0.5
Fluorescent	0	18.6	14.3	9.8	3.7
	6	18.3	13.4	7.2	1.2
	12	18.4	12.2	4.6	0.9
	18	18.2	10.0	3.1	0.2

[a] Average for three replicates.

[b] Standard error for both milks $\sqrt{\frac{EMS}{3}} = 1.1$.

sities of 6, 12, and 18 ft-c. resulted in greater loss of ascorbic acid than when the milks were stored in the dark ($P < 0.001$). The artificial lights were more detrimental to the ascorbic acid content of homogenized milk than to that of cream-line milk ($P < 0.001$). Furthermore, exposure of the milks to incandescent light resulted in greater retention of ascorbic acid than exposure to fluorescent light ($P < 0.01$). The rate of loss of ascorbic acid was directly proportional to light intensity ($P < 0.001$ for the linear trend).

As was anticipated, a difference in the ascorbic acid content of the milks among 0, 1, 2, and 4 days in cold storage was observed ($P < 0.001$). The concentration of ascorbic acid decreased in a uniform manner with time in storage ($P < 0.001$).

The downward trend in the average levels of ascorbic acid in the homogenized and cream-line milk, when exposed to varying intensities of incandescent and fluorescent light for various periods of storage, was expressed by the following equations:

(1) $Z = 21.572 - 0.27X - 3.529Y$ (homogenized milk)
(2) $Z = 18.764 - 0.167X - 4.174Y$ (cream-line milk)

where Z represents the level of ascorbic acid; X, the light intensity, and Y, the days in storage.

The effects of days in cold storage during the winter months and varying intensities of incandescent and fluorescent light on degree of oxidized flavor ($\sqrt{\text{total score}} + \frac{1}{2}$) in homogenized and cream-line milk are shown in Table 2.

The analysis of variance of the transformed flavor scores, representative of the development of oxidized flavor, revealed that exposure of homogenized and cream-line milk to incandescent and fluorescent light at intensities of 6, 12, and 18 ft-c. resulted in greater incidence of oxidized flavor development than when the milks were stored in the dark ($P < 0.001$). There was no appreciable difference between homogenized and cream-line milks in their degree of oxidized flavor development due to exposure to the artificial lights, nor did the two types of light differ measurably in their effect on the development of the off-flavor. The degree of oxidized flavor development was directly proportional to light intensity ($P < 0.001$ for the linear trend).

As was anticipated, a difference in the degree of oxidized flavor development in the milks among 0, 1, 2, and 4 days in storage was noted ($P < 0.001$). The degree of off-flavor development increased directly with days in storage ($P < 0.001$).

DISCUSSION

The results indicated that lights in milk storage coolers should remain off as much as possible to minimize the oxidation of ascorbic acid and development of oxidized flavor in milk bottled in clear glass. This applies primarily to the bottled milk in the top tier of the stacked milk cases and especially to the portion nearest the light source. The results further indicated that lights in milk coolers, if they remain on for a major portion of the day, should be of minimum intensity to

TABLE 2

Effect of days in storage under varying intensities of incandescent and fluorescent light on degree of oxidized flavor (transformed scores) in homogenized and cream-line milk

Source of light	Light intensity	Days in storage			
		0	1	2	4
	(ft-c.)	Degree of oxidized flavor			
		Homogenized milk[b]			
Incandescent	0	0.707[a]	0.707	0.707	1.225
	6	0.707	1.462	2.327	2.353
	12	0.707	1.559	2.853	3.020
	18	0.707	2.181	2.968	3.187
Fluorescent	0	0.707	0.707	0.707	0.880
	6	0.707	1.171	1.774	2.402
	12	0.707	1.965	2.613	2.856
	18	0.707	1.836	2.912	2.942
		Cream-line milk[b]			
Incandescent	0	0.707	0.707	0.998	1.559
	6	0.707	1.171	2.084	2.533
	12	0.707	1.483	2.412	2.613
	18	0.707	1.774	2.387	2.905
Fluorescent	0	0.707	0.707	0.880	1.724
	6	0.707	1.344	1.793	2.482
	12	0.707	1.814	2.171	2.603
	18	0.707	1.656	2.712	2.700

[a] Average $\sqrt{\text{Score} + 0.5}$ for three replicates.

[b] Standard error for both milks $\sqrt{\frac{\text{EMS}}{3}} = 0.198$.

retard detrimental effects on milk and that incandescent light should be used in preference to fluorescent light in order to minimize ascorbic acid oxidation. There is the possibility that milk exposed to light in coolers might develop oxidized flavor and lose its original ascorbic acid content more readily and more quickly by further exposure to light on the milk route or on the customer's doorstep.

The relative stability of ascorbic acid in the homogenized milk samples stored in the dark and the instability of ascorbic acid in the cream-line milk samples similarly stored (Table 1) may be related to the pasteurization temperatures used for the two milks. Josephson and Doan *(2)* have indicated that sulfhydryl substances in milk heated in excess of 170° F. act as antioxidants towards ascorbic acid. Sufficient sulfhydryl compounds may have been formed at the higher pasteurization temperature used for homogenized milk in this investigation to prevent rapid oxidation of ascorbic acid during storage in the dark.

The fact that homogenization increases the susceptibility of milk to off-flavor development due to light exposure has been well established *(1, 4)*. However, there appeared to be no marked difference in degree of oxidized flavor development due to light exposure between homogenized and cream-line milk in this study. Sufficient sulfhydryls may have been formed at the pasteurization temperature of 170° F. used for homogenized milk to cause the degree of oxidized flavor development in homogenized milk to be less than anticipated and similar to that for the lower temperature pasteurized cream-line milk. Thus, higher

pasteurization temperatures may tend to retard oxidized flavor development in homogenized milk exposed to light. Conversely, a few practical plant operators have observed that homogenized milk pasteurized at minimum temperatures and exposed to light develops oxidized flavor to a lesser degree than when pasteurized at higher temperatures. This may be due to the higher temperature of pasteurization resulting in greater protein denaturation. The presence of this denatured protein may affect light absorption and contribute to the induction of off-flavors. More research is needed to clear up the discrepancies regarding the effects of various pasteurization temperatures on the development of off-flavors in milk exposed to light.

SUMMARY

Samples of homogenized and cream-line milk, pasteurized during the winter months and bottled in clear glass, were stored at 40° F. in the dark, under frosted white incandescent light (at intensities of 6, 12, and 18 ft-c.), and under fluorescent light (at intensities of 6, 12, and 18 ft-c.) for 0-, 1-, 2-, and 4-day periods.

Ascorbic acid oxidation and degree of oxidized flavor development were less and progressed at a less rapid rate in homogenized and cream-line milk samples stored in the dark than in aliquot samples exposed to 6, 12, or 18 ft-c. of incandescent or fluorescent light. Fluorescent light resulted in less ascorbic acid retention in homogenized and cream-line milk than did incandescent light, but no marked difference was noted between these two lights in respect to oxidized flavor development.

Lights in market milk storage coolers should remain off and/or be maintained at a low intensity to minimize ascorbic acid oxidation and oxidized flavor development in homogenized and cream-line milk during predelivery storage.

ACKNOWLEDGMENT

The authors wish to express their appreciation to L. R. Glazier, H. W. Jackson, A. H. Manke, and L. R. Mattick for their cooperation in scoring the milk samples. The authors are also indebted to H. D. Eaton for aid in the statistical aspects of this paper and to Cecilia Dembiczak for help in the statistical analysis of the data.

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BOVINE HYPERKERATOSIS (X-DISEASE): A REVIEW

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The names "hyperkeratosis" and "X-disease" have been widely used to designate a disease in cattle first described in detail by Olafson *(29)* in 1947. The condition was first recognized in May, 1941, in New York state and was recorded in 1942 *(11)*. The disease had been reported in 32 states by October, 1948 *(42)*. A cooperative project to study the pathology, cause, and treatment of the disease was initiated in 1949 by 17 agricultural experiment stations, the Bureau of Animal Industry, and the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

No accurate figures are available on the extent of the losses caused by the disease. Estimates *(23)* range from 2 to 4 million dollars annually for the years 1948-1952. It has also been estimated *(7)* that cattle worth 4 million dollars have died or been slaughtered because of the disease in the southeastern states alone. These estimates are probably conservative.

The disease has been reported in Germany by Wagener *(44)*, in Morocco by Martin and Hinterman *(25)*, in Australia by Whittem and Blood *(48)*, and in New Zealand by Haughey and Cooper *(17)*.

THE NATURE OF THE DISEASE

The symptoms and lesions of X-disease are numerous, and it should be emphasized that thickening of the skin is only one of the lesions which develop as the disease progresses. Olafson *(29)* and Olafson and McEntee *(30)* described profuse lacrimation and salivation, depression, anorexia, and loss of condition in cattle affected with the disease. Severe diarrhea was seen in some of the affected animals. In addition, mastitis, prolonged gestation, dystocia, retained fetal membranes, and metritis were noted in cows with hyperkeratosis. Retarded growth of the horns was noted in younger animals. These authors also noted papillary proliferations on the tongue, oral mucosa, and esophageal mucosa and in the gall bladder and large bile ducts. Cystic dilatation of the renal tubules, as well as of the gastric and intestinal glands, was described. A slight fibrosis was found to accompany proliferation of the smaller bile ducts, as well as fibrosis of the pancreas and proliferation of the ducts. Squamous metaplasia occurred in the interlobular and main ducts of the parotid and submaxillary salivary glands.

McEntee and Olafson *(27)* have described the pathology of the reproductive tract in cattle with hyperkeratosis. In bulls, squamous metaplasia of the accessory sex glands and excretory ducts of the testes occurred. The pseudostratified columnar epithelium of the epididymis gradually stratified and in some areas the lumen became plugged with keratin. The epididymis became enlarged and hardened so that the condition could be diagnosed by palpation in the living animal. In mature bulls the germinal epithelium disappeared, leaving tubules

Received for publication January 6, 1955.

lined chiefly with Sertoli cells, and the basement membranes became hyalinized. Approximately 10 months is required for the reestablishment of normal spermatogenesis once these changes have occurred in a severe case of experimentally produced hyperkeratosis, according to the data of Vlahos *et al. (43)* and Olson and Skidmore *(37)*.

In cows and heifers metaplasia of the cervix and Gartner's ducts occurred along with moderate dilation of the endometrial glands. The ovaries became small and inactive *(27)*.

The plasma vitamin A in cattle decreased to extremely low levels within 5 days after the substance which produced the disease was fed *(13)*, and the blood levels of ascorbic acid are reported *(20, 28)* to be elevated in cattle with hyperkeratosis.

Hove *(19a)* has presented data showing that X-disease in cattle is associated with a decrease in plasma tocopherol.

Jubb *(21)* has found that the acidophylic cells of the anterior pituitary undergo nearly complete degranulation in cattle with hyperkeratosis, an effect not seen in cattle having a simple vitamin A deficiency.

These symptoms and lesions have been described, in whole or in part, by most investigators working on bovine hyperkeratosis. These include, among others, Bell *(1, 2)*, Sikes and Bridges *(38)*, Olson *et al. (35)*, Miller *et al. (28)*, Sippel *(40)*, Wagener *(44)*, and Kohler *(22)*.

Sheep fed large amounts of the same toxic feed that produced hyperkeratosis in cattle developed somewhat different lesions, including liver cell necrosis, regeneration, and fibrosis, but no bile duct proliferation *(27)*. In the ram some testicular degeneration occurred, but metaplasia of the excretory ducts of the testes and accessory sex organs did not occur. In the ewe squamous metaplasia of the endometrial glands with profuse keratinization developed.

ISOLATION AND IDENTIFICATION OF THE CAUSATIVE AGENT

In the earlier phases of the research on hyperkeratosis some workers believed the disease was caused by a virus. Attempts to find an infectious agent resulted in numerous negative reports *(11, 12, 34, 35, 40)*.

At the outset, one of the most enigmatic aspects of the hyperkeratosis problem was the apparent dissimilarity of the numerous substances which were involved in various outbreaks of the disease. Olson *et al. (35)* produced the disease in calves by feeding pelleted dehydrated alfalfa and dicalcium phosphate. Olafson and McEntee *(30)* produced the condition by feeding a processed wheat concentrate. Miller *et al. (28)* fed a particular lot of timothy hay and produced hyperkeratosis. Wagener *(44)* and Hansel *et al. (13, 14, 31)* reported the production of hyperkeratosis by a particular lot of a wood preservative produced in Germany. Bell *(1)* produced the disease by feeding a lubricant. Washko *et al. (46)* produced the disease in calves placed on a farm where a natural outbreak had previously occurred. The calves received only pasture and block salt.

A few of the reports of substances which failed to produce hyperkeratosis may be cited. Thomas and Moss *(41)* found no evidence of X-disease in young

dairy bulls fed toxic amounts of molybdenum. Gibbons *et al. (9)* showed that cases of X-disease in Alabama had not been produced by DDT. Miller *et al. (28)* failed to produce the disease by feeding rancid fat, naphthalene, and pentachlorphenol. In earlier studies, Olafson *et al. (32)* fed numerous substances without producing the disease. These included a thallium salt, naphthalene, alphachloronaphthalene, many surface-active agents, mineral oil, DDT, 19 different commercial lubricants, and heat-polymerized linseed oil.

In 1951, the nature of the disease was somewhat clarified by the ether extraction and preliminary fractionation of the causative agent from a processed wheat concentrate reported by McEntee *et al. (26)* and Hansel *et al. (13)*. The substance appeared in the free-fatty acid fraction of the extract but not in the phenolic or neutral steroid fractions. In later fractionations it was found that the active principle itself was not a fatty acid but appeared in the nonsaponifiable fraction of the ether extract.

In 1952, evidence from three sources showed highly chlorinated naphthalenes to be the causative agents of X-disease. Bell *(2)*, working in cooperation with the research laboratories of the company which produced the lubricant previously shown to cause the disease, found that highly chlorinated naphthalene which had been added to the lubricant was the causative agent. Sikes and Bridges *(38)* and Sikes *et al. (39)* produced the disease with pentachlornaphthalene. Olafson *et al. (31)* and Hansel *et al. (14)* isolated the causative agent from the German wood preservative and identified it by infrared and ultraviolet absorption curves and micro-analyses as a highly chlorinated naphthalene. Later, Hansel *et al. (15)* isolated the causative agent from the processed wheat concentrate and also identified it as highly chlorinated naphthalene. This wheat concentrate consisted of bread crumbs obtained from the floor beneath the slicing and wrapping machine in a bakery. The bread itself was not found to be toxic.

Blickenstaff and Callen *(4)* isolated the causative agent from a lot of pelleted cottonseed meal and identified it as a highly chlorinated naphthalene by infrared and ultraviolet absorption spectra, microanalysis, and X-ray diffraction patterns.

Bell *(3)* has studied the relative toxicity of the chlorinated naphthalenes. Naphthalenes containing 36.0 and 46.0% chlorine (corresponding to di- and trichloro derivatives) did not produce the disease. Slight symptoms were produced by tetrachloronaphthalene, and all of the more highly chlorinated derivatives produced the disease. Olafson and coworkers *(32)* have obtained similar results. Some naphthalenes of higher and lower levels of chlorination were probably present in the purified naphthalenes used in these studies, and in addition each of the above fractions contained several isomers differing in the relative positions of the chlorine on the naphthalene nucleus. For example, there are 14 position isomers of pentachloronaphthalene. The materials isolated from the wood preservative and the processed wheat concentrate were probably mixtures of naphthalenes of various degrees of chlorination. The material isolated from the pelleted cottonseed meal *(4)* had a chlorine content similar to that of pentachloronaphthalene but probably consisted of a mixture of highly chlorinated naphthalenes. Studies of the effects of each of the various isomers would be of

interest, but the problem of obtaining each isomer in a pure state is an extremely difficult one.

Although the methods used to isolate and identify chlorinated naphthalene from the German wood preservative *(14)*, the processed wheat concentrate *(15)*, and the pelleted cottonseed meal *(4)* all proved useful for the particular substance being studied, no simple method for measuring the chlorinated naphthalene content of various feeds has yet been devised. The method of Blickenstaff and Callen *(4)* is likely to be the most useful for feedstuffs containing relatively small amounts of chlorinated naphthalenes, but it does require some special equipment. Engel *et al. (8)* have developed a colorimetric method for the determination of chlorinated naphthalenes based on the production of a yellow color when petroleum ether solutions of these compounds are combined with dimethyl aniline. This procedure proved applicable to the detection of highly chlorinated naphthalenes in petroleum products but has not been successfully applied to animal feeds.

The removal of chlorinated naphthalenes from products that might be consumed by cattle somewhat deemphasizes the need for a simple method for their determination.

COMMERCIAL USES OF HIGHLY CHLORINATED NAPHTHALENES

Highly chlorinated naphthalenes have been added to lubricants as extreme pressure agents, and the use of such lubricants on feed-pelleting machines has been responsible for many cases of hyperkeratosis. Copenhaver and Bell *(6)* prepared a pelleted feed, using a lubricant containing 3% chlorinated naphthalene on the pelleting machine and produced hyperkeratosis in calves fed the pelleted feed. A control lot of calves fed pellets made when the mill was lubricated with a lubricant not containing chlorinated naphthalene did not develop the disease. A lesser number of cases of the disease have occurred as a result of cattle licking grease containing highly chlorinated naphthalene from farm machinery. Gregory *et al. (10)* have reported the production of hyperkeratosis by feeding a concentrate contaminated only by the vapors of octachloronaphthalene that was painted on the walls of a storage room.

Other commercial uses of highly chlorinated naphthalenes that might possibly lead to their accidental consumption by cattle are: *(a)* additives for motor tune-up oils, *(b)* electrical insulating compounds, *(c)* flame resistant agents for paints, floor finishes, plastics, and fabrics, *(d)* electrical sealing compounds and *(e)* binders for ceramics.

CHLORINATED NAPHTHALENES AND VITAMIN A METABOLISM

The effect of chlorinated naphthalenes on vitamin A metabolism has been repeatedly demonstrated. Hansel *et al. (13)* found that plasma vitamin A levels declined rapidly when substances which produced hyperkeratosis were fed, and this effect proved useful in subsequent fractionation and isolation studies. The low plasma vitamin A levels persisted for at least 1 month beyond the period

during which the toxic agents (later shown to be chlorinated naphthalenes) were fed. Hoekstra *et al. (19)* reported similar findings and noted partial, temporary alleviation of the hyperkeratosis syndrome as a result of vitamin A therapy over 9-12 day periods. In general, the use of vitamin A therapy for hyperkeratosis has been disappointing. Calves fed highly chlorinated naphthalene will develop hyperkeratosis despite the concurrent administration of massive daily doses of vitamin A, although the appearance of the symptoms is slightly delayed *(32, 47)*. Plasma vitamin A returns to low levels after cessation of the vitamin A therapy in affected animals *(13, 19)*. The question of whether vitamin A deficient animals are more susceptible to chlorinated naphthalene poisoning than are normal animals has not been satisfactorily settled.

Goats, sheep, swine, mice, chickens, and rats, in contrast to cattle, all appear resistant to chlorinated naphthalene poisoning *(19, 32)*. In recent experiments Warner *(45)* has shown that dairy calves depleted of their vitamin A stores will succumb to the disease and exhibit low vitamin A plasma levels when a total of 500 mg. of chlorinated naphthalene is fed with either vitamin A or carotene. With similar treatment vitamin A depleted goats appeared normal in all respects and maintained normal plasma A levels. The relationship of this species difference in susceptibility to the well-known species differences in carotene-vitamin A metabolism is not yet understood. The highly chlorinated naphthalenes may prove useful research tools in studies of vitamin A metabolism in various species.

EFFECTS ON GROWTH, REPRODUCTION, AND LACTATION

Decreased growth rate or loss of weight in cattle with hyperkeratosis has been mentioned by many workers *(6, 19, 23, 28, 30)*. Since growth rates are influenced by so many nutritional and hormonal factors, it is useless to speculate at present on the mechanism of this action of the chlorinated naphthalenes. It is not unlikely that a reduced feed intake, the anti-vitamin A effect, and the degranulation of the acidophyls in the anterior pituitary are all factors in the adverse effects of chlorinated naphthalenes on growth rates.

Failure of the reproductive processes in cattle with hyperkeratosis is almost a necessary sequel to the lesions previously described *(27)* of the reproductive tracts of both bulls and cows. Spermatogenesis ceases in bulls with experimentally produced hyperkeratosis, and normal sperm production is not reestablished for approximately 10 months *(43)*. Abortions are likely to occur in cows pregnant at the time of the outbreak of the disease *(23, 29, 39)*. Olson *et al. (36)* have shown that reproduction is not permanently impaired by the disease. Ninety-four heifers that recovered from an outbreak of the disease eventually produced normal calves. In general, those most severely affected with the disease were the slowest to conceive.

A decreased milk flow and a decreased percentage of fat in the milk occur in cows with hyperkeratosis *(23, 32, 39)*. Olson *(33)* and Olafson and McEntee *(30)* have reported the development of hyperkeratosis in calves receiving milk from cows with the disease. Indications are that the causative agent appears in the milk for a considerable period of time after it is withdrawn from the feed.

OTHER SUBSTANCES POSSIBLY RELATED TO HYPERKERATOSIS

Although many of the outbreaks of X-disease have now been traced to highly chlorinated naphthalene ingestion, some outbreaks of the disease are still unexplained. At the same time, there is no convincing evidence that substances other than highly chlorinated naphthalenes produce the disease. Hoekstra *et al. (18)* produced skin lesions in calves by spraying them with mineral seal oil, but these authors point out that the condition produced differed from that produced by their hyperkeratosis-producing feed, or by highly chlorinated naphthalene. Lesions were not observed in the gastrointestinal tract, gall bladder, or kidneys. Harshfield and Rehfeld *(16)* also have reported a chronic dermatosis in cattle as a result of oil applications. No symptoms other than those on the skin were noted.

Carll *et al. (5)* isolated three species of aspergilli from the same processed wheat concentrate used by other workers to produce hyperkeratosis. Bread on which one of the aspergilli had been cultured was toxic when administered in an aqueous slurry by stomach tube. The lesions produced, however, were not characteristic of hyperkeratosis, and this same lot of processed wheat concentrate has also been shown to contain highly chlorinated naphthalenes *(15)*. In addition to the material isolated and identified as highly chlorinated naphthalene, the German wood preservative *(14)* also contained a second active fraction, having an odor similar to that of trichlorobenzene. This fraction was contained in the steam distillate from the wood preservative. Fractional distillations indicate that this material consists largely of a mixture of dichloronaphthalenes *(32)*.

It is noteworthy that no new outbreaks of the disease have been reported during the past year *(24)*. The cooperation of oil companies and feed processors in eliminating chlorinated naphthalenes from products used on the farm has been an important factor in the reduction of the incidence of the disease.

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COMPONENTS OF THE RELATIONSHIP BETWEEN LEVEL OF PRODUCTION AND RATE OF MATURITY IN DAIRY CATTLE

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It is important in selection programs to arrange for the optimum combination of selection pressure and size of the generation interval to obtain the maximum rate of improvement *(2, 5, 10)*. In the selection of dairy sires, genetic rate of progress can be increased by using only first lactations of daughters because of the decreased age of sires when progeny tests become available *(11)*. However, sires might be ranked differently if more than first lactation records are considered. To determine whether first lactation production is influenced by differences in rate of maturity is the object of this study.

Lush *(6)* and Spalding *(13)* have shown discrepancies between different sets of age correction factors. This indicates that environmental factors affect the shape of the age curve. Johansson *(5)* states that increase in production with age decreases with increased level of feeding and management. Genetic information on the relationship between age and level of production has not heretofore been available.

In recent years, with the widespread establishment of artificial insemination programs, there has been frequent criticism of the use of daughters' first lactation production for sire evaluation on the basis that such a practice would adversely affect life-time production. Sufficient experimental information is not available to judge the validity of this criticism. Although Rendel and Robertson *(9)* have shown that longevity is not of major importance in the economics of milk production, they further point out that even a slow but gradual reduction in longevity should be avoided because of the resulting decrease in possible selection intensities.

Brody *(1)* shows that there exists a striking inverse relationship between rate of maturity and longevity among species. Such a genetic association reflected in production traits would have to exist within a breed of dairy cattle to cast doubt on the advisability of selecting sires on their daughters' first lactation production.

Production measurements of longevity in dairy cattle are difficult to obtain, if available at all. However, because of the relationship between age and production level it is possible to obtain corresponding measurements of rate of maturity and level of production.

SOURCE AND ANALYSIS OF DATA

The D.H.I.A., I.B.M. recorded data from New York state were available for this study. For the main part, first and second lactation records for cows with

Received for publication February 4, 1955.

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at least two records and freshening first between the ages of 18 and 34 months were used. Represented were 3,912 cows located in 1,094 different herds by 126 different artificially used sires, and covering eight different years. All corresponding single lactation[2] records were also obtained for additional study with caution not to include first lactation records for which insufficient time existed for the reporting of a second record. The pertinent information recorded on each I.B.M. card was:

1. Mature equivalent, 2×, 305-day, milk and fat production.
2. Age at freshening.
3. Individual number.
4. Sire and dam number.
5. Herd number.

Incomplete records were eliminated but complete lactations which were shorter than 305 days were included.

All major analyses were performed on I.B.M. machines. The 3,912 paired lactation records were summary punched onto a new deck of cards. The new deck contained, in addition to the information listed above, the increase in milk and fat production[3] and age at freshening from first to second lactation. The age at freshening measurements were included since it is known that age at freshening is determined partly by size or live weight. These data were analyzed according to the procedure presented by Henderson *(4)* for the estimation of variance components.

The first analysis was based on a within-year, herd × sire classification. This classification was chosen to avoid confusing herd and sire variation with environmental annual trends in level of production, which were known to be very large. The analysis enabled the estimation of residual, sire, herd, and herd × sire variances for level of production,[4] increase in level of production from first to second lactation, calving interval, and age at first freshening. Aside from variation in generation interval and selection intensities the ratio of the residual variance to the sire variance, (σ^2_e/σ^2_s) is a measure of the relative effectiveness of sire selection for a particular trait. The larger this ratio, the greater is the residual or unexplainable variation in relation to the sire variation. Thus, the smaller the ratio, the greater the accuracy in ranking sires according to their transmitting abilities. These ratios, along with the estimates of variances for all traits are presented in Table 1. A detailed explanation of variance estimates resulting from similar data is given by Dunbar and Henderson *(3)*.

The very large sire variance for age at freshening and the herd times sire variance for all production traits indicated the need for additional investigation. It was decided to study the seasonal variation for all traits and, as a result, the data in Figure 1 were obtained. In this figure are plotted the unweighted yearly

[2] First lactations will refer to first lactations which were followed by at least one lactation and single lactations will refer to first lactations which were not followed by another lactation.

[3] Production or record will refer throughout to records corrected for age.

[4] Level of production was measured by first lactation records.

TABLE 1
Components of variation from within-year analysis

Trait	Variance component estimates[b]				
	σ^2_s	σ^2_h	σ^2_{hs}	σ^2_e	σ^2_e/σ^2_s
Milk production[a]	3,569	21,905	8,548	30,853	9
Fat production	433	3,718	526	3,641	8
Age at first freshening	1.0	2.4	−0.4	6.3	6
Calving interval	−0.02	0.6	0.5	3.8	∞
Increase in:					
Milk production[a]	986	6,429	128,587	39,714	40
Fat production	155	1,075	1,315	4,769	31

[a] As the original milk production records were rounded to the nearest 10 lb. the variances refer to units of 100 squared lb.

[b] σ^2_s = sire variance, σ^2_h = herd variance, σ^2_{hs} = herd × sire variance, σ^2_e = residual variance.

averages by month of freshening for milk and fat production and age at first freshening. The latter measurement contains variation similar to that which Plum and Lush *(7)* detected in the Iowa cow testing population. This variation is caused by a conscious attempt on the part of dairymen to postpone the breeding of cows that would otherwise freshen in the summer, so that they will freshen in the fall or winter. The fall and winter periods are shown in Figure 1 to be favorable to high production. Because of this high seasonal variation, the data were divided into three seasonal groups according to the month of freshening.

Since a disproportionate number of progeny among sires over seasons would bias upwards estimates of the sire variance, a chi square test of this possible disproportionality was performed. With 668 degrees of freedom, the resulting chi square value of 910 indicated beyond doubt that sires had different frequencies of progeny numbers over seasons. Hence, the data were reanalyzed according to a general factorial arrangement of herds, sires, and year-seasons in an attempt to correct for the seasonal variation. In addition to the necessary assumption of independent and random herd and sire effects, in the previous analysis, the present analysis assumes that time trend effects are also independent random variables.

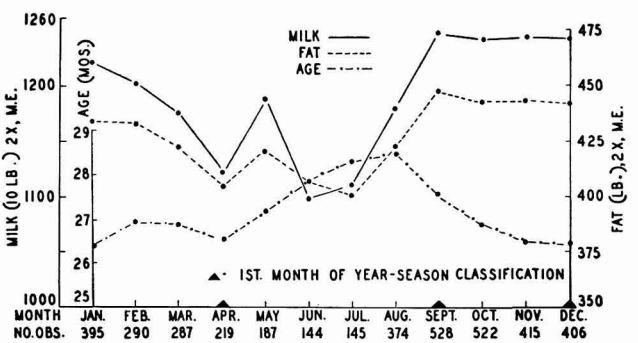

FIG. 1. Seasonal variation in age first fresh and level of production.

TABLE 2
Variance components from factorial analysis

Trait	Variance component estimates[b]						
	σ^2_s	σ^2_h	σ^2_p	σ^2_{hs}	σ^2_{hp}	σ^2_e	σ^2_e/σ^2_s
Milk production	4,651	20,001	2,699	1,139	9,546	28,693	6
Fat production	625	2,829	404	210	1,280	3,258	5
Age at first freshening	0.2	1.6	0.2	−0.3	1.4	6.4	32
Increase in:							
Milk production[a]	2,250	2,085	2,990	6,754	8,385	35,643	16
Fat production	226	345	447	1,071	1,115	4,467	20

[a, b] Refer to Table 1.

Table 2 contains the variance estimates resulting from the factorial analysis along with the ratios (σ^2_e/σ^2_s). The calving interval measurement was dropped from this and other analyses because the first analysis confirmed previous studies *(3, 8)* that it contains little genetic variation.

Another investigation was required, namely, a study of the association between level of production and increase from first to second lactation production. This was conveniently accomplished by using the previously applied techniques to the estimation of covariances. From these, together with previous variance estimates, could be estimated various environmental and genetic correlations.

TABLE 3
Estimated correlations between level of first lactation production, age, and increase in production with age

Traits	Correlation coefficients		
	$r_{gg'}$	$r_{hh'}$	$r_{ee'}$
Fat production and increase	0.248	−0.951	−0.515
Milk production and increase	−0.040	−0.564	−0.366
Age at freshening and increase in fat production	0.748	−0.985	−0.033

A within-year analysis was used to estimate the covariances between level of fat and milk production for first lactations and increase in production from first to second lactation production and between age at first freshening and increase in fat production. The following correlations were estimated and are presented in Table 3 for the three pairs of measurements.

1. Genetic correlation $= r_{gg'} = \dfrac{\sigma_{ss'}}{\sqrt{\sigma^2_s\,\sigma^2_{s'}}}$

2. Herd correlation $= r_{hh'} = \dfrac{\sigma_{hh'}}{\sqrt{\sigma^2_h\,\sigma^2_{h'}}}$

3. Residual correlation $= r_{ee'} = \dfrac{\sigma_{ee'}}{\sqrt{\sigma^2_e\,\sigma^2_{e'}}}$

The prime indicates that two traits are involved; $r_{ee'}$ was obtained by subtracting from the residual variances and covariance three-quarters of the corresponding genetic variances and covariances because the residual variance and

covariance contains cow variation and variation due to Mendelian sampling, both of which contribute a total of three-fourths genetic variance or covariance.

These correlations are subject to some limitations of interpretation. It is known that an automatic association between level of production and increase in level of production exists because it is somewhat similar to the correlation between a whole and a part of the whole. This is not a serious limitation because the automatic part of the association is contained in the residual covariance. Yet the variances used in the correlation formulas are biased because of selection practiced. Thus, the correlations estimated are biased only in magnitude but not in direction.

It was recognized at the outset that the estimates of sire variances for increase in level of production are subject to bias by disproportionate rates of culling among sire progenies. The greater the culling pressure on first lactation performance for a group of progeny, the larger the drop in production from first to second lactation because of the lack of perfect repeatability of level of production among lactations within cows. Therefore, the data used for estimating the variances and covariances were merged with records of single lactation daughters of the same bulls. Summary cards were produced for sires within years containing total production for first and single lactations and the corresponding number of lactations. With these, a least-squares analysis was performed to test the significance of:

1. The variation among sires in the difference between their single- and first-lactation-daughter production and age fresh.
2. The variation among sires in level of production and age fresh of all daughters.
3. The variation among single and first lactation production and age fresh.

The mean squares and F values resulting from this analysis are presented in Table 4.

TABLE 4

F tests on the first and single lactation production difference, and the sire variance for both this difference and level of production

Trait		1st vs. single lac. production	Sires	Sires × 1st vs. single lac. prod.	Residual
Age	m.s.	17.64	30.90	6.59	8.49
	F	2.08	3.64	0.78	
Milk	m.s.	742,524.60	144,816.89	61,247.40	65,049.77
	F	11.41	2.23	0.94	
Fat	m.s.	123,931.40	17,293.86	7,713.69	8,242.47
	F	15.04	2.10	0.94	
	d.f.	7	323	243	5,753[a]
F for : $P(F \geqslant F_o)$					
	0.01	2.64	1.25[a]	1.25[a]	
	0.05	2.01	1.17	1.17	

[a] The F_o values were obtained from the table presented by Snedecor *(12)* and are for 200 d.f. for the numerator mean square. Infinite d.f. were used for the denominator mean square.

The results presented in Table 4 indicate that selection bias in estimates of the sire variances for increase in production was nonexistent because of the nonsignificant interaction mean square for sires times first vs. single lactation production. Sires are indicated as having a significant effect on age at freshening and level of milk and fat production. The significant mean squares for first minus single lactation differences refer to –0.6 months of age, 1,338 lb. of milk and 60 lb. of fat and indicate that selection was practiced for high production. However, the fact that the single lactation cows are shown to be older at first freshening than cows having more than one record indicates a size difference in favor of the selected cows. Whether this size difference was caused by selection for production or directly by selection for size could not be determined with the data at hand.

Another similar least squares analysis involving herds in place of sires indicated rates of selection varied considerably among herds. Because of this interaction it was found that herd variation is larger after selection than before selection when all records are considered.

DISCUSSION

Two variance components analyses have shown that rate of maturity as measured by increase in production from first to second lactation is from one-fourth to one-third as heritable as level of first lactation production (Tables 1 and 2). Age at freshening was indicated in the first analysis to be largely determined by the sire. However, by removing seasonal trends the sire influence was shown to be small and unimportant.

A strikingly high herd times sire interaction resulted from the within-year analysis. It was suspected that with the confounding of sires with years and a possible large herd times time period interaction the herd times sire interaction was biased upwards. This was confirmed with a factorial analysis which permitted a simultaneous estimation of both the herd times sire and sire times year-season interaction.

The estimated correlations between level of first lactation production and increase in level of production from first to second lactation indicate several important considerations in relation to the operation of a dairy cattle breeding program. Of primary importance here is the indication of a zero or slightly positive genetic correlation between level of production and the age effect on level of production. Therefore, sire selection on the basis of first lactation daughter performance might increase but most likely would not change the increase from first to second lactation production in future generations. Since the shape of the "age curve" is not independent of separate age effects, it appears from the present results that selection on the basis of level of first lactation production would favor increased life-time production.

The corresponding correlation estimates among herd averages are strong indications of the need for separate age correction factors for herds producing at different levels. This is in addition to their importance in pointing to the need for studies dealing with effect of level of feeding and management on longevity.

It would appear that the higher the level of herd feeding and management, the smaller the increase from first to second lactation production. This probably results from a positive association between rate of heifer development and level of production among herds.

The negative residual correlation is in agreement with the low repeatability between first and second lactation production, as has been shown by many studies. With beneficial chance effects on first lactation production, the expectation is that the chance effects will not be in the same direction of influence for the second lactation because of the low correlation between successive records.

The negative correlation for herds between age and difference between first and second lactation production is probably the result of herd differences in age and the relation between age and size. Dairymen who breed their heifers young are probably breeding them smaller than the over-all average size of heifers when bred. With the assumption that this corresponds to a low level of nutrition the expectation is that the increase in production from first to second lactation would be greater for heifers bred young and smaller for heifers bred old. This correlation represents, in part, the same phenomenon as does the corresponding negative correlation between level and increase in production among herds. It also points to a need for greater scrutiny in developing age correction practices for individual herds, or for sire selection in artificial insemination when bulls' progenies are in different herds.

The genetic correlation between age at first freshening and increase from first to second lactation fat production is surprisingly large in a positive direction. It is not reasonable to assume that sire progenies differ in relation to feeding levels or other environmental influences. However, it is perhaps possible to consider that the younger a sire's progeny at freshening or at breeding, the more developed they are for their age and the less is the increase from their first to second lactation production. Another possibility is that of a discrepancy observed in the age correction factors used.

Lush and Shrode *(6)* and Spalding *(13)* have shown that these factors are too large for heifers in their first lactation and too small for second lactation heifers. The existence of such a discrepancy would obviously cause a positive correlation between age and difference between first and second lactation production since, as age decreased, the first lactation would be continuously biased upward and the second lactation would be simultaneously biased downward. An increase in age would likewise be associated with a change in the same direction for difference in level of production. This bias is believed to be exaggerated by the fact that within-year variation for age of sire progenies has been shown to be overly large by the disproportionate use of sires over seasons.

SUMMARY

Evidence is presented by the use of a variance and covariance analyses technique applied to production records of artificially sired cows to support the use of first lactation records on daughters of young dairy cattle sires being evaluated.

The heritability of rate of maturity reflected in change of production with age was found to be one-third to one-fourth that of level of production.

It is shown that level of herd production has far more influence on the relationship between level of production for successive lactations than does level of production among progeny groups of sires, the latter association being essentially zero. An increase in level of production among herds is accompanied by a decrease in the increase from first to second lactation production.

Herd variation was found to be the largest single source of variation in production traits. The fraction of herd variation which is genetic was not estimated, but it was found that sires may be expected to be ranked in the same order according to daughter production in different herds.

ACKNOWLEDGMENT

This study was made possible through facilities and organization provided by the Extension Division, Animal Husbandry Department, Cornell University, and the New York Artificial Breeders' Cooperative, Inc., Ithaca, N. Y.

The senior author's participation was made possible through the Canada Department of Agriculture's educational leave policy.

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THE COMPARATIVE EFFECTS OF VARIOUS ANTIBIOTICS AND AN ARSENICAL UPON THE GROWTH, HEALTH, AND CERTAIN BLOOD CONSTITUENTS OF DAIRY CALVES[1,2]

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The effects of antibiotic feeding to dairy animals have been summarized in recent articles *(15, 22)*; therefore, extensive review seems unnecessary. Numerous investigators have observed that aureomycin has a growth-stimulating effect on dairy calves, and several reports have attributed a similar effect to terramycin. A slight growth stimulation from bacitracin supplementation of calf rations also has been suggested *(10, 27)*. Studies with *p*-amino phenyl arsonic acid indicated an improvement of hair coat and general appearance of calves but growth effects were inconsistent *(3, 11)*. Penicillin appears to be ineffective in promoting calf growth *(16, 21, 27)*.

The occurrence of macrocytic anemia and leucopenia following the feeding of either penicillin or aureomycin to calves in amounts of 50 and 100 mg. per day, respectively, has been indicated in a recent report from Denmark *(18)*. However, no serious hematological reactions to antibiotic feeding have been observed in studies conducted in the United States with various species of animals. Therapeutic administration of chloromycetin has been suggested as an etiological agent in the development of certain blood dyscrasias in human beings *(17)*. No report on the feeding of chloromycetin to ruminants has been encountered; however, inhibition of in vitro cellulose digestion by rumen microorganisms has been demonstrated *(12, 28)*.

The mechanism of antibiotic and arsenical action in growth stimulation is unknown; nevertheless, the preponderance of evidence suggests that control of "debilitating infection" may be involved *(14)*. In view of this hypothesis and the established relationship between blood morphology and infectious conditions, it was anticipated that blood cell counts might be of value in the clarification of the mode of action of antibiotics and arsenicals. Since the state of current information regarding the physiological effects of antibiotics and arsenicals administered orally to calves is incomplete and inconclusive, the present study was undertaken to compare the effects of several of these substances on growth, feed utilization, health, blood cell numbers, hemoglobin, plasma fat, and fecal pH.

Received for publication February 7, 1955.

[1] Journal Paper No. J-2695, Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 814.

[2] Supported in part through funds provided by Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.

EXPERIMENTAL PROCEDURE

The studies reported herein were conducted in two experiments with 62 Holstein calves. Aureomycin, terramycin, and penicillin were evaluated in the first experiment and terramycin, bacitracin, chloromycetin, and 3-nitro-4-hydroxy phenyl arsonic acid were studied in the second.[3] In Experiment I each group consisted of eight calves (four males, four females), and in Experiment II each group was composed of six calves (three males, three females). The calves were permitted to remain with their dams for 3 days postpartum and subsequently were transferred to individual pens and were allotted randomly to the respective groups. Thereafter the quantity of liquid fed was based on body weights at 4 days of age. Whole milk averaging 3.0% (Experiment I) and 2.8% (Experiment II) fat was fed at the daily rates of 5.0 and 3.6 lb. per 100 lb. body weight during the first and second weeks, respectively, of the experiments. A milk replacement,[4] containing primarily dried whey product reconstituted with water (14% milk replacement, 86% water), was fed at the following daily rates per 100 lb. body weight from the first through the 7th weeks, respectively: 3.0, 5.4, 10, 8, 8, 6, and 4 lb. One half of the calves in Experiment I were fed milk replacement in two feedings daily (6 A.M., 4 P.M.); the other half received the same level in four feedings daily (6 A.M., 11 A.M., 4 P.M., 9 P.M.). In Experiment II all calves were fed twice daily (6 A.M., 4 P.M.). Starter[5] consumption was limited to a maximum of 2 lb. per day during the first 7 weeks and to a maximum of 4 lb. the 8th through the 12th week, when experimental feeding was concluded. Medium quality alfalfa hay was provided ad libitum.

The antibiotic supplements were fed at the rate of 40 mg. daily per calf in the milk replacement during the initial 7 weeks; thereafter 80 mg. daily were fed in the calf starter. The arsenical was administered in the fluid portion of the diet at the daily rate of 30 mg. through the 6th week of the experiment and in the starter throughout the 12 weeks of the experiment at the rate of 30 mg. per pound. The intake of arsenical was approximately 57 p.p.m. total dry matter in the ration.

Body weights and measurements were taken at the beginning of the experimental period. Body weights also were taken each week and other body measurements (height at withers, chest circumference, and barrel circumference) every 4 weeks during the study. Additional weights were obtained at 4 and 8 weeks after treatment termination. Incidence and severity of diarrhea were estimated by daily observations of fecal samples obtained by manual stimulation of defecation. Rectal temperatures were taken daily. Samples of venous blood were drawn at weekly intervals for hematological observations, which included erythrocyte,

[3] Aureomycin is the trade name for the antibiotic chlortetracycline, fed as Aurofac 2A and D; terramycin is the trade name for oxytetracycline, fed as Bi-Con-TM-5; and chloromycetin is the trade name for chloramphenicol, fed as the mycelial meal.

[4] Supplied through the courtesy of Western Condensing Co., Appleton, Wisc.

[5] Composed of 40% ground corn, 30% ground oats, 28% soybean oil meal, 1% steamed bone meal, and 1% iodized salt.

total leucocyte, and differential leucocyte counts (lymphocyte, neutrophil, monocyte, eosinophil, and basophil) *(25)*.

In Experiment I hemoglobin *(25)*, blood plasma fat *(1)* and fecal pH also were determined each week. During diarrhea pH values and differential leucocyte counts were obtained daily.

RESULTS

A summary of the growth data for the two experiments is presented in Table 1. The mean body weight gains of the aureomycin and terramycin groups in Experiment I exceeded those of the controls at 12 weeks by 51 and 55%, respectively. A growth stimulation from aureomycin and terramycin was apparent as

TABLE 1

Effect of antibiotic and arsenical supplementation on weight gains and certain body measurements

			Weight gains to:					Increases in body measurements—0-12 weeks		
			Experimental			Post-treatment				
	Dietary group[a]	Initial weight	4 wk.	8 wk.	12 wk.	16 wk.	20 wk.	Wither height	Chest circ.	Barrel circ.
		(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*	*(in.)*	*(in.)*	*(in.)*
	C	93	5	33	69	117	164	2.9	6.9	15.6
Expt.	A	91	14	51	104[b]	129	177	4.8	7.8	16.6
I	T	91	14	51	107[b]	139	180	5.0	7.8	16.7
	P	88	7	31	59	97	151	3.6	6.4	14.8
	C	80	8	32	65	101	156	3.6	5.9	14.7
Expt.	B	92	12	38	82	112	162	3.7	7.1	15.8
II	Cl	88	12	39	72	106	144	3.3	7.8	15.1
	AA	92	15	41	83	125	167	4.2	7.9	16.2
	T	88	11	41	88	118	160	4.4	7.5	15.3

[a] C = control, A = aureomycin, T = terramycin, P = penicillin, B = bacitracin, Cl = chloromycetin, AA = 3-nitro-4-hydroxy phenyl arsonic acid.

[b] Statistically significant (P = 0.01) compared with the control and penicillin-fed groups in Expt. I.

early as 28 days of age. Analysis of variance of body weight gains to 88 days of age indicated that the calves fed aureomycin and terramycin had gained significantly more than other groups (P = 0.01). Gains of the penicillin-fed calves averaged 14% less than those of the control group, a reduction of growth which approached statistical significance at P = 0.05. Weight gains of calves fed milk replacement four times per day were similar to those of calves fed twice daily.

Mean body weight gains during the 12-week period for the chloromycetin, bacitracin, arsonic acid, and terramycin groups of Experiment II exceeded those of the control group by 11%, 26%, 28%, and 35%, respectively. Differences in weight gains for the controls versus antibiotic- and arsenical-treated animals at 88 days of age were found to approach statistical significance (P = 0.07).

After discontinuance of antibiotic supplementation the relative growth advantage for aureomycin and terramycin groups tended to decrease in relation to the other groups, thereby reducing the earlier weight advantage (Table 1). Rates of gain for the penicillin and control groups exceeded those of other groups for the 8-week post-treatment period.

TABLE 2
Mean feed consumption and efficiency of feed utilization

	Dietary group[a]	Whole milk	Milk replacement[b]	Starter	Hay	TDN (total all feeds)	TDN per lb. gain
			(mean per calf, lb.)				
Expt. I	C	54	280	147	72	183	2.7
	A	54	289	179	70	204	2.0
	T	55	284	174	88	212	2.0
	P	53	274	119	68	160	2.8
Expt. II	C	47	234	144	61	171	2.9
	B	54	264	162	69	194	2.4
	Cl	54	242	158	62	185	2.6
	AA	55	268	161	72	195	2.4
	T	50	260	161	70	192	2.2

[a] C = control, A = aureomycin, T = terramycin, P = penicillin, B = bacitracin, Cl = chloromycetin, AA = 3-nitro-4-hydroxy phenyl arsonic acid.
[b] Liquid milk replacement, 14% solids.

Feed efficiency (calculated TDN *(20)* per pound weight gain) was superior and starter consumption greatest in the groups which gained weight most rapidly (Table 2). Efficiency of feed utilization was improved significantly ($P = 0.01$) in Experiment I by aureomycin and terramycin as compared with the penicillin and control groups. Comparison of all treated groups in Experiment II with the controls also suggested ($P = 0.09$) an improvement in the efficiency of feed utilization.

The arsenical-, terramycin-, and aureomycin-fed calves appeared to be more thrifty and their hair coats were somewhat smoother than those of other calves at the conclusion of the supplemental feeding period. The appearance and vigor of the penicillin and chloromycetin calves seemed to be inferior to those of other treated groups.

No treatment effects on blood constituents were found (Table 3). Since the trends were relatively consistent among groups and between experiments, the values for all groups were combined to establish normal curves for the conditions imposed in this study (Figures 1 and 2). A sudden drop in erythrocyte, leucocyte, and neutrophil counts during the period from 2 to 5 weeks was typical of all groups. These values gradually increased during the period from 6 to 12 weeks. Hemoglobin also exhibited age trends, the mean changes tending to parallel those for erythrocytes (Figure 1).

Blood plasma lipid levels, as measured by the method of Allen *(1)*, also appeared unaffected by treatment (Experiment I). The values were relatively high at 4 days, decreased to minimum values at about 5 weeks, and subsequently rose gradually (Figure 1).

Diarrhea appeared to be primarily of the noninfectious type, with greatest incidence and severity during the period of the 3rd through the 5th weeks (Figure 3). None of the experimental treatments employed were effective in relieving the laxative symptoms, but relief was sometimes obtained by temporary reduction of milk and/or milk replacement intake.

TABLE 3

Hematological data (mean of weekly samples during 12 wk. period)

	Dietary group[a]	Plasma (Allen) fat levels	Hemoglobin	Erythrocytes	Leucocytes					
					Total	Lympho-cytes	Neutro-phils	Mono-cytes	Eosino-phils	Baso-phils
		(mg/100 ml.)	*(g/100 ml.)*	*(millions/emm.)*	*(thousands/emm.)*	*(%)*	*(%)*	*(%)*	*(%)*	*(%)*
Expt. I	C	89	11.9	8.9	9.4	69	29	2	<1	<1
	A	84	11.4	9.0	8.6	70	27	2	<1	<1
	T	86	11.9	8.7	9.5	67	29	2	<1	<1
	P	80	11.8	9.0	9.3	72	27	1	<1	<1
Expt. II	C	—	—	9.2	8.4	70	28	2	<1	<1
	B	—	—	9.5	8.3	70	27	2	<1	<1
	Cl	—	—	9.2	8.2	68	30	2	<1	<1
	AA	—	—	8.9	8.6	75	24	1	<1	<1
	T	—	—	9.3	8.4	72	25	2	<1	<1

[a] C = control, A = aureomycin, T = terramycin, P = penicillin, B = bacitracin, Cl = chloromycetin, AA = 3-nitro-4-hydroxy phenyl arsonic acid.

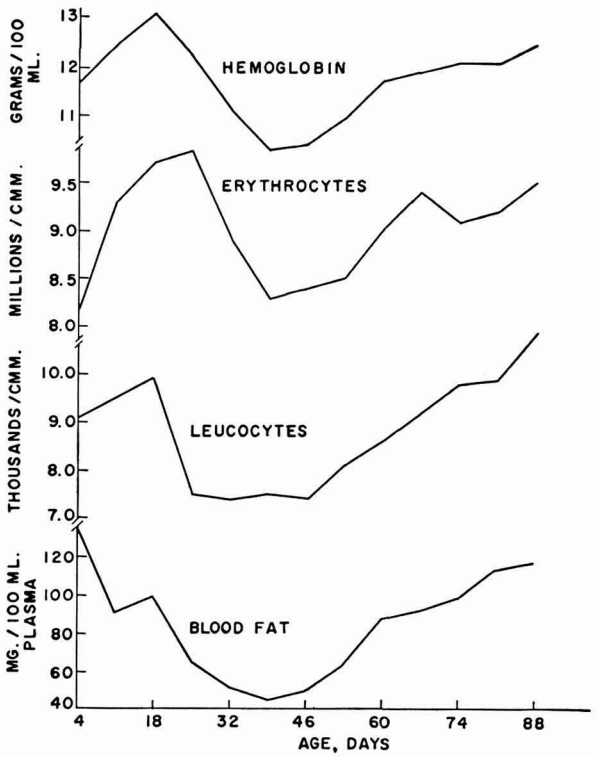

FIG. 1. Mean weekly values for certain blood constituents (hemoglobin and blood fat, 32 calves; erythrocytes and leucocytes, 62 calves).

There was no relation between fecal pH and antibiotic feeding or severity of diarrhea (Experiment I). The mean fecal pH values for the respective groups were: control, 6.6; aureomycin, 6.5; terramycin, 6.6; penicillin, 6.8.

DISCUSSION

The observed growth promotion from aureomycin and terramycin is in accord with previous work. Because of differences in experimental procedure it is difficult to compare the results from bacitracin supplementation in this study with those of other experiments. Practically identical gains for bacitracin and control groups were reported by Rusoff and Davis *(23)*, whereas results of other studies *(10, 27)* indicate a tendency toward growth promotion by this antibiotic, as was observed in the present study. The observed effect of 3-nitro-4-hydroxy phenyl arsonic acid on calf growth corresponds to the results in swine *(7, 26)* and poultry *(2, 4, 19)* and is in agreement with the preliminary findings of Graf and Holdaway *(11)* using *p*-aminophenyl arsonic acid. The ineffectiveness of chloromycetin corroborates, in general, observations with other species *(6, 9, 13, 26)*.

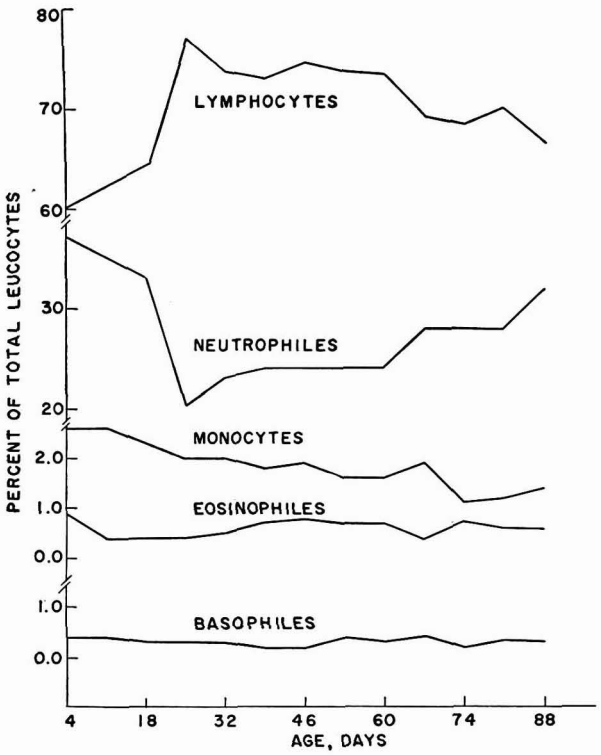

FIG. 2. Mean trends in differential leucocyte counts (62 calves).

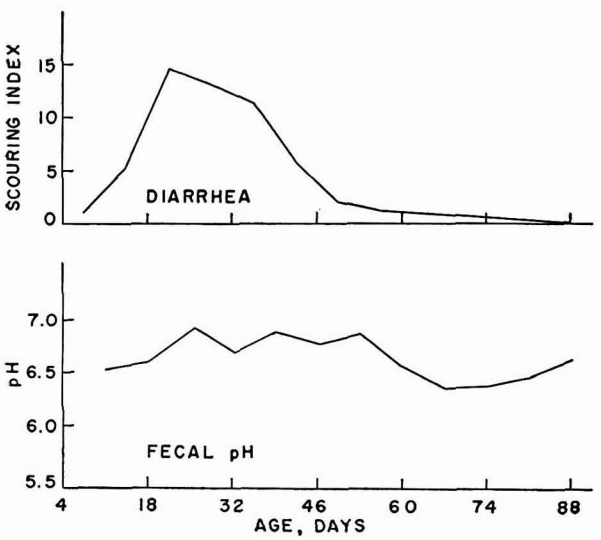

FIG. 3. Mean trends in diarrhea (62 calves) and fecal pH (32 calves).

The failure of penicillin to stimulate growth substantiates earlier reports *(16, 21, 27)*. The effectiveness of aureomycin, terramycin, bacitracin, and arsonic acid in improving feed efficiency appears to be the result of increased feed consumption with a concurrent increase in rate of gain and consequent lowered maintenance per pound of gain.

A temporary reduction in rate of gain following discontinuance of the feeding of some of the antibiotics also has been observed by others *(8, 10)*. This phenomenon may have resulted from an alteration in gastrointestinal microflora to which these animals could not adjust immediately. This alteration in growth rate would appear to add support to the hypothesis that an alteration of microflora is responsible for at least a part of the growth-stimulating effects of antibiotics. The absence of a reduced growth rate in the arsenical group following discontinuance of supplementation might indicate a different mode of action and/or a residual effect.

The contrasting results of the hematological studies conducted in Denmark *(18)* and those of the present investigation are difficult to reconcile. If there are deleterious hematological effects from antibiotic supplementation, there apparently are important conditional influences. According to a popular theory of antibiotic action, benefits result from repression of low-grade infections. If such infections are reflected to a detectable extent by elevated white blood cell counts, an inverse relationship between response to antibiotics and white cell counts might be expected. In the present study, although growth responses to antibiotics were observed, there were no appreciable differences among groups in white blood cell counts.

Any attempt to explain the characteristic trends of blood cell counts certainly would be tenuous. It seems possible, however, that the peculiar segment of the leucocyte curve noted between the 2nd and 6th weeks might be associated with the amount of diarrhea prevailing during this period. Since increased numbers of lymphocytes in the intestinal wall would be anticipated, large fluid losses through these tissues may possibly produce excessive losses of these cells *(29)*. The age trends in hemoglobin levels noted in the present study also have been observed by Thomas *et al. (24)*; however, the minimum values reported by them were much lower.

A number of workers have noted a reduced incidence and/or severity of diarrhea of antibiotic-fed calves. Since none of the supplements used in this study controlled the diarrhea incurred, it might be proposed that this laxation was of noninfectious origin and that the antibiotics and arsenical employed are ineffective in controlling this type of scours. Blaxter *et al. (5)* reported pH values in normal calves of 6.8 as compared with 6.2 in "loose" calves and 6.0 in calves with severe diarrhea. These findings were not supported by data of the present study (Figure 3).

The apparent superiority of the 3-nitro-4-hydroxy phenyl arsonic acid in maintaining an increased rate of gain during the post-treatment period would indicate a need for additional investigations to *(a)* supplement the data herein reported regarding its growth-promoting potential, *(b)* determine if this arseni-

cal will interact with antibiotics in calf growth stimulation, *(c)* determine whether a mechanism different from that of antibiotics is involved in response to arsenicals, and *(d)* ascertain whether there is any residual effect after removal of the arsenical from the diet.

Since antibiotic-fed calves tend to lose much of their growth advantage subsequent to cessation of antibiotic feeding, the practicality of supplementing calf rations might be questioned. However, the rapid early growth, increased feed consumption, and improved feed efficiency may be of real value in reducing unthriftiness, "debilitating infection," and even the high mortality that is often encountered in raising dairy calves.

SUMMARY

The comparative effects of feeding aureomycin, terramycin, and penicillin (Experiment I) and terramycin, bacitracin, chloromycetin, and 3-nitro-4-hydroxy phenyl arsonic acid (Experiment II) to dairy calves were evaluated. Mean body weight gains over a 12-week period as per cent of the mean gains of the controls were: Experiment I, terramycin, 155%; aureomycin, 151%; and penicillin, 86%; Experiment II, terramycin, 135%; arsonic acid, 128%; bacitracin, 126%; and chloromycetin, 111%. The treatments that stimulated growth also improved efficiency of feed utilization. The most rapidly gaining groups also attained greater height at withers and appeared somewhat superior in condition and hair coat at completion of the experiment; however, these differences were not marked. No pronounced ration effects were noted on incidence and severity of diarrhea, although both were relatively high during weeks 3 to 5, inclusive.

Blood cell counts (erythrocytes, leucocytes, and differential leucocytes), hemoglobin, plasma fat, and fecal pH appeared to be unaffected by antibiotic or arsenical supplementation. Also, there was no apparent effect of diarrhea on fecal pH. Rather marked age trends in the blood constituents were noted.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to R. F. Elliott of Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y., for the Aurofac 2A and D; to H. G. Luther of Chas. Pfizer and Co., Inc., Brooklyn, N. Y., for the Bi-Con-TM-5; to L. Michaud, of Merck and Co., Rahway, N. J., for the procaine penicillin G; to F. E. Eads, Parke Davis and Co., Detroit, Mich., for the chloromycetin mycelial meal; to K. E. Passoth, S. B. Penick and Co., New York, N. Y., for the bacitracin; and to T. W. Zbornik, Dr. Salsbury's Laboratories, Charles City, Iowa, for the 3-nitro-4-hydroxy phenyl arsonic acid.

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TECHNICAL NOTES

A NOTE ON THE THIOBARBITURIC ACID TEST FOR MILK LIPID OXIDATION[1, 2]

Interest in the thiobarbituric acid (T.B.A.) test as a means of measuring oxidative changes in milk and other lipid-containing products is evident from recent publications *(4, 6)*. The chemical basis of the test is not well understood, and efforts to clarify this point through chemical characterization of the pigment(s) have been relatively unsuccessful to date. However, some further light on this matter may be evident from the following observations.

Freshly prepared α, β unsaturated aldehydes do not appear to give the characteristic pink color in the T.B.A. test. However, when such compounds are submitted to the test in the presence of small quantities of cupric ion or after they have autoxidized for several days in air at 25° C., a pink color is obtained. As representatives of this class of compounds, acrolein, crotonaldehyde, and 2-heptenal[3] were investigated. Spectral data were obtained with a Beckman DU spectrophotometer. Figure 1 presents spectral characteristics of T.B.A. tests on

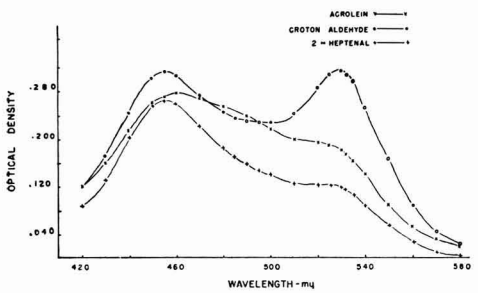

FIG. 1.

the three compounds in the presence of 100 p.p.m. of copper. One-ml. quantities of 0.001 *M* acrolein, 0.001 *M* crotonaldehyde and 0.01 *M* 2-heptenal were tested. Levels of copper below 10 p.p.m. were observed to give significant color increases.

The effect of storing 2-heptenal exposed to air for 10 days at 25° C. on the spectral properties of its T.B.A. test is shown in Figure 2 together with an absorption curve for the color from autoxidized linoleic acid. The nature of the curves, in both Figures 1 and 2, with maxima in the regions of 450 and 532 mμ is characteristic of those obtained in the T.B.A. tests of oxidized lipid materials *(1, 2)*. Keeney *(5)*

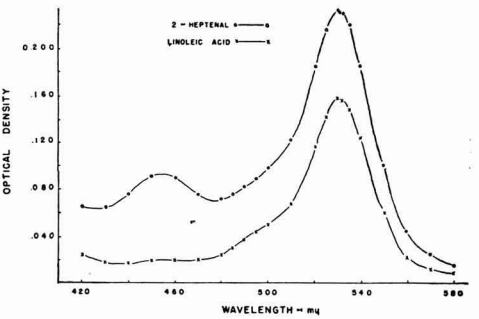

FIG. 2.

has obtained evidence that the T.B.A. test with color maxima at 532 mμ is a class reaction for β ketoaldehydes.

These observations on the role of α, β unsaturated aldehydes and copper in the T.B.A. test are of interest in view of the identification of such aldehydes as the cause of oxidized (cardboard) flavor in skimmilk *(3)* and the report that traces of copper cause an increase in the intensity of the T.B.A. test of milk *(2)*.

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[1] Authorized for publication on April 12, 1955, as Paper No. 1961 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

[2] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces and has been assigned No. 552 in the series of papers approved for publication. The views or conclusions contained in the report are those of the authors and are not to be construed as necessarily reflecting the views or endorsement of the Department of Defense.

[3] Secured through the courtesy of Dr. Percy Julian, The Glidden Co., Chicago.

A MULTIPLE REGRESSION STUDY OF THE CARR-PRICE REACTION FOR VITAMIN A IN THE PRESENCE OF CAROTENE[1]

The use of the Carr-Price reaction for the estimation of vitamin A in the presence of interfering compounds, notably carotenoids, and the techniques employed to correct for such interferences have been amply reviewed *(3, 5)*. In accord with good analytical procedure, methods which separate vitamin A and permit its estimation in the absence of interfering substances would appear to be preferable. For some biological materials such a separation is needed; however, in some instances, e.g., in bovine blood, α- and β-carotene *(2)* make up the principal interfering components, and the widely used correction of Dann and Evelyn *(1)* may be adequate. Where other interferences are operative, the use of internal standards is reported to allow the correct estimation of vitamin A *(4)*.

Before attempting a determination of the magnitude and the nature of the interference in the Carr-Price reaction for bovine blood, it was deemed necessary to retest, with pure solutions, the validity of the method of correction used by Dann and Evelyn. This correction is based on the assumption that the absorbancy of the blue color in a mixture of vitamin A and carotene is equal to the sum of the absorbancies of blue color developed by corresponding concentrations of vitamin A and carotene when unmixed.

Standard solutions of vitamin A (crystalline alcohol, General Biochemicals) and carotene (90% β-, 10% α-, General Biochemicals) were made up and combined in all possible combinations to give concentrations of vitamin A of 0.0, 0.3, 0.6, 1.2, 2.4, 4.8, and 9.6 γ and of carotene 0, 1, 2, 4, 8, 16, and 32 γ in 10 ml. of solution, the volume read. These solutions gave transmittancies of approximately 10% to 100% at 440 mμ and approximately 20% to 100% in the Carr-Price reaction at 620 mμ. One complete set of combinations was run on each of four different days.

The following equation or model was fitted to the data by least squares:

$$z = b_{00} + b_{10}x + b_{20}x^2 + b_{01}y + b_{02}y^2 + b_{11}xy + b_{21}x^2y + b_{12}xy^2 + b_{22}x^2y^2$$

in which

z = absorbancy produced by the Carr-Price reaction (620 filter)
x = concentration of vitamin A (γ per sample)
y = concentration of carotene (γ per sample)
b's = fitted coefficients.

None of the coefficients of the terms involving products or products of powers of vitamin A concentration with carotene concentration was significantly different from zero. Thus, the additivity assumption of the correction of Dann and Evelyn appears to be justified. The coefficient of the square of carotene concentration also was not significantly different from zero, indicating that it is safe to assume that Beer's law is followed in the Carr-Price reaction for carotene. That Beer's law is not followed precisely for vitamin A was shown by the finding that the coefficient of the square of vitamin A concentration deviated significantly ($P < 0.001$) from zero. An assumption that Beer's law is followed for vitamin A would lead, however, to a trivial error, because the deviations from Beer's law accounted for only 0.1% of the variance due to vitamin A concentration.

Under the assumptions that Beer's law is followed for both vitamin A and carotene and that in mixtures the absorbancy is additive, the fitted equation was

$$z = -0.0003 + 0.0690x + 0.0040y \pm 0.0052$$

in which z, x, and y are defined as before. Per unit weight then, carotene produces about 1/17 as great a color density in the Carr-Price reaction as does vitamin A. This agrees closely with the correction of Dann and Evelyn.

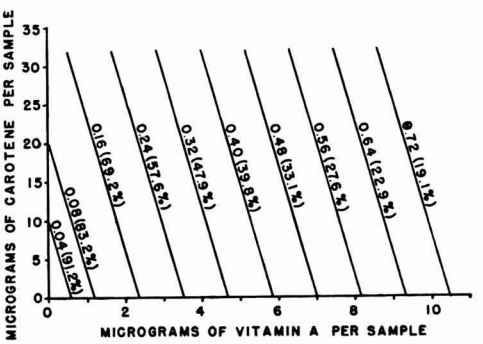

FIG. 1. Concentrations of vitamin A and carotene (γ/10 ml.) resulting in equal absorbancy (or per cent transmittance) for the Carr-Price reaction.

The coefficient of variation for a single absorbancy reading was 2.3% when variation for days was removed and 4.3% when variation for days was ignored. The latter represents the error under operating conditions, for some unknown day to day variation can always be expected.

This study confirms that of previous workers *(4)*, namely, that in the Carr-Price reaction with pure solutions, carotene contributes to the

[1] This study was supported by funds provided by the Chas. M. Cox Company, Boston, Mass., and the Big-Y-Foundation, Norwich, Conn.

absorbancy in a linear and additive manner. In addition, however, it demonstrates a method whereby multiple regression analysis may be used to estimate the magnitude of the interference which carotenoid pigments may cause when applying the Carr-Price reaction to biological materials.

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REPORT OF THE PUBLIC RELATIONS COMMITTEE THE AMERICAN DAIRY SCIENCE ASSOCIATION 1954-55

During the past year, the Public Relations Committee of the Association gave specific attention to the following:

1. To consider the role of the American Dairy Science Association in secondary school counseling and recruitment for the dairy industry and, to the extent possible, initiate appropriate action to attract a larger number of superior young persons into this field.

2. To investigate ways and means by which the Association may be more effectively publicized among nonmembers and other organizations and to take such immediate steps as appear desirable in this connection to improve the external public relations of the Association.

3. To direct the attention of the Association to the fact that the organization was early dedicated to the objective of encouraging and fostering improvement in teaching and that the time is propitious for definite action to be taken in this regard.

4. General proposals for maintaining a continuing effective program of Public Relations.

Secondary School Recruitment. In respect to the secondary school recruitment activity, the Committee initiated the following:

1. Movement to obtain industry-wide support for production of suitable films: It has been generally recognized that there is need for effective films which could be shown to secondary school and other nondairy groups which would portray the magnitude and challenge of the dairy industry and stress the career opportunities which are available in this field. The Committee recommended that the Association assume a leadership role in connection with obtaining industry-wide support to produce two films, one dealing with the farm or production phase of dairying, the other with the industrial or manufacturing phase of industry. The Committee recognized the need for getting all interested dairy groups to cooperate in this venture in order that the films produced would be representative of the entire industry and would be the most effective films possible.

A statement was prepared for distribution to various industry groups calling their attention to the fact that suitable films are needed as an adjunct to effective secondary school recruitment programs and advising them of the desire of the Association to assist in coordinating the efforts of all groups toward the production of such films. This statement was approved by the Executive Board and sent by the President to sixty leading dairy organizations. The statement was also placed in the form of an Association Resolution and submitted to the Resolutions Committee of the Association for appropriate action.

2. Preparation of a manual or guide for secondary school recruitment programs in the dairy industry: Many suggestions were received relative to the steps which might be taken to attract a larger number of secondary school students into the dairy field. The suggestions proposed were combined in a manual entitled "A Guide for Secondary School Recruitment and Counseling Programs in the Dairy Industry." This was approved by the Executive Board for publication in the *Journal of Dairy Science*. Reprints are to be made available for general distribution.

Educational Purposes. Over the years, the annual meeting of the American Dairy Science Association has been devoted largely to research, even though the Association was established also for the purpose of improving teaching. Therefore, the Committee suggested that the attention of the Association membership be focused on the educational aspect to emphasize the role of the Association in the improvement in educational methods, practices, and policies. The Committee proposed that each annual meeting of the American Dairy Science Association have a program on "Dairy Education" at which time down-to-earth discussions would be held on improved methods of teaching, techniques for handling teaching aids, etc. The Executive Board accepted this proposal and authorized the appointment of an Education Committee *(a)* to investigate the possibility of establishing a new section of Dairy Education and *(b)* to develop a session on teaching for the next meeting of the Association.

Association Publicity. The Committee felt generally that great improvement is possible in publicizing the activities of the Association through publications other than the Journal. Particularly was the need expressed for more publicity of the annual meeting (both pre-meeting and post-meeting), and for popular treatment of the technical papers presented at the annual meeting.

Action taken during the year by the Committee involved the following: *(a)* Limited publicity of activities of certain Association groups

was given to trade periodicals during the year. *(b)* Prior to the annual meeting, a listing of the technical papers and the various symposia to be presented at this year's annual meeting was sent to various dairy trade associations requesting that the information appropriate to the respective association be brought to the attention of the members. In addition, suitable news releases, featuring the scientific presentations of the meeting, were distributed to suitable trade periodicals. *(c)* Plans were made for post-meeting publicity. This publicity had two purposes. First, the attempt was made to supplement the regular publicity released by the local institution pertaining to highlights of the meeting, officers elected, etc. Specific attention was given to featuring the personal aspects —particularly by using pictures and stories pertaining to committees, sectional officers, and social events. Second, efforts were expended to have popularized summary accounts of the technical sessions pertaining to the main areas of research. This was accomplished by having member-reporters who prepared the highlights of certain technical sessions. These articles after proper editing, and accompanied by suitable photographs, were released to trade periodicals.

What May Be Done to Maintain an Effective Public Relations Program:

1. *Publicity.*

   The Public Relations Committee should serve as the focal point for a continuous publicity program with the view of keeping the dairy industry as a whole informed of the Association's aims, purposes, achievements, and activities. All publicity is to be released by the secretary-treasurer of the Association.

   During the year, the members, committees, and officers should keep the Pub-Relations Committee advised of all activities of the Association which may well further the interests of the Association by being publicized. Pictures and articles on committee meetings held during the year could be used to advantage. Excellent communication between the secretary-treasurer, the Journal editor, and the Public Relations Committee will be necessary if this phase of the program is to be effective.

   For the annual meeting, the Public Relations Committee should cooperate with the secretary-treasurer, with the Journal editor, and with the publicity committee of the institution where the meeting is to be held, in publicizing the meeting.

   Pre-annual meeting publicity. The Public Relations Committee should be advised by the Chairman of the Program Committee of program development. Early information on the papers to be presented, the symposia to be held, and the outstanding speakers to be present, could all be used to advantage by the Public Relations Committee. These articles could highlight the subjects to be discussed in symposia and point out their importance to the dairy industry at large. In addition, the listing of the principal papers to be presented in the various areas would make good copy for the dairy trade periodicals. As soon as possible, the titles of papers dealing with specific subjects could be obtained and sent to the respective executive secretaries of the trade associations, inviting the secretary to call these to the attention of his membership. Pictures of key committees, sectional officers, the Executive Board, and of the previous year's meeting, can all serve as a basis around which to develop copy to publicize the meeting. The objective of this is to bring to the attention of interested persons in the various areas of dairying the fact that the American Dairy Science Association is to have a meeting of great interest and importance to persons in all branches of the industry. Care would be taken to work cooperatively with the local publicity committee, the secretary-treasurer of the Association, and the Journal editor.

   Post-annual meeting publicity. The purpose of this will be to bring to the attention of all Association members who did not attend the meeting and to nonmembers the fact that an outstanding meeting was held and material was presented from which they might have gained valuable information.

   The heart of the post-meeting publicity should be an effective popular accounting of the technical papers and the symposia. One approach is for the Public Relations Committee to select certain persons who would serve as reporters at the various sessions. Each of these persons would have the responsibility of bringing together in an effective manner an accounting of the subject matter which was presented or discussed during the session to which he was assigned. For example, one or more persons may be assigned the task of preparing a summation of papers dealing with cheese research. Such material

could be brought together, effectively developed and edited, and could well be a feature article in one of the trade periodicals. Again, the use of pictures taken at the annual meeting would be helpful. The post-meeting publicity would need to be coordinated with the publicity handled by the local publicity committee.

Wherever possible, the local publicity committee should be encouraged to handle the bulk of this work. The responsibility of the Public Relations Committee would be to coordinate the publicity, supplementing wherever possible so that the interest of the Association will be considered along with the interest of the local institution.

2. *Internal Public Relations.*

The Public Relations Committee is to serve as needed in creating and maintaining high morale and high individual membership enthusiasm within the Association. This may be accomplished by improvement of communication between the sections of the Association and the Executive Board and by creating an atmosphere so that each individual member will be given the maximum of consideration.

3. *Future Leader Recruitment and Training.*

Effective public relations is needed to make certain that the Association assumes its rightful leadership in bringing to the attention of secondary school students the opportunities and challenges which the dairy industry affords. All aspects of programs of secondary school recruitment and counseling should be a major concern of each member of the Association. Effective secondary school counseling and recruitment must be conducted at the local level, but the Association can do its part in encouraging interested groups throughout the country to take an active role in this regard.

The Association should keep the members always alert to the necessity of having university and college curricula in dairying adequate for current industry needs. Consideration should be given to nation-wide surveys to ascertain enrollment trends, curriculum needs and changes, staff qualifications, physical facilities, progress of trained persons in the commercial field, and related matters. In this regard, the philosophy of professionalizing certain branches of dairying should not be ignored. For example, a category of "Professional Dairy Technologist" might well be used to indicate a man of outstanding distinction and with a high degree of professional training.

The Association membership should be kept aware of the treatment by the commercial industry of the men who have been trained in our educational institutions. Recruitment of secondary school students is difficult unless one can point with positiveness to graduates in dairying who have achieved outstanding success in the industry. The Association may utilize national surveys and continuous studies in order to be aware of the weaknesses of the commercial industry in respect to personnel handling so that, if the need arises, positive action may be taken to remedy the situation and improve the opportunities for university and college trained men.

4. *Educational Needs.*

The Association cannot overlook the fact that, as the leading educational organization in dairying, it must devote considerable attention to ways and means of improving teaching. Many of the members of the Association are employed directly in teaching, either in the classroom or in extension, and efforts are needed to encourage proficiency in these areas. Furthermore, the training of men to meet the present-day exacting needs of industry requires instruction of the highest order.

F. J. Arnold
Iowa State College, Ames
R. E. Frost
American Dairy Association, Chicago
Burdet Heinemann
Producers Creamery, Springfield, Mo.
H. B. Henderson
University of Georgia, Athens
J. J. Jezeski
University of Minnesota, St. Paul
I. A. Gould, *Chairman*
The Ohio State University, Columbus

PROCEEDINGS OF THE FIFTIETH ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

June 20-23, 1955

T. D. HARMAN, *Acting Secretary-Treasurer*

The American Dairy Science Association met for its opening session in Brody Hall, Michigan State College, East Lansing, Michigan. After the singing of the National Anthem, the invocation, and an address of welcome by Dean C. M. Hardin of the Michigan State College of Agriculture, Earl Weaver, presiding officer, introduced President L. A. Moore. His address follows.

PRESIDENTIAL ADDRESS

This, our 50th annual meeting, places A.D.S.A in the category of one of the older and mature scientific societies. Next year on the occasion of the 51st meeting at the University of Connecticut we will celebrate our golden anniversary. I am sure that our membership will desire to take note of this occasion with activities of commemoration.

I would like to spend a part of my time on the affairs of our Association. Last year your president, Doctor W. V. Price, gave a very concise outline of the status of the Association, so in order to avoid repetition I will call attention to only a few special matters of interest. Last year the secretary-treasurer, Mr. Perry Ellsworth, resigned and Dr. T. D. Harman, of The Ohio State University, has been effectively serving as acting secretary-treasurer during the year. A three-man committee of your Executive Board consisting of the past president, the present president, and the vice-president, was asked to develop a more permanent arrangement. As has been announced in your Journal, we have been fortunate in obtaining the services of a former president of our Association, H. F. Judkins. He brings to our Association a wealth of experience and prestige in the dairy industry through his association as a teacher, researcher, and a worker in the industry. I also want to express the appreciation of our Association to Ohio State University and especially to Dr. Harman for helping us out of a difficult situation during the past year.

L. A. Moore

For the record I would like to take this opportunity to point out that the three-man committee studied the program for several months and considered several solutions to the over-all problems of our Association. Because of the size and activities of A.D.S.A. the committee felt our Association should consider at some later date the possibility of a full-time executive secretary and that we should strongly consider combining our business operations, including the editorial duties, with some other similar scientific organization for more efficient operation. Many small scientific societies are finding rising printing costs for the publication of their respective journals and their business operation difficult to meet. I believe that we should be on the alert for possible cooperation with other similar societies for a more efficient operation.

Last year the rugged individualists on the Board of Directors, as described by Dr. Price, voted to increase annual dues to $10.00 per year in order to meet the requirements of the budget. Some were fearful that we would lose membership. Our paid up membership in 1954 was 1,709 and for 1955 it is 1,618. I believe that by the end of this year we will be at least even with the 1954 figure. In 1954 we had 1,286 subscriptions and in 1955 we have 1,307. We believe that the increase in membership dues, subscriptions, and advertising rates will keep our budget in balance, at least for the time being. We believe that the new sections in our Journal initiated by our good editor, Dr. P. H. Tracy, will begin to pay off by a wider acceptance of our Journal in the industry.

In this connection our Membership Committee under the chairmanship of Dr. H. A. Bendixen has made a good start in setting up procedures to be used in the future to increase our membership. I feel sure we can do a better job of selling the advantages of A.D.S.A. to those who should be interested in membership in the Association. More personal contact by all the membership to prospective members should do the job needed.

I wish to take this opportunity to thank chairmen and members of the various committees who have worked for the betterment and prestige of our Association during the past year. Almost 200 of our members have participated in various committee activities. I hope their efforts do not go unnoticed by our membership. Dr. Price last year also reviewed the activities of most of these committees, and I shall not take the time to repeat his complete review. I shall, however, call your attention to the activities of a few of the committees solely for the purpose of keeping our membership informed.

The Public Relations Committee has proposed the development of two films, one in production and the other in manufacturing, to be used at the high school level. The purpose of the films would be to interest high school students in careers in the dairy industry, where we have a shortage of trained personnel. Letters were sent to leaders in industry to determine their interest in the project. The replies have been gratifying, and the committee is to be congratulated for its initiative. I hope later events will prove this effort to be fruitful.

In the same connection I would like to comment on our student affiliate program. Here, I believe, it is to our interest to further strengthen the program. You may be surprised to learn that last year at the Pennsylvania State University meetings there were 592 full members and 110 student affiliates registered. The latter number accounts for almost 14% of our membership. We, as an Association looking for further strength, can ill afford to neglect 14% of our membership. This year, I note by the program that student affiliates have an exhibit and that they will meet with faculty advisors this afternoon. I welcome the students who are present at our meetings this year, and I hope our sessions will prove beneficial to you. I wish to compliment Dr. W. L. Slatter and his committee for their efforts this year with the Student Affiliate program.

Dr. O. F. Garrett, chairman of the Internal Procedures Committee, has proposed recommendations for more efficient operation of our Association.

Through the efforts of our Dairy Science Teaching Award Committee under the leadership of Professor C. E. Wylie we are to give recognition to the outstanding teacher in dairy manufacturing at the awards ceremony. The Milk Industry Foundation has kindly furnished the financial backing for making this award. I would like to take this opportunity to thank all committees for the effort and time they have devoted to our Association.

I should now like to pass from the affairs of our Association to some problem areas in the dairy industry where I believe our members have responsibility. As one who has been in the research field for some 25 years, I shall make a few remarks about research in general without becoming involved in a deep philosophical discussion.

We have heard the ascent of civilization described by the different ages, such as the stone age, the iron age, the chemical age, and the atomic age. Actually, today we are in the age of research. I feel much like the colored preacher who was about to begin his Sunday sermon when he said, "Brethern and Sistern, before I begin this sermon today I would like to say something." Like the colored preacher I should like to say something, which I hope will become stenciled in the pages of your mind: Progress and development in this age are dependent upon research.

With the world population increasing, largely because of the results of research, we are actually in what might be termed the vicious cycle of research. We have become dependent on research and, like the bear's tail, we don't dare let go because we might be bitten. The bite would be starvation of our people and stagnation of our country. We have only to look about us at other countries, where the main product of human effort has not been in the form of research, to bring us to such a realization.

Our constitution states, "The object of the Association shall be to stimulate scientific research in all phases of interest to the dairy industry and to dairy science." The results of scientific research promote changes — changes which often affect the very roots of our agriculture. It has been said that research creates more problems than it solves. Such a philosophy sounds futile, but it is the sign of progress and the advancement of civilization. How many of us would like to return to the methods of dairying as they were known fifty years ago at the time of the birth of this Association, before the general use of the Babcock test and pasteurization?

Some dislocations produced as a result of scientific research are minor, but others are major indeed. We have only to look at the discovery of the nature of the atom as an example par excellence of a finding which is producing world wide impact.

We, as scientists in the dairy industry, must not resist the new because of possible dislocations but should bend our efforts toward ironing

out the difficulties created by new research findings. I would like to call your attention briefly to just a few examples of problems as I see them, without attempting to expound on all our problems.

Recent nutrition research and the relative cost of butterfat compared to other fats indicate that the dairy industry might well de-emphasize the fat content of milk and place more emphasis on the solids-not-fat. Our dairy breeds of cattle have emphasized fat production; now we may wish to emphasize production of S.N.F. This may mean dislocation in some of our present conceptions of breeds and the breeding of dairy cattle. Some may not like this change, but can we afford to resist such a change and are we ready to meet the challenge? Some dairy scientists have already given thought to the problem and the evidence indicates the possibility of breeding for more S.N.F.

Other problems related to dairy cattle breeding also confront us—the breeding of cattle able to utilize large quantities of forage to go along with our grassland farming program, cows with a longer life, more heat-resistant cattle for some areas, and possibly resistance to diseases, such as mastitis. The dairy scientist in the field of breeding has his hands full for the next fifty years.

Another development of research which is just beginning to break out of the "cage," after years of study, may have a tremendous impact on the dairy industry. I refer to recent developments in the processing and packaging of milk. In this connection I have learned that the meaning of the letters H. T. S. T. might be high-temperature short-time sterilization. Milk may be sterilized, for example, at a temperature of 285° F. for 15 seconds or its equivalent, concentrated, and canned aseptically to produce milk which, when reconstituted, has a nearly normal flavor.

The application of high-temperature short-time sterilization may prove to be applicable as well to partially concentrated or to whole milk. The problems of gelation, flavor, etc., which have held such developments in abeyance for years, appear to be yielding to the application of fundamental chemistry by utilizing such techniques as chromatography, electrophoretic studies, and ionic relationships. Here is an example where the short cut procedure of trial and error studies has failed and where the application of fundamental research to understand the innermost mechanisms of chemical and physical changes is proving to be profitable. Concomitantly, such fundamental studies may well solve the problem of producing a dried milk powder which, when reconstituted, will retain the characteristics of fresh milk.

However, let us dwell on the impact of these research findings upon our industry, an impact in which dairy scientists should be interested. The conservative scientists point out the possibility of supplying milk to isolated areas and to the Armed Forces in any part of the world. The less conservative point out that owing to longer shelf life of these products the midwestern farmer, for instance, will be brought into competition with the farmer in our eastern milk shed area. Artificial barriers to the movement of milk now common in some areas may receive the equal of an atomic blast. Further, the impact may carry so far as to affect the methods of milk distribution to the housewife.

In this example, while the research worker has undoubtedly created problems which will need further study, the principal effect could well be one of tremendous economic consequence in the development of our dairy industry. Of course, there will be resistance to such changes, but the services and products which Mr. John Q. Citizen knows to be available and desires, he usually gets. The dairy industry need not be reminded of a fairly recent example of the public's desires in relation to fats other than butter.

I have referred to trial and error research. Trial and error research was primarily used in the development of present methods of making grass silage. Through the trial and error approach, successful practical methods of harvesting hay crops as silage have been established without a really fundamental understanding of the chemistry and bacteriology involved. These findings have resulted in a great impact on methods of preserving the hay crops. The making of grass silage in the United States has increased fivefold during the past five years. It is one of the most current topics appearing in farm magazines. Yet today we have new problems in grass silage-making which we cannot answer because of the lack of fundamental information. For instance, the development of forage harvesters to cut the crop directly from the field creates problems we did not have five years ago. The use of certain chemicals, the use of horizontal silos, the effect of silage feeding on cheese quality, and why silage made under identical conditions from year to year can vary so much in quality are problems needing further study.

Had we approached this problem in the beginning from the fundamental side, I believe today we could answer most of these questions. The challenge to the research worker in this

field is to back up and find out the facts. Do we accept this challenge?

These are only a few examples of the problems in which the dairy research scientist is interested. For your further interest you will recall that last year the Secretary of Agriculture requested our Association to suggest problems which need answering by the dairy scientists. Dr. Price summarized your replies. This material has been reproduced in mimeograph form and is available in the offices of your respective dairy departments and experiment stations. If you are interested in research problems, I suggest you consult this report.

Research in tax supported institutions today is receiving much wider consideration from the laymen groups, in which I would include various review committees of industry and members of the legislative branch of our state and national governments. Such interest is most valuable in spreading the gospel of the value of research, in acquainting the laymen with research in its many aspects, and in keeping the research worker in touch with practical problems. However, to depend on such interest to guide and develop research programs is somewhat similar to a doctor asking his patient to prescribe proper treatment. The solution of practical problems of direct and immediate interest to the dairy farmer and to people in industry could well crowd out a proper balance between practical and fundamental research.

Generally, suggestions offered by such groups are helpful, yet many times the interpretations and advice given by such groups can be most frustrating to the conscientious research worker. The research worker is a specialist who has been trained to ascertain the important problems to guide and develop a solution to the problems. The research scientist is just as dedicated to being useful to society as the doctor, the preacher, or the school teacher. We have arrived where we are today through the efforts of the research scientist. Let us strive to keep research in the hands of the research scientist and conserve this valuable manpower.

In summary, the research worker of yesterday, today, and tomorrow has had, and will continue to have, problems to occupy his full energies. Many times the research findings create more research problems and cause tremendous dislocations in our industry. Sometimes the research worker must back up and replace trial and error procedures with the application of the fundamental approach. We cannot resist the march of science, but we must interest ourselves in some of the dislocations it may cause. The research scientist must be open minded, fearless, and always searching for the facts.

BUSINESS MEETING

June 23, 1955

President Moore called the business meeting to order at 10:00 A.M. in Brody Hall. Approximately 250 members were present.

REPORT OF THE EXECUTIVE BOARD

The meeting convened at 9:20 A.M. with President Moore presiding. The following Board members were present: L. A. Moore, I. A. Gould, T. D. Harman, L. H. Rich, G. A. Hyatt, Jr., G. W. Salisbury, W. V. Price, P. H. Tracy, D. V. Josephson, R. E. Hodgson, and N. N. Allen. Also present were incoming Secretary-Treasurer H. F. Judkins and Vice-President C. F. Huffman.

The Secretary read the minutes of the last Board meeting. The minutes were approved as corrected.

The following actions were approved by mail prior to the meeting and reported by President Moore:

(1) Rules and Regulations of Teaching Award Committee.

(2) Rules and Regulations of Extension Dairyman Award Committee.

(3) Selection of H. F. Judkins as Secretary-Treasurer.

(4) Approved J. J. Jezeski and J. T. Reid as additions to the Editorial Board.

(5) Accepted the Public Relations Committee recommendations.

(6) Approved Milk Industry Foundation Award.

The Board suggested that the Historian, in cooperation with the Editor and Program Committee of the Association, be requested to bring up to date the history of the Association in all details and cooperate with the Editor in preparing suitable copy for publication in the special issue of the Journal, if approval is given to that particular publication.

Approved the selection of W. A. Wentworth as an Honorary Member of the Association.

Accepted with thanks the Borden Foundation offer of making available the Borden Awards for 1956.

Accepted the invitation of the University of Illinois to meet there in 1959, the invitation of the University of Georgia to meet there in 1962, and the invitation of the University of Kentucky to meet there in 1965.

Approved the renewal of the following Student Affiliate chapters: Texas A & M College, Ohio State University, Virginia Polytechnic Institute, University of Tennessee, Oklahoma A & M College, Rutgers University, University of Massachusetts, University of Georgia, and University of Florida and approved the granting of a charter to the Colorado A & M College.

Accepted the report of the Ballot Tabulating Committee.

Accepted the report of the representative of the Ralston-Purina Research Fellowship Committee.

Accepted the report of the representative to the Policy Committee of the Scientific Agricultural Societies, who reported on the aims of this Policy Committee and allocated $100 as the support of the Scientific Manpower Commission through Policy Committee of the Agricultural Societies.

Accepted the report of the Dairywide Coordinating Committee on Nutrition Research.

Accepted the report of the Rules and Regulations Governing the Borden Award for research in dairy production and dairy manufacturing, amending it slightly to allow for an easier selection of the recipients.

Accepted the report of the Dairy Remembrance Fund.

Accepted the report of the Public Relations Committee with commendations to the Committee for their excellent job and suggested that the Committee report be revised for publication in the Journal.

Instructed the president of the Association to appoint an Education Committee to consider the problems of establishing a new section of the Association to be designated as the Dairy Education Section and to recommend to the Board whether or not a section be established.

Received, with thanks to the Committee for a job well done, the report of the Internal Procedures Committee and continued the work of this Committee for one more year.

Voted that each section chairman or member of the Association shall be invited to present problems pertinent to the section at the Board meetings. Stated that it is the responsibility of the president to invite section chairmen to attend specific sessions of the Board.

Approved the report of the Teaching Award Committee with the exception of the detail calling for a certificate to be given to the recipient in the name of the A.D.S.A. Went on record as opposing the granting of an award or recognition in the field of dairy production teaching until such time as a sponsor has been obtained

who will donate a monetary award comparable to that in dairy manufacturing.

Accepted the Student Affiliate Committee report.

Accepted the report of the Regulatory Agency Committee with a vote of commendation for a tremendous job well done and suggested that the report be published in the Journal.

Approved the report of the Constitution and By-Laws Committee as now written with the changes as have been applied and directed that a ballot on the constitution revision be sent to the membership with the notices of the annual dues and further directed that the revised copy of the proposed Constitution be sent to Editor Tracy for publication in the Journal.

Indicated that the Program Committee would be selected by the president with the advice of the Executive Board and recommendation of the outgoing Program Committee Chairman from among the retiring chairmen of the sections.

Received the Grassland Committee report.

Received the report of the International Science Foundation Committee, which recommended that A.D.S.A. not join the International Science Foundation.

Received the report of the Membership Committee and ordered that a brochure be brought into final form by the Membership Committee in cooperation with and assistance and advice of the Editor.

Referred the procedural manual of the Membership Committee back to the Committee for further study and completion.

Received the report of the Journal Management Committee with thanks to J. H. Erb and the Committee for a fine job and went on record as favoring the encouragement of the student note section of the Journal.

Re-employed Editor Tracy for the coming year and expressed deep thanks and commendation for his excellent services.

Accepted the Secretary-Treasurer's report.

Accepted the Auditing Committee report.

Adopted a budget of $50,892.50 for the fiscal year 1956.

Appointed George Werner to serve on the Journal Management Committee for a three-year term commencing July 1, 1955.

Approved a communication from Chairman Slatter of the Student Affiliate Committee establishing recognition for outstanding club activities and a plan to present such awards anually beginning at the next annual meeting of the Association.

Granted life membership to H. E. Otting.

Accepted Necrology Committee report.

Respectfully submitted, T. D. Harman, *Acting Secretary.*

Upon motion duly seconded, this report was accepted.

SECRETARY-TREASURER'S REPORT

Fiscal Year 1954

The following is a comparative statement of our membership, subscriptions, and student affiliates:

	To June '55	Total 1954	To June '54	Total 1953	To June '53
Members	1702	1787	1752	1745	1648
Subscribers	1361	1454	1333	1418	1298
Student Affiliates	381	362	347	293	279
Honorary Members	11	11	11		
Life Members	6	8	9		

The number of memberships for the year 1954 was higher than 1953; however, for the year 1955 the membership has dropped slightly. This drop is due, no doubt, to the increase in membership dues. The student affiliate memberships increased considerably over 1953, and the figures reveal that the total student affiliate membership is even higher for 1955. This increase is due to the very aggressive work of our Student Affiliate Committee. The number of subscriptions for 1954 was higher than for 1953 and so far in 1955 we have more subscribers than we had this time last year. This might be attributed to the greater scope of reader interest material in the Journal and the higher value the Journal has attained in the eyes of those who conduct research, college classes, and the general business of dairy production and manufacturing. The total Journal circulation for 1954 increased 147 over 1953.

On December 31, 1954, there were 27 student affiliate chapters, an increase of one over last year. One request for a new chapter certificate has been received so far in 1955, making the present total 28.

The Association suffered a loss of $5,697.49 for the year 1954 and to meet this deficit and the deficit of 1953 it was necessary to cash bonds which had been purchased in previous years in the amount of $6,147.00. The Association has, at present, a total of $27,753.00 in Government Bonds of the F & G series.

Income from advertising during 1954 dropped to $5,566.51 compared to $6,491.04 in 1953. However, the income from advertising as of June 1, 1955, is $2,971.72 compared to $2,340.86 for the same period in 1954. An increase in advertising rates and increased activ-

ity on the part of the Journal editor has made this difference.

Sales of back copies of the Journal fell from $1,555.55 in 1953 to $1,256.76 in 1954; however, in 1955 there has been an increase of $97.52 over the similar period in 1954.

A new source of revenue has appeared this year, the sale of reprints. For the January, February, and March issues of the Journal $1,884.48 has been received for reprints ordered by institutions, companies, and authors.

A detailed audit was made by the Auditing Committee, who physically counted the bonds held by the Association. Mr. Walter Burnham, the auditor, met with the Committee and explained the financial statements of the Association and answered any questions that were raised.

The results of the Executive Board's action to increase membership dues, subscription rates, advertising rates, and charge for reprints are revealed quite clearly in the attached statement of income for 1955, 1954, and 1953. It reveals that to date we have received $43,131.54 as of June 1, 1955, whereas for the similar period in 1954 we received only $27,926.26 and for the entire year of 1954 we received $38,151.20 and $41,711.23 for the year 1953.

The Nominating Committee nominated the following men in April, 1955: for vice-president—C. F. Huffman, Michigan, and N. N. Allen, Wisconsin; for directors—R. E. Erb, Washington; I. W. Rupel, Texas; E. L. Fouts, Florida; and A. J. Morris, Utah.

On June 1, 1955, the Ballot Tabulating Committee announced the following results: vice-president, C. F. Huffman, Michigan; directors, I. W. Rupel, Texas, and E. L. Fouts, Florida.

The Executive Board has been able to secure the services of Mr. H. F. Judkins as secretary-treasurer. Mr. Judkins has a wealth of executive experience and wide acquaintance within the entire dairy industry. He served as president of our Association in 1942. We are indeed fortunate to have him with us now in the position of secretary-treasurer.

For your present acting secretary-treasurer the past year has been one of many pleasant surprises, wonderful experiences, some rather anxious moments, and above all the pleasure of meeting and working with the dedicated group of men who compose your Executive Board.

To serve as secretary in this Association is an experience that might be wished for everyone in the Association for it reveals the immense potential of our Association and the truly fine men and women who make up its membership.

I should like to pay my signal honor to Miss Martha Riemenschneider for her very fine and devoted work as the Secretary's secretary.

It has been a privilege to serve you and I shall cherish the memories of the past year throughout my lifetime.

Respectfully submitted, T. D. Harman, *Acting Secretary.*

Upon motion duly seconded, report was received.

EDITOR'S REPORT FOR THE YEAR 1954

Volume 37 of the Journal contained 151 original articles, 2 reviews, 3 technical notes, and 27 "Our Industry Today" articles.

There were 1,510 pages in Volume 37 as compared with 1,370 pages in the preceding volume and 191 pages of abstracts as compared with 186 pages in Volume 36.

The total pages of "People and Events" was 62, as compared with 52 for the preceding year.

Twenty-two per cent of all articles submitted were rejected or withdrawn—27% of the manufacturing articles and 18% of the production articles.

Articles submitted dealing with the chemical subjects were the largest in number (37); those on nutrition were second (35); bacteriology, third (34); artificial insemination, fourth (25); dairy technology, fifth (21); breeding, sixth (21); physiology, seventh (17); and miscellaneous, eighth (14). It is recognized that such a classification is not entirely accurate, as it is arbitrarily made. The proportion of submitted production articles of original research to manufacturing articles was 56 to 44, which shows a gain in manufacturing articles over last year.

One new department was introduced in the 37th volume — Technical Notes. The interest shown in this department indicates that it fills a need on the part of investigators for a place to record significant findings that do not justify the elaboration expected of a journal article.

The Editor believes there has been a general improvement in the quality of papers accepted for publication and the manner of their preparation. It is urged that even greater consideration be given to suggestions for preparing manuscripts, as set forth in Volume 37, page 103, *Journal of Dairy Science.*

The various departments, federal agencies, and commercial companies are urged to supply the editor with information for the People and Events section. This section has proven popular with the readers, but a more complete cov-

erage of events in the industry is desired. Some departmental agencies have been very cooperative in this respect. Unfortunately, some are seldom heard from. This is a public relations angle that has tremendous possibilities and should not be overlooked.

The Our Industry Today section is supported by voluntary contributions. Members who have topics they would like to prepare for publication in this department are urged to contact the editor. Arrangements have been made with some of the leaders of the industry to prepare a series of worth-while papers for this section in coming issues.

It is hoped to continue the series of short biographical sketches of "Pioneers of the Dairy Industry." It is suggested that teachers urge their students to read these write-ups as a part of the class assignment, thus getting better acquainted with the Journal and at the same time learning something about the people who have pioneered our great industry. Those having suggestions for people to be featured in this section should contact the Editor.

The Editor has enjoyed the cooperation of a large number of individuals in performing his duties. The services of the Editorial Board are outstanding. These men have done a marvelous job in passing on the merits of the manuscripts sent to them for review. The spirit with which their criticisms are received by the authors has been noteworthy. With but few exceptions these contributors have accepted the comments made by the reviewers and the editor as an honest effort to help them improve their material.

The cooperation of J. Hoffman Erb, G. W. Trimberger, and W. M. Roberts, the Committee on Journal Management, in policy making matters has been very helpful. The support of the officers and the membership in general is greatly appreciated.

There are a multitude of details to be looked after by the editor. Manuscripts must be carefully edited for style, accuracy, clearness, and correctness. This means each article must be read several times, checked, and rechecked even before it goes to the printer and again afterward. A definite printing schedule must be maintained, if the Journal is to reach the members on time. The help and cooperation of Rosamond M. Tracy and of J. M. Hill of the Garrard Press is what makes these things physically possible. Much recognition is due them.

The services of W. O. Nelson, the abstract editor, who also prepares the yearly index, are abstractors and news gatherers is also acknowledged.

A new undertaking of the Editor during the past year has been to solicit advertising. Additional revenue from this source is badly needed by the Association. Help of all members is needed to sell more advertising space. It is suggested that you assist in these ways:

1. Read the advertising in the Journal each month.
2. Note that occasionally there are companies who place in their ad a blank for you to fill out and send in for information. Make use of these leads, for that is one way the advertiser knows the money spent for space in our Journal pays.
3. When you deal with these people, mention the fact that you saw their ad in the *Journal of Dairy Science* and that you as a member appreciate their support of our Association.
4. Encourage manufacturers who do not use space in our Journal and who make or sell a product used by members of our Association in their professional duties to contact the editor regarding advertising.
5. Encourage operators of commercial laboratories and dairy and food consultants to buy space in the Professional Directory. This new department if properly developed will prove valuable not only to readers of the Journal but to the laboratory operators and consultants as well.
6. Encourage the use of the Bulletin Board for positions open and jobs wanted. This department can be especially useful in recruiting candidates for research and teaching positions as well as for positions in industry.

Respectfully submitted, P. H. Tracy, *Editor.*

Upon motion duly seconded, report was accepted.

REPORT OF JOURNAL MANAGEMENT COMMITTEE

The Journal Management Committee was in close communication with Editor Tracy throughout the year. The following is a report of the main activities of the committee.

1. Upon recommendation of the Editor, the Committee approved the following appointments to the Editorial Board: Dr. J. J. Jezeski, University of Minnesota, to review articles in the field of bacteriology; Dr. J. T. Reid, Cornell University, to review articles in animal nutrition.
2. The Committee recommended that the Editor be charged with the responsibility for deciding whether or not Association committee

of published committee reports should not be furnished without charge to committees without the approval of the Executive Board. The Committee recommended that all reprints of current, as well as past, articles be charged for at the same rate. Reprints of articles on which the type has been destroyed should be charged for at the printer's cost plus a 50% mark-up. Reprint covers should be made available at printer's cost. Reprints should be sold to authors at the stated Association price.

3. The Committee approved the inclusion of a new heading in the popular section of the Journal to be entitled "Technical Notes." This includes brief descriptions of experimental findings, technical developments, etc., which for one reason or another do not fall in the category of regular articles.

4. The Committee approved experimenting with a column in the Journal to be entitled "Student Notes." The Editor is to watch the quality of the items submitted and use his discretion as to what is suitable for publication.

5. The Committee rejected the following requests for exchange of publications: Polish Technical Abstracts, Hungarian Technical Abstracts, and Analytical Abstracts of the Society of Public Analysts.

6. The Committee approved an exchange of advertising with Animal Breed Abstracts of Edinburgh, Scotland, whereby each journal will carry information about the other in advertisements four times yearly.

7. The responsibility for obtaining advertising was shifted from the Secretary to the Editor in March of this year. Editor Tracy has produced a very attractive brochure describing our Journal for advertisers. He has put forth a real effort both by personal solicitations and by mail to gain more advertising. The results from this effort will not be made evident at once because of advertising contract periods, but the committee feels that good ground work has been made for future advertising in our Journal.

8. Rates for advertising appearing in the Journal were increased as recommended by the Executive Board at the last meeting.

9. All back issues of the Journal previously stored in Columbus, Ohio, were transferred to the Garrard Press for storage during January of this year. Approximately 15,000 pounds of back issues were inventoried and placed in storage.

10. The Garrard Press, publishers of the Journal, announced a 2.5% increase in the charge for publishing the Journal, effective with the June, 1955, issue. This will amount to an increase of approximately $750 per year.

The Journal Management Committee makes the following recommendations to the Executive Board:

1. That the Executive Board execute contract with Garrard Press, Champaign, Illinois, covering rates for publishing the Journal, effective with the June, 1955, issue to June, 1956. A copy of the contract, as prepared by Garrard Press and signed by the representative, Mr. Hill, is being submitted to the Executive Board for signing by the Secretary-Treasurer.

2. That the report of the annual meeting as published in the Journal be condensed in size. In the past, this report has been quite lengthy and involved considerable cost, since our present page cost is approximately $18. In 1954, 20 pages were given over to publishing the report of the meeting.

3. An outline of main items to be covered in the minutes of the various sections should be prepared by the Secretary-Treasurer and given annually to the secretaries of the various sections. This would affect standardization of the minutes and make for more efficient publishing of the minutes.

4. The Necrology Committee should be advised to keep the Editor informed of member deaths throughout the year. This would eliminate the necessity of publishing the Necrology Report in connection with the annual meeting. At the annual meeting the names of those who have died during the past year will be read and the assembled members of the Association will arise for a moment of silence.

5. The Board should decide on a policy of membership payments when a member dies. Should a refund be made?

6. Consideration should be given to the publishing of a Fiftieth Anniversary Edition of the Journal. In addition to giving our members information about the early founding of the Society, it could provide considerable income in the way of special advertising included in the Fiftieth Anniversary Edition.

7. Publishing of the membership list as a separate reprint and offering for sale. (The Secretary indicates there is much demand for a membership list.) It has been suggested this list could carry some advertising and thus provide additional income.

8. That the length of service of the members of the Editorial Board be 4 years, three members per year to be appointed January 1 of each year.

9. That the Journal Management Committee Chairman be invited to attend specific sessions

of the Executive Board, to-wit, those sessions which involve the budget.

The Committee should continue to work on the desirability of changing the size and format of the Journal.

The Committee wishes to express appreciation and commendation to P. H. Tracy who, as editor, has continued to make an outstanding contribution to the success of the Journal. Appreciation is also expressed to his assistant, Rosamond Tracy; Abstract Editor, W. O. Nelson; and the Editorial Board.

Respectfully submitted, W. M. Roberts, G. W. Trimberger, J. H. Erb, *Chairman.*

Upon motion duly seconded, report was accepted.

AUDITING COMMITTEE REPORT

To the Executive Board and Members of
The American Dairy Science Association

Gentlemen:

On May 13, 1955, Mr. Walter C. Burnham, a Certified Public Accountant, met with the Auditing Committee of the American Dairy Science Association. At that time the committee reviewed Mr. Burnham's report of his audit of the Association's business for 1954.

Mr. Burnham has made a thorough examination of the records. He has checked the bank statements and examined all the U. S. Government Bonds. He has verified by correspondence the inventory of Journals, the Twenty-Year Index, and the Ten-Year Index, all of which are now housed at the Garrard Press at Champaign, Illinois.

The Auditing Committee is satisfied that the financial statement for the year is correct. The committee wishes to commend Mr. Burnham, the auditor, for the thoroughness of his work. We recommend that the financial statement be accepted by the Executive Board and the members of the American Dairy Science Association.

Respectfully submitted, W. J. Harper, T. M. Ludwick, W. J. Brakel, *Chairman.*

Upon motion duly seconded, the report was accepted.

REPORT OF NECROLOGY COMMITTEE

The Necrology Committee wishes to report that the following members of the Association have passed away since our last annual meeting:

A. C. Baltzer, Michigan
R. T. Coie, Washington
C. N. Hall, Pennsylvania
J. C. Hening, New York
D. H. Nelson, Massachusetts
S. M. Salisbury, Ohio
O. J. Schrenk, Illinois
V. H. Townley, Minnesota

It would seem appropriate that members gathered at this meeting stand in silence for a moment in memory of our departed members.

Respectfully submitted, F. W. Atkeson, E. L. Jack, K. E. Gardner, R. G. Connelly, R. Whitaker, *Chairman.*

Upon motion duly seconded, report was accepted.

RALSTON-PURINA RESEARCH FELLOWSHIP COMMITTEE REPORT

Forty-six applications were received by the Ralston-Purina Research Fellowship Committee for the ten fellowships available this year. These fellowships carry an annual stipend of $1,560.00 and are awarded for one year. This was the second largest number of applications received since the program was started eight years ago.

Fellowships were awarded to the following men for graduate study in Dairy Husbandry: W. R. Baumgardt, Purdue University; P. A. Putnam, Cornell University; C. W. Walker, University of Wisconsin.

Fifty-six graduate student research grants have been awarded under this program. As your representative on the Ralston-Purina Research Fellowship Committee, I would like to express our appreciation to this company for their interest in and fiancial support of research and leadership training in the dairy field.

Respectfully submitted, J. W. Pou.

Upon motion duly seconded, the report was passed.

REPORT OF THE A.D.S.A. STUDENT AFFILIATE COMMITTEE

At the 1954 meeting of the Student Affiliate Committee, student affiliate members, and faculty advisers, it was recommended that a student news section be started in the Journal and that arrangements be made for a display that would show local club activities at the 1955 meeting.

The Committee is pleased to report that the first student news section in the Journal will appear in the June issue and that 11 student affiliate chapters took part in the activities display.

Student affiliate membership in the Association is as follows:

Number of students who took advantage of the Nov. 1 membership deadline (received 15 issues of the Journal for the price of 12)	107
Graduate student members	210
Undergraduate members	167
Total student affiliate membership (as of May 15, 1955)	377

During the past year there were 27 active student affiliate branches of the parent organization. Colorado A & M College has applied for a charter during the past year and an inquiry has been received from a second organization.

The following objectives have been considered by the Committee and suggested as more or less permanent goals for the student affiliate program.

1. To bring to the student an appreciation of the magnitude of the dairy industry and the opportunity it offers and the training required for success in the field.

2. To help develop closer relationships between students, faculty, and industry, and between educational institutions.

3. To aid in the development of strong local affiliate chapters for the purpose of developing leadership among the students majoring in dairying.

4. To acquaint the student with the American Dairy Science Association, its scope and purposes, and the role of affiliate members in this over-all program.

5. To utilize the assistance and the thinking of undergraduate and graduate students to direct the attention of industry leaders and educators to student problems and needs.

On Tuesday, June 21, 1955, a student affiliate-faculty adviser meeting was held, at which 32 representatives of 23 universities were present.

It was recommended that the student activities exhibit be repeated again next year and that some form of recognition be considered for the chapter (or chapters) having the most outstanding activities program.

The possibility of giving an outstanding student award was also discussed and will be studied further by the Student Affiliate Committee.

Respectfully submitted, L. K. Crowe, I. I. Peters, P. M. Reaves, W. W. Snyder, W. L. Slatter, *Chairman.*

Upon motion duly seconded, the report was accepted.

REPORT OF TEACHING AWARD COMMITTEE

Since the annual meeting at Pennsylvania State University, this committee lost one of its members, Professor S. M. Salisbury, deceased.

According to the recommendation of this committee to the Board of Directors and approved at the annual meeting in 1954, the first teaching award in dairy technology of $1,000 provided by the Milk Industry Foundation was made last night. This award is to be offered in odd years. A special committee including some of the members of this committee was appointed by the President to make the selection of the winner.

The Committee recommends that a Production Teaching Award be made in 1956; that one or more new members be added to the committee; and that efforts be directed toward securing a sponsor for the Production Teaching Award.

Respectfully submitted, W. B. Combs, H. P. Davis, H. B. Henderson, A. H. Rishoi, R. J. Werner, C. E. Wylie, *Chairman.*

Upon motion duly seconded, the report was accepted.

REPORT OF DAIRYWIDE COORDINATING COMMITTEE ON NUTRITION RESEARCH

The Committee is composed of about 40 members representing 14 national dairy groups.

This Dairywide Coordinating Committee was organized in 1953 to provide assistance for better coordination of nutrition research in the dairy industry and greater use by the dairy industry of available information concerning the nutritional value of milk.

Subcommittees have been named to consider the various objectives of the Committee. The principal subcommittees appointed with a brief statement of their objectives follows:

1. An attitudes poll subcommittee to poll industry to determine consumer and professional attitudes toward dairy foods.

2. A research survey subcommittee to review scientific data to provide the factual background for public information about dairy foods and to suggest additional needed nutrition research to the dairy industry.

3. An editorial subcommittee to formulate recommendations based upon information supplied by the research survey subcommittee for use in public relations, advertising, and other educational work.

4. A subcommittee to consider why there has been a failure of industry to utilize nutrition

information already available through research channels.

During the past year the research survey subcommittee has prepared a list of dairy industry sponsored research projects including titles, objectives, research workers, source of support, etc., which will be released pending approval by the over-all committee. In addition, recommendations for nutrition research programs, both general and specific, have been prepared for release to interested and responsible agencies. Finally, a list of subjects, wherein sufficient information is available from research laboratories to warrant release of information for improving public appreciation of the role of milk and milk products in good health and nutrition, has been passed on to the editorial subcommittee for development. Part of this list of subjects follows:

1. The role of dairy foods in weight reduction diets and the need for agreement in all industry promotion.
2. The biological value of milk protein based on its amino acid content.
3. Milk as an economical source of food protein.
4. How milk contributes to the protein needs of infants, children, and adults.
5. How milk contributes to the treatment of specific diseases.
6. Dairy foods as an important source of dietary fat.

The editorial subcommittee has undertaken the task of developing these six topics during the remainder of 1955 to provide specific information for immediate use by industry through various trade publications.

The real merits and accomplishments of the Dairywide Coordinating Committee for Nutrition Research can be judged only after more efforts have been made to develop the objectives. Its success is largely dependent upon the publicity and circulation given to the various materials prepared by the subcommittees. The broad objectives of the program are good and deserving of continued encouragement and support by the American Dairy Science Association.

Respectfully submitted, J. D. Ingle, K. G. Weckel, R. G. Hansen, *Chairman.*

Upon motion duly seconded, the report was accepted.

INTERNAL PROCEDURES COMMITTEE REPORT

The Internal Procedures Committee recommended and the Executive Board approved the following items of interest for the improvement in the affairs of our Association:

1. The various section secretaries are invited to file a written report of their sections' activities with the secretary, and the chairmen are invited to appear at the general business session of the Association to present matters pertinent to their sections and our Association.
2. The President is encouraged to invite section chairmen to attend the Executive Board meetings and participate in its discussion.
3. It is suggested that the President recognize the section chairmen formally in the general business meetings.
4. Adopted a procedure for disposing of sectional committee reports by:
   a. Establishing a Review Committee.
   b. Charging that Committee with
      (1) Reviewing the section committee reports;
      (2) Recommending their acceptance, modification, or rejection.
5. Required that those who present papers at annual meeting must be members or student affiliate members in the Association.
6. Indicated that members of Association and sectional committees must be members of the Association and developed the thought that maximum membership participation be encouraged by having no member on an excessive number of committees and by seeking appointees from the junior or newer members of the Association.
7. Stated that only papers covering work not yet published nor presented before national scientific societies other than A.D.S.A., or its divisions, are acceptable for inclusion among the contributed papers in the regular program of the annual meeting of A.D.S.A. This would not apply to symposia of invitational papers.

Respectfully submitted, S. N. Gaunt, H. B. Henderson, P. L. Kelly, A. J. Morris, O. F. Garrett, *Chairman.*

Upon motion duly seconded, the report was accepted.

REPORT OF PUBLIC RELATIONS COMMITTEE

It has been recommended and approved by the Executive Board that the full report of the Public Relations Committee and the Recruitment Guide be published, and therefore at this time the full context of the report will be omitted.

Respectfully submitted, F. J. Arnold, Burdet Heinemann, H. B. Henderson, D. H. Jacobsen, J. J. Jezeski, I. A. Gould, *Chairman.*

Upon motion duly seconded, the report was approved.

RESOLUTIONS COMMITTEE REPORT

WHEREAS, The 50th Annual Meeting of the American Dairy Science Association has been held on the campus of the Michigan State College at East Lansing, Michigan, and

WHEREAS, The host institution undertook the difficult task and responsibility of arranging the details necessary for the successful conduct of the annual meeting during the centennial year of the host institution, and

WHEREAS, The arrangements that have been made by the local institution have been more than adequate in every detail, thus permitting this association to hold one of its most pleasant and successful meetings enjoyed by men, women, and children alike, therefore be it

Resolved, That the American Dairy Science Association extend its sincere appreciation for the innumerable courtesies extended and services provided for by Michigan State College, to Dr. John A. Hannah, President, Michigan State College; to Dr. T. K. Cowden, Dean of the School of Agriculture; and especially to Dr. Earl Weaver, Head of the Dairy Department, and to his staff and colleagues who contributed so much toward making possible this successful meeting.

WHEREAS, Many commercial organizations have contributed greatly to the success and enjoyment of the 50th annual meeting, therefore be it

Resolved, That the American Dairy Science Association express to those organizations its sincere appreciation.

WHEREAS, The Borden Company Foundation has for the 19th year made available for presentation by the American Dairy Science Association the Borden Awards for outstanding research in dairy production and dairy manufacturing, therefore be it

Resolved, That the American Dairy Science Association express to the Borden Company Foundation its appreciation for these Borden Awards by which the American Dairy Science Association may recognize achievement in the fields of dairy production and dairy manufacturing research.

WHEREAS, The American Feed Manufacturers Association has made available to the American Dairy Science Association the 8th American Feed Manufacturers Award for outstanding research in dairy cattle nutrition, therefore be it

Resolved, That the American Dairy Science Association express its appreciation to the American Feed Manufacturers Association for this award by which recognition is given to outstanding research in dairy cattle nutrition.

WHEREAS, The DeLaval Separator Company has made available to the American Dairy Science Association the 5th DeLaval Extension Dairyman Award for outstanding achievement in dairy extension, therefore be it

Resolved, That the American Dairy Science Association express its appreciation to the DeLaval Separator Company for the award by which outstanding work in the field of dairy extension may be recognized.

WHEREAS, The Milk Industry Foundation has this year made available to the American Dairy Science Association the first Milk Industry Foundation Dairy Manufacturing Teaching Award for outstanding teaching in dairy manufacturing, therefore be it

Resolved, That the American Dairy Science Association express its appreciation to the Milk Industry Foundation for the award by which outstanding teaching in dairy manufacturing may be recognized.

WHEREAS, The American Dairy Association and the National Dairy Council are effectively engaged in a variety of activities to promote the sale and use of milk and other dairy products, and

WHEREAS, The American Dairy Association and the National Dairy Council have provided funds to support research in various fields of dairy science currently and for a number of years in the past, and

WHEREAS, The American Dairy Association and the National Dairy Council have made possible, through their financial support and enthusiastic interest, the joint Symposium on Dairy Products in Human Nutrition, therefore be it

Resolved, That the American Dairy Science Association commend the efforts of these organizations and their associated groups or agencies for promoting the wider use and understanding of milk and its products and for active support of research in dairy science.

WHEREAS, The American Dairy Association of Michigan and the Michigan State Department of Agriculture have generously made available in convenient location plentiful supplies of milk, cheese and ice cream, and other Michigan food products for the refreshment of members during the sessions, therefore be it

Resolved, That the American Dairy Science Association extend its appreciation to these two organizations for their thoughtfulness and generosity.

WHEREAS, The American Dairy Science Association has taken recognition of the fact that there exists a great shortage of superior young men well-trained in the science of dairying,

and that there is a dangerously low enrollment in the dairy departments of the country, and

WHEREAS, The Association recognizes that great competition exists among all science areas for superior secondary school graduates and that other science groups are actively engaged in promoting their respective interests, and

WHEREAS, The American Dairy Science Association, being a leading scientific and educational organization in the dairy industry, is cognizant of its responsibility in this connection and also recognizes that a progressive cooperative endeavor is necessary on the part of all organized dairy groups if the dairy industry is to be properly promoted and if the dairy story is to be told effectively to promising secondary school students throughout the land, and

WHEREAS, The Association believes that an important and essential approach to the matter of secondary school promotion is the development of effective films suitable for showing to secondary school and lay groups and portraying the various career opportunities of the dairy industry, and that the most effective films with the broadest scope can be produced only by the cooperation of all key dairy groups so that every major field of dairying will be properly displayed and portrayed, therefore be it

Resolved, That the American Dairy Science Association assume its rightful leadership position and bring this matter to the attention of the leading dairy trade, professional organizations and companies, requesting that they consider cooperative action in the production of satisfactory films as an industry-wide project, and, furthermore, that the American Dairy Science Association express its desire to serve as a coordinating agency in order that these greatly needed films will become a reality in the near future and that they will represent the highest standards of education, science, and industry.

Respectfully submitted, G. H. Hartman, R. E. Erb, E. T. Itschner, F. M. Murdock, D. J. Hankinson, *Chairman.*

Upon motion duly seconded, the report was accepted.

REPORT OF REGULATORY ADVISORY COMMITTEE

It has been recommended and approved by the Executive Board that the Report of the Regulatory Advisory Committee be published in full after revision and editing by the Chairman with the assistance of the Editor; therefore, the report will be omitted at this time.

Respectfully submitted, A. C. Dahlberg, J. T. Miles, W. M. Roberts, *Chairman.*

Upon motion duly seconded, the report was received.

REPORT OF EXTENSION SECTION

The first activity of the Extension Section was an open meeting of the D.H.I.A.-I.B.M. Committee, which was attended by approximately 125 extension workers and others interested in this program.

J. D. Burke presented a paper, "Information Relating to the Organization of Statewide Dairy Herd Improvement Cooperatives."

The opening session of the section was called to order by Chairman E. T. Itschner at 1:30 P.M., June 21. Three papers on teaching methods were presented.

The Exhibits Committee had exhibits of teaching aids and demonstration methods from twenty states. A panel discussion, E-4, using D.H.I.A. records as effective teaching tools was presented. The panel consisted of J. D. Burke, *Moderator,* D. E. Voelker, C. H. Parsons, and H. G. Gilmore.

Leo Fryman presented the report of the Dairy Records Committee, which included recommendations on a National Eartagging System, revision of D.H.I.A. forms and rules. Several motions for slight revision of one proposed rule were offered but not approved. The report was approved as read.

The 4-H Club Committee report was presented by John Norris and approved.

Marvin Senger and Leo Fryman were nominated for secretary of the Extension Section. The nominations were closed and the ballot count was Fryman 32, Senger 28. Fryman was declared elected secretary for the coming year with the Vice-Chairman George Werner to rotate to Chairman and J. D. Burke to Vice-Chairman.

The Extension Section met with Production Section B on a symposium, Ratio of Forages to Grain in the Milking Ration, and this is included in the Production Report. The Joint Committee reports are also reported in the Production Report.

Dairy cattle health problems and 4-H Club work were discussed under the Chairmanship of George Werner.

This was followed by a panel discussion on the same subject. The panel consisted of George Hyatt, *Moderator,* Irving Wyeth, R. D. Stewart, Nevels Pearson, J. D. George, and E. R. Bonewitz.

Copies of all committee reports, resolutions, papers, and minutes are permanently filed with

the Dairy Research Branch and copies distributed to all Extension dairymen.

Respectfully submitted, J. D. Burke, *Secretary.*

Upon motion duly seconded, the report was accepted.

REPORT OF MANUFACTURING SECTION

Papers and symposia were presented as indicated in the program except for two papers read by title.

Business meetings at 11:00 A.M. and 4:00 P.M., June 22, 1955, Chairman G. H. Hartman, presiding.

The Chairman of the Nominating Committee, S. L. Tuckey, presented the committee candidates. There were no nominations from the floor. The following officers were elected for 1955-56: W. M. Roberts, *Chairman;* H. L. Templeton, *Vice-Chairman;* and F. J. Babel, *Secretary.*

The following Committee reports were made and accepted:

1. Committee for Recommending Uniform Procedures for Making Acidity Determinations of Fluid Dairy Products. F. J. Doan read the report of J. G. Leeder, *Chairman.* Publication of this report in the *Journal of Dairy Science* recommended by the Section, and the Section and the Committee dismissed with thanks.

2. Committee on Curd Tension of Milk; H. E. Calbert, *Chairman.* Progress report made on the activities of the Committee. The Committee to be continued for another year.

3. Committee on Butter; C. Jensen, *Chairman.* This Committee proposes to devote its attention for the coming year to one of the three fields of activity outlined previously for the improvement of butter quality. This Committee will be continued.

4. Committee on Dairy Products Judging; G. M. Trout, *Chairman.* Report reviewed the activities of the past year and included the names of recipients of the 1954 fellowships together with schools selected for graduate work. This Committee to be continued for another year.

5. Committee on Milk Protein Nomenclature, Classification, and Methodology; A. M. Swanson, *Chairman.* This Committee continues to have as its objective the establishment of a definite and logical classification of milk proteins. Nomenclature to be revised in the light of latest information. This Committee will be continued.

6. Committee on a Score Card for Cottage Cheese; G. M. Trout presented the report for H. C. Olson. This Committee is developing a score card for cottage cheese and has made very definite progress. This Committee to be continued for another year.

7. Committee on Resolutions; S. T. Coulter, *Chairman.* This Committee presented two resolutions. The first commended the present program and recommended its continuance as a combination of symposia, panel discussions, and individual contributed papers. The second resolution emphasized the desirability of distributing committee work of the Section as widely as possible by suggesting that no committee member be asked to serve on the same committee for more than five years and that a system of rotation be worked out, that two men be rotated on a five-man committee and one man on a three-man committee each year.

Motion was made, seconded, and carried that the incoming Section Chairman appoint a publicity committee to work with the Publicity Committee of the Association.

Motion made, seconded, and passed that the Judging Committee be instructed to check on the possibility of setting up a score card for concentrated milks, both fluid and dry.

A number of suggestions were made relative to topics that are of interest to the members of the Section and might be made subjects of symposia for later programs.

The Section expressed its appreciation to the officers for their work during 1954-55.

Respectfully submitted, G. H. Hartman, *Chairman;* Wm. Roberts, *Vice-Chairman;* H. L. Templeton, *Secretary.*

Upon motion duly seconded, the report was accepted.

REPORT OF PRODUCTION SECTION

In accordance with the listing in the official program, 109 papers were discussed in the Production Section.

The Production Section business meeting was held at 11:00 A.M., Wednesday, June 22, with Chairman R. E. Erb presiding.

The report of the Dairy Cattle Judging Committee was presented by the Chairman, E. E. Ormiston. Recommendations of the committee which were approved were: (1) that the Production Section of the American Dairy Science Association continue to cooperatively authorize and approve the rules for the National Intercollegiate Dairy Cattle Judging Contest; (2) that the published Rules and Regulations for the conduct of the 1955 National Intercollegiate Dairy Cattle Judging Contest, except for details of time and place of the contest, become

the official rules for its conduct subject to the changes listed as approved in the remainder of this report; (3) *eligibility for contestants* to read as follows: "The student must be enrolled in a four-year or longer course leading to a degree in agriculture, veterinary medicine, or agricultural education and have completed not less than 36 weeks of college work. Any student who has been a member of a team competing in the National Intercollegiate Dairy Cattle Judging Contest or has acted as an official judge of dairy cattle at a fair or show or has at any time served as a teacher of dairy cattle judging in an agricultural college or secondary school or has completed a four-year course in college work or has competed in more than two intercollegiate dairy cattle judging contests is not eligible for entry in this contest;" (4) that oral reasons be given on one class of each breed and that of these not less than three nor more than four cow classes be included; and (5) that the complete amended rules be recommended for publication in the *Journal of Dairy Science* and copies of the same be made available to participating colleges and judging team coaches and the management of the show where the contest is to be held.

It was also decided that the judging of bulls should not be discontinued and that Milking Shorthorn classes should not be included as an official class in the National Intercollegiate Dairy Cattle Judging Contest.

The Nominating Committee recommended the names of S. W. Mead and J. W. Sykes for vice-chairman, and S. B. Marshall and A. R. Porter for secretary. S. W. Mead was elected vice-chairman and S. B. Marshall secretary. It was necessary to elect a vice-chairman since the secretary of 1955 will not be available to serve during 1956. It was moved, seconded and passed that N. P. Ralston, present vice-chairman, serve as chairman for the next year.

A report for the Guidance Committee was made by N. N. Allen. He reported that the committee had worked cooperatively with the Internal Relations Committee to recommend that a paper previously presented as a progress report at a regional meeting is satisfactory for presentation at the annual meeting or for publication in the *Journal of Dairy Science*. This committee also reemphasized the necessity of limiting the length of abstracts for papers to 200 words.

D. M. Seath reported for the Resolutions Committee.

R. E. Erb served as chairman during the reading of the joint Production-Extension Section committee reports on Wednesday, June 22. The following reports were given:

G. H. Wise of North Carolina reported for the Dairy Cattle Health Committee. Attention was focused on complete eradication of brucellosis and control of calfhood diseases and repeatable factors causing reproductive disturbances. It was moved, seconded, and duly carried that the report of the committee be accepted.

R. A. Corbett, University of Maine, reported on the work of the Dairy Cattle Breeding committee. The use of correction factors for adjusting records for incomplete lactations, size of cow, length of preceding dry period, and length of calving interval were recommended. The Committee provoked a stimulating discussion on their proposed revisions to regulations governing the artificial insemination of purebred dairy cattle. The proposed revisions were adopted, including provisions for registry and transfer of frozen semen samples under specific conditions in a manner similar to a live animal.

Upon a motion from H. A. Herman, duly seconded and carried, it was recommended to Dr. J. F. Kendrick, USDA Dairy Branch, that, as facilities permit, state averages for lactation records of grades and purebreds be published by breeds, years, and states, including all production records from cows sired by either artificial breeding or natural service.

Hilton Boynton, University of New Hampshire, reported for the Dairy Cattle Type Committee. They specifically recommended summarizing research on dairy cattle type, development of a heifer score card and adoption of a suggested Type Evaluation Score Card. It was moved, seconded, and carried that the report of the committee be approved.

Ray Albrectsen of New York reported for the Breeds Relation Committee. The recommendations of the committee that HIR rules be changed to allow four cows rather than three to be milked at one time and that the total milking per day shall not exceed 90 were approved. Also approved was the committee's recommendation that the Judging and Showing Procedure booklet developed by the American Guernsey Cattle Club be adopted by the American Dairy Science Association and Purebred Dairy Cattle Association. It was moved, seconded, and favorably voted that the report of the committee be approved.

Respectfully submitted, R. E. Erb, *Chairman;* N. P. Ralston, *Vice-Chairman;* G. W. Trimberger, *Secretary.*

Upon motion duly seconded, the report was accepted.

REPORT OF REGISTRATION COMMITTEE

State	*Number*
Alabama	5
Arizona	2
Arkansas	6
California	21
Colorado	6
Connecticut	16
Delaware	5
District of Columbia	34
Florida	14
Georgia	19
Idaho	2
Illinois	152
Indiana	30
Iowa	61
Kansas	14
Kentucky	24
Louisiana	14
Maine	10
Maryland	57
Massachusetts	23
Michigan	39
Michigan—MSC staff	113
Minnesota	74
Mississippi	1
Missouri	25
Montana	4
Nebraska	24
Nevada	1
New Hampshire	13
New Jersey	20
New Mexico	1
New York	123
North Carolina	38
North Dakota	11
Ohio	110
Oklahoma	10
Oregon	8
Pennsylvania	46
Rhode Island	1
South Carolina	5
South Dakota	5
Tennessee	10
Texas	13
Utah	14
Vermont	10
Virginia	20
Washington	20
West Virginia	11
Wisconsin	101
Wyoming	3
Norway	1
Puerto Rico	1
Scotland	1
Canada	47
Alaska	1
Argentina	2
Japan	1
Philippines	1
Sweden	1
Men	842
Women	316
Children	202
Total	1,360

Respectfully submitted, L. A. Johnson, *Chairman.*

Upon motion duly seconded, the report was accepted.

AWARDS PROGRAM

The Association Awards presentation took place in Brody Hall, Michigan State College, East Lansing, Michigan, June 22, 1955. President Moore presided.

AMERICAN DAIRY SCIENCE ASSOCIATION TEACHING AWARD

W. B. Combs, Chairman of the Teaching Selection Committee presented the winner.

"It has long been the wish of many of our members that our Association do something to recognize outstanding teachers of Dairy Science. The American Dairy Science Association at its annual meeting in 1954 at Pennsylvania State University voted to recognize the outstanding teachers of Dairy Science, and the Milk Industry Foundation generously agreed to sponsor a teaching award for the outstanding teacher in the field of dairy manufacturing on odd years.

F. H. Herzer

"The recipient of this award has been actively engaged in teaching in dairy manufacturing for 41 years. He received his B.S. degree in dairy technology in 1914 at the Ohio State University and his M.S. degree from Iowa State College in 1935. He accepted a position in 1915 as associate professor at the institution with which he is now associated. He has been largely instrumental in building up a dairy manufacturing curriculum for that institution, having developed and taught nearly all of the courses that are offered in the field, and at present is actively engaged in teaching a number of courses and serving as head of the department.

"It is through his students that one gains a very keen insight as to his real qualifications as a man and a teacher. Through his leadership he has been able to guide and direct his students through their four years in college and in their work in the years to follow. 'He is the type of teacher,' states one of his former students, 'who takes pride in seeing students go out and make successes and real contributions to the dairy industry.'

"'To me,' stated one young man, 'his unselfish attitude, together with a lifetime of invaluable contributions to the dairy industry in our country, most certainly demonstrates his worthiness of any honor that may be bestowed upon him.' For many years he has been an outstanding coach of dairy products judging teams competing at international contests.

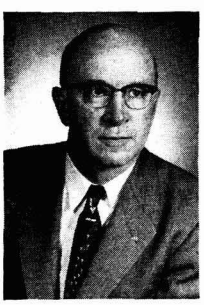
"The Teaching Award Committee is pleased to present the first recipient of the Teaching Award in Dairy Manufacturing, Frederick Herman Herzer, professor and head of the Dairy Department at Mississippi State College."

Hubert Garrecht, representing the Milk Industry Foundation, presented F. H. Herzer with a check for $1,000.00 and a plaque.

DE LAVAL EXTENSION DAIRYMAN AWARD

L. H. Rich, Chairman of the DeLaval Extension Dairyman Award Committee, presented the winner.

"The candidate for the DeLaval Achievement Award in Dairy Extension was born in 1902 in Hornick, Iowa. He graduated from Iowa State College in 1926. In 1940 he obtained his M.S. degree from that institution.



F. J. Arnold

"He began his career as extension dairyman in his own state in 1927. It was his responsibility to select and train Dairy Herd Improvement supervisors. He helped to organize bull associations, which continued over the years. He was also directly responsible for the planning of exhibit material at the National Dairy Cattle Congress.

"In 1943 he left Iowa to take charge of the Dairy Extension Program in Maryland, where he developed new subject matter material with special attention to visual aids. Dairy breeding schools were organized. A short course for dairy fieldmen was begun. His most important contribution, however, was the organization of the Maryland Artificial Breeding Cooperative in 1946. In 1954 a total of 43,000 cows were serviced by this organization.

"Our candidate coached the national 4-H judging teams, and calf selection parties were organized for club members for obtaining good project animals at reasonable prices. In 1947, the position as Iowa's Extension Dairyman was accepted by the recipient of the Award.

"His more recent work at Iowa has included sponsoring of fast milking, labor-saving demonstrations, youth activities, production testing, and disease control. He has also served as official classifier for the Brown Swiss Cattle Breeders Association and as assistant superintendent of the National Dairy Cattle Congress. He has been active in the Extension section of A.D.S.A. and in the Purebred Dairy Cattle Association.

"The recipient of this award, Floyd J. Arnold, is respected over the nation for his integrity, his vision, and his hard work."

H. L. Barnes, sales manager of the DeLaval Separator Company, presented Mr. Arnold with a check for $1,000.00 and a framed certificate.

AMERICAN FEED MANUFACTURERS' AWARD

J. W. Thomas, member of the American Feed Manufacturers' Award Committee, presented the winners in the following manner.

"For seven consecutive years, the American Dairy Science Association has recognized outstanding contributions to dairy cattle nutrition by selecting candidates for the American Feed Manufacturers' Award. During this period more than 100 papers involving 35 individuals or groups of research workers were found worthy of consideration for the award. On the basis of standards set forth by the American Dairy Science Association, your committee this year, for the first time, has selected a research team as candidates for the award. This team of investigators has carried on a well designed and continuing series of investigations on the lipid metabolism of the dairy calf, methods of administration of vitamin A, feeding value of antibiotics, and surf-

N. L. Jacobson

actants, distribution of P^{32} in the dairy calf, and feeding various hay-grain ratios to lactating cows. Practically, the results of these studies have provided criteria to recognize lipid deficiency in the calf, means for more efficient utilization of supplementary vitamin A by the calf, and evaluation of antibiotics in the dairy cattle feeding program. Fundamentally, these investigations have provided a wealth of information as to blood constituents and changes with various dietary lipid regimes, as well as basic information on the possible role of antibiotics and surfactants in dairy calf nutrition.

R. S. Allen

"These studies represent the combined efforts and initiative of two research workers, a dairy nutritionist and a biochemist. The former was awarded a B.S. degree in 1940 by the University of Wisconsin. He received an M.S. degree from Iowa State College in 1941 and a Ph.D. degree in 1947, after he had served in the U. S. Navy from 1942 to 1946. Since 1947, he has been on the Dairy Husbandry faculty at Iowa State College, first as an assistant professor, then associate professor, and currently professor in charge of dairy nutrition.

"The biochemist received a B.S. degree in chemistry from Brigham Young University in 1939 and an M.S. degree in 1940. After service with the U. S. Army, he received a Ph.D. degree in biochemistry from Iowa State College in 1949. He is currently associate professor of chemistry and dairy husbandry at Iowa State College.

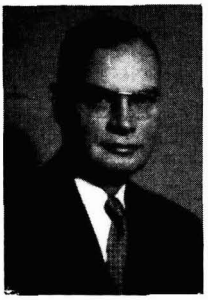
"On behalf of the Award Committee, it is a pleasure to present Norman L. Jacobson and Robert S. Allen of Iowa State College as the candidates of the American Dairy Science Association for the 1955 American Feed Manufacturers' Award in Dairy Cattle Nutrition."

W. T. Diamond, secretary of the American Feed Manufacturers' Association, presented N. L. Jacobson and R. S. Allen with a check made out to them jointly.

ASSOCIATION HONORARY MEMBER AWARD

H. A. Bendixen, Chairman of the Honors Committee, presented the recipient as follows.

"The man being honored by us today is one who, in common parlance, 'gets around,' and wherever he has gone he has been a leader. His services to the American Dairy Science Association have been invaluable for many years, and his influence for good in the national and international affairs of the dairy industry has been outstanding By honoring him, the American Dairy Science Association is honoring itself.



W. A. Wentworth

"Walter Allerton Wentworth was born in New Hampshire in 1888. He attended high school in Iowa and in 1910 earned his B.S. degree in agriculture at Iowa State College. After a distinguished career, he was honored by his Alma Mater in 1953 with the College's Alumni Honor Award.

"Immediately after his graduation he did research work at Michigan State College, but in 1911 he took over the management of a purebred Holstein herd in Iowa. From 1917-1919 he served as county agricultural agent of Kossuth County, Iowa. For the next four years he simultaneously held the positions of secretary for the Iowa Dairy Council, the Iowa Milk Dealers' Association, and the Iowa Creamery Secretaries and Managers Association.

"In 1923 he became secretary of the Ohio Dairy Products Association. He managed this association for the next six years and in addition found time for many civic activities in Columbus. In 1935 the Borden Company induced him to accept the position of director of public and industry relations for the Midwest district. Mr. Wentworth became director of public relations for the Borden Company the next year and director of industry relations in 1943. Since 1945 he has also been a member of the Borden Company Foundation, serving as its secretary until 1954. He has served on a large number of important industry committees and has filled many important offices.

"It was as the representative of the Foundation that Mr. Wentworth became a well-known and beloved figure in the eyes of the entire membership of the American Dairy Science Association, since at many of our annual conventions he presented the coveted Borden Awards to our most distinguished research scientists in the fields of dairy production and dairy manufacturing.

"At this time the American Dairy Science Association in turn honors Mr. Wentworth for a lifetime of devoted service to the great dairy industry as well as his continued interest in and invaluable assistance to the Association in many of its problems. May he continue to lend a friendly hand to the Association and together with his charming wife, Aubyn Chinn Wentworth, favor our organization with his inspiring presence and valuable counsel at our meetings and in committee deliberations for many years to come.

"In a spirit of deep appreciation and with great pleasure we present to Walter Allerton Wentworth this certificate of Honorary Life Membership in the American Dairy Science Association."

President L. A. Moore presented Mr. Wentworth with a framed certificate of Honorary Membership.

BORDEN AWARD IN DAIRY MANUFACTURING

S. L. Tuckey, Chairman of the Borden Award in Dairy Manufacturing Committee, presented the winner.

"The recipient of the 1955 Borden Award for Research in Dairy Manufacturing was born in Connecticut in 1916. He worked in a dairy plant during summer vacations from the time he was in the sixth grade until he was graduated from college. Undoubtedly the lessons which he learned at that time on the value of self-discipline through hard work contributed much to his success.

F. V. Kosikowski

"His undergraduate training was received at the University of Connecticut, from which he was graduated with honors in 1934. He was awarded the Dairy Industries and Supplies Association Judging Fellowship in 1938, which permitted him to do advanced study. For this he selected Cornell University where he was awarded the M.S. degree in 1941 and the Ph.D. degree in 1944. He has advanced through the ranks from instructor in 1942 to professor of dairy industry in 1953.

"In 1952 he was the United States representative, by invitation, at the United Nations and International Dairy Federation at the Western European Seminar on Recent Advances in the Science and Practice of Cheese Making, held at Poligny, France. In 1955 he was awarded a Fulbright Fellowship to do research work at the Station Centrale de Microbiologie at Recherches Laitieres, Jouy-en-Josas, France.

"His special interests and achievements in research have been in the factors which contribute to the ripening and flavor development of Cheddar cheese. He has also developed a phosphatase test applicable to all dairy products and has surveyed New York fluid milk markets for the purpose of determining the prevalence of antibiotics and other drugs which might affect lactic acid fermentation in milk.

"The recipient of this award has been ever alert to new ideas and methods and their application to problems in dairy manufacturing, as evidenced by the more than 50 publications of which he has been author or co-author. Frank V. Kosikowski is respected and admired by his students and associates, by the commercial dairy industry, and members of the American Dairy Science Association who now honor him."

John H. McCain, Borden Company Foundation, presented Dr. J. M. Sherman, Cornell University, with Dr. Kosikowski's medal and check for $1,000.00.

BORDEN AWARD IN DAIRY PRODUCTION

R. E. Hodgson, Chairman of the Borden Award in Dairy Production Committee, presented the winner.

"The recipient of the 1955 Borden Award for outstanding Research in Dairy Production was born in Oregon in 1895. He obtained pre-college training in the Portland schools and after service in the United States Army in Europe from 1917 to 1919 obtained the B.S. degree from Oregon State College in 1923 and the M.S. degree from the University of Washington in 1927. He served as instructor in organic chemistry at Oregon State College until 1929 when he joined the staff at Michigan State College as an assistant chemist, advancing to associate chemist in 1943, associate

C. W. Duncan

professor in 1946, and professor in agricultural chemistry in 1952, the position he holds today.

"His work at Michigan State College has dealt with a wide range of problems in nutrition and blood chemistry. He has emphasized fundamental research, but at the same time he has shown a keen interest in the solution of practical problems. While carrying on a major portion of the actual work in research, he has also rendered yeoman service as a counselor and has been a real spark plug for teams of research workers.

"The major contributions for which Professor C. W. Duncan is being recognized are for research accomplishments pertaining to the biochemical and physiological characterization of the protein and other constituents of blood, milk, and semen of the bovine; for investigations relating to the vitamin and mineral requirements, especially the trace minerals, of the cow and calf; for research relating to the composition, digestibility, and nutritional value of feeds; and for studies of the nutritive effects of crops grown on soils of different fertility level on the health, production, and reproduction of dairy cows."

J. H. McCain presented Doctor Duncan with a check for $1,000.00 and a gold medal.

INSTALLATION OF OFFICERS

President Moore installed the following officers: E. L. Fouts and I. W. Rupel, association directors; C. F. Huffman, vice-president; and I. A. Gould, president.

PEOPLE and EVENTS
in the Dairy Science World

Pioneers in the Dairy Industry

These days most babies are given evaporated milk formulas. It was not always so. Acceptance by the medical profession and the public began about 25 years ago, following a long line of publications in the medical journals reporting carefully controlled clinical studies in which babies given evaporated milk formulas were compared with those on other feeding procedures. When FRANK ELMORE RICE became associated with the Evaporated Milk Assoc., first as a consultant in 1927 and then as executive secretary in 1928, the number one project was to stimulate and encourage through grants-in-aid just such clinical studies.

F. E. Rice

Dr. Rice was born July 31, 1887, in Cuba, Indiana, a town of less than 50 inhabitants in the southern part of the state. Later the family moved to Spencer, Indiana. After finishing the Spencer public schools and one year at Indiana University, Mr. Rice taught one year in a country school, urged by a hard-working country physician father who thought a boy's education should include other things than classroom instruction. He returned then to Indiana University for three more years and received an A.B. degree in chemistry in 1909. As an undergraduate his athletic prowess consisted of playing in the band at athletic games. For one summer during this period he was employed in the chemical research department of the American Steel and Wire Company at Joliet, Ill.

In the fall of 1909 he went to Cornell University to accept a graduate assistantship in the Chemistry Department. After some further years of combined teaching and advanced study, he received a Ph.D. degree from Cornell in 1914. Dr. Rice remained at Cornell until 1924, first as an instructor and later as an assistant professor in chemistry. During these years, he carried on researches in the field of agricultural and food chemistry, particularly on dairy products. He also spent two summers in the chemical laboratory of the New York Agricultural Experiment Station at Geneva. During this period he published the results of many research studies and also numerous articles both popular and technical in the food and nutrition field. The *Journal of Dairy Science* in the 1920's carried several reports of his researches. At this time and later he was a contributing abstractor for *Chemical Abstracts*.

Beginning in 1917, Dr. Rice was employed by the Nestle Company as a consultant and research chemist. At that time this company had many problems connected with their suddenly expanding export business in evaporated and condensed milks and other dairy products.

In the fall of 1924, the Rice family moved to Raleigh, N. C., where he accepted a professorship in chemistry at North Carolina State College. During his three years at this institution, he taught courses in organic and biological chemistry and directed the work of graduate students. At this time he published a textbook, *Organic Chemistry*, designed for students in biological, medical, agricultural, and home economics fields, which text was used in a number of colleges. During his last year at Raleigh, he was chairman of the Chemistry Department. In 1925 he was elected chairman of the North Carolina Section of the American Chemical Society.

As executive secretary of the Evaporated Milk Assoc. from 1928 to 1954, Dr. Rice directed the research and education program on evaporated milk and vitamin D milk, which led to the acceptance of this form of milk by medical and nutrition leaders for the feeding of babies. He has authored a number of articles in medical and technical journals on the nutritional values of evaporated milk and its varied uses, including the feeding of infants.

Among trade association activities in which the Evaporated Milk Assoc. has been engaged is one of special interest to the whole dairy industry. In 1931 certain forces were endeavoring to repeal the filled milk laws of the states and the federal law. The Evaporated Milk Assoc. inaugurated a defensive program, led by Dr. Rice, which resulted in the defeat of these forces in most states, and the federal law prohibiting shipment in interstate commerce of filled milk was strengthened.

Dr. Rice was designated as managing agent for the Evaporated Milk Marketing Agreement in September, 1933, one of the earliest marketing agreements under the Agricultural Adjustment Act. He was an official U. S. delegate to the 1953 Intern. Dairy Congress in Holland. He served as chairman of the section devoted to concentrated milks and contributed two papers to the Congress program.

After 25 years of active membership in the American Trade Assoc. Executives, Frank Rice was made a life member in 1954. He was a member of the Trade Assoc. Executives Forum of Chicago for as many years—its president in 1937. He is a member of Sigma Xi, Phi Kappa Phi, Alpha Chi Sigma, Gamma Alpha, Phi Sigma Kappa, the Executives Club of Chicago, the Agricultural Club, and various Masonic bodies.

His hobby recently has been photography. He has been a member of the Photographic Society of America for many years—on its board of directors and chairman of the Stereo Division in 1952-54. In that Society he has been honored as a "Fellow," and thus can write FPSA after his name. He is a 3-star exhibitor in color, owns more than half a dozen cameras. In 1953 he was given the David White Award "for outstanding contributions to the art and science of stereo photography."

Beginning in 1949, working with the Chicago Historical Society, Dr. Rice started a project designed to encourage local amateurs to make pictures of the Chicago scene for the permanent files of the Society for current reference and for future generations. Under his direction and that of his successors, several thousand pictures have been added to those files.

In July 1954, Dr. Rice retired as executive secretary of the Evaporated Milk Assoc. Since that time he continues as "consultant" with certain general and specific assignments.

E. H. PARFITT

Carnation Adds Frozen Food Division

With the acquisition of Mrs. Lee's Pies, Inc., makers of the "Simple Simon" line of frozen pies and cookie rolls, Carnation has further integrated its activities with the food field. D. W. HOGUE, general manager of Carnation's Northern California fresh milk and ice cream division, will assist A. G. READ, former president of Mrs. Lee's Pies, Inc., in managing the new addition to the company. This growing trend of large dairy corporations to diversify in other branches of the food industry should be of tremendous significance to those responsible for planning the dairy technology curricula in our state universities.

Holland to Head Dairy Industry Department at Cornell

On July 1, R. F. HOLLAND became head of the Dairy Industry Department at Cornell Univ. succeeding J. M. SHERMAN, who has filled that position for the last 32 years. Dr. Sherman will continue on the staff of the College of Agriculture as professor of bacteriology. He will devote full time to research and writing.

Professor Holland, a native of Holley, N. Y., received the B.S., M.S., and Ph.D. degrees from Cornell, in 1936, 1938, and 1940, respectively. From 1935-39 he held the title of instructor in dairy chemistry, and previous to that was bacteriologist for Inlet Valley Farms, Inc. (a local dairy plant), 1932-35. Before joining the Cornell faculty as professor of dairy industry in 1945, Dr. Holland served as director of chemical research for G.L.F. for 4 years. He has also had experience as dairy sales engineer for the Cherry-Burrell Corp. and was associate in research for the State Agricultural Experiment Station, Geneva, from 1939-41.

At Cornell he has been in charge of the extension work in the Dairy Department and has taught specialized courses in dairy industry, dairy chemistry, and bacteriology. He has published many papers of an educational, extension, and research nature in dairy science. One of his technical bulletins published at Geneva concerned the effect of time and temperature of pasteurization on some of the properties and constituents of milk.

The new department head resides in Trumansburg with his wife, two sons, and a daughter. Another son is a second lieutenant at Fort Sill, Oklahoma.

Leeders on European Trip

PROFESSOR and MRS. JOE LEEDER of Rutgers University are spending the summer in Europe. Dr. Leeder plans to make extensive studies of ice cream plants in London, Amsterdam, and Milan.

Welch New Vice-President of Wilbur-Suchard Chocolate Co.

R. C. WELCH has been made vice-president in charge of manufacturing for the Wilbur-Suchard Co. Since 1943 he has served as plant superintendent. Prior to that time he was in charge of quality control at Sylvan Seal Milk Co. in Philadelphia. Welch took his undergraduate training at Washington State College, and his doctor's degree was obtained from Pennsylvania State Univ.

Newman Made Beacon Milling Company Executive

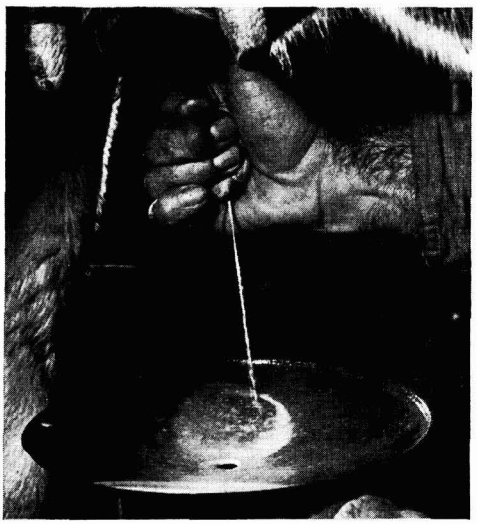
P. E. NEWMAN was made executive vice-president of the Beacon Milling Co., Cayuga, N. Y., June 29. Newman is a graduate of the Purdue Agricultural College. He received his M.S. degree from Wisconsin and his Ph.D. degree in animal nutrition from Cornell. He joined Beacon in 1937 as a dairy nutritionist working on the development of dairy rations. Dr. Newman is also a graduate of Harvard School of Advanced Business Management.

New Department Organized at Colorado

A Department of Dairy Industries has been organized at Colorado A. & M. College. E. K. MCKELLAR, head of the new department, will be assisted by B. J. DEMOTT and G. M. WARD.

New Plate-Type Strip Cup Detects Mastitis Early

One of the handiest and most important dairy tools is the strip cup. Perhaps more than any item except the scrub brush, it can safeguard the health of the herd and quality of milk by early detection of mastitis. The late DR. CLAUDE BRYAN of Michigan, a recognized expert on mastitis, said that steady use of a strip cup would catch 75% of udder infections at the early stage detectable only by a laboratory test.



A new plate-type strip cup introduced by Babson Bros. Co. of Chicago has a wide, flat, dark-colored surface, with concentric rings like a phonograph record, which show up small flakes of mastitis immediately—before the usual "ropiness" appears. If small flakes of clotted milk are detected, they are advance danger signs of a bacteria count as high as two million. Milk from that cow should immediately be discarded and the udder treated according to the veterinarian's recommendations.

Irrigation Studies to Be Made

Reflecting the rapidly growing use of supplementary irrigation as a means of increasing crop yields and farm profits, Olin Mathieson Chemical Corp. is initiating a program of research on the agronomic and technical aspects of irrigation. Supervised by the company's irrigation department, of which T. W. CROCKETT is manager, the program will be directed by G. G. WILLIAMS, Purdue Univ. agronomist, who joined the company August 1 as manager of irrigation research and planning.

The program has three objectives: to determine the effect of irrigation in combination with high analysis water soluble fertilizers to promote maximum yields on various soil types; to determine which crops and which soils can be most economically irrigated; and to develop improved irrigation equipment and methods.

Activities at National Dairy Research Laboratories

RANDALL WHITAKER has returned from a trip to Europe, during which he visited the Hannah Dairy Research Institute at Kirkhill, Ayr, Scotland, and the National Institute for Research in Dairying of the Univ. of Reading, Shinfield, Berkshire, England. He also visited dairy plants in England, Holland, and Switzerland. Dr. Whitaker gave an account of his travels before a seminar in a talk titled "Some Observations on Dairy Practices in Europe."

E. O. WHITTIER also recently addressed the seminar on the work of the government Dairy Products Laboratory in Washington, formerly the Bureau of Dairy Industry. Others who have appeared before the seminar in recent months and their topics are: D. B. HAND of the New York State Expt. Sta., "Food Technology in Korea"; J. B. ALLISON of Rutgers Univ., "Protein Nutrition and the Tumor-Host Relationship"; H. F. DEPEW, director of the Plant Production Division, National Dairy Products Co., Inc., "The Parade of Progress in the Milk and Ice Cream Industry"; H. B. HASS of the Sugar Foundation, "Sucrochemistry"; W. D. BELLAMY of General Electric, "Treatment of Milk Constituents with High Energy Cathode Rays"; MARY B. HORTON, director of Sealtest Consumer Service, "Our Other Boss—Mrs. Consumer"; M. S. SHAHAN of the Plum Island Animal Disease Lab., who spoke on the work of that institution; and L. B. ROGERS of M.I.T., "Electrochemical Phenomena in Dilute Solutions."

A. H. JOHNSON, president of the Laboratories, has been appointed to the National Academy of Sciences—National Research Council's Civil Defense Foods Advisory Committee—to represent the dairy industry. Dr. Johnson is also a member of the Dairy Research and Marketing Advisory Committee of the USDA.

THOMAS BONNITT and ALVIN HOLZBERG have recently joined the Commercial Development Dept. of the Laboratories to aid in its expanding activities. NEIL SULLIVAN has joined the Dairy Products Lab. as chemical engineer and JULES GUTH as research chemist; JOHN LOMOT, the Chemical Products Laboratory, as analytical chemist; and SALLY MOORE, the Fundamental Research Laboratory, as bacteriologist.

Mudge Retires at California

C. S. MUDGE, chairman of the Bacteriology Dept. of the Univ. of California at Davis, ended 33 years of service to the University and

the state when he retired July 1. He joined the faculty in 1922 as a dairy bacteriologist and remained in that capacity until 1947, when the Bacteriology Dept. was created. His research has been aimed at solving problems of dairy plant sanitation, particularly of streptococcus bacteria in milk. Among his many publications are a book, *A Fundamental Approach to Bacteriology,* and a U. C. Agr. Expt. Sta. circular on bacteriology laboratories for dairy plants.

A native of Providence, R. I., Mudge received a B.S. degree from Brown Univ., in 1911, and a Ph.D. degree from the same institution 4 years later. In 1915 he served as research bacteriologist for the National Canners Assoc. From 1916 until he joined the staff at Davis, he was with the Dairy Division of the USDA, in Washington, D. C. Dr. Mudge plans to continue his research on dairy sanitation problems.

Emil Howe Renamed to Top NADEM Post

EMIL HOWE, Waukesha Foundry Co., was reelected chairman of the six-man Executive Committee of National Association of Dairy Equipment Manufacturers at NADEM's 10th annual meeting held in May at the Kenwood Country Club in Bethesda, Md. D. H. BURRELL, III, Cherry-Burrell Corp., was reelected vice-chairman, and the other members of the committee are: H. I. EDWARDS, The Pfaudler Co.; P. K. GIRTON, Girton Mfg. Co.; FRED HINRICHS, Tri-Clover Division, Ladish Co.; and H. L. SOLIE, General Dairy Equipment Corp.

All of the above have served previously in these posts, with the exception of Mr. Girton, who is replacing W. J. WACHOWITZ, SR., of Alloy Products Corp., who did not seek reelection.

Kentucky to Hold Conference

From Nov. 28 to 31, the Dairy Section of the University of Kentucky will hold its 3rd Annual Dairy Manufacturing Short Course. Subject matter will cover latest information on basic problems in market milk, ice cream, and cheese. The program is designed to be of interest to both managers and operating personnel of these types of plants.

THE DAIRY SHRINE CLUB

A Guest Editorial

In answer to a long-felt want, The Dairy Shrine Club was organized in 1949 by a group of men who had earned national recognition as leaders in their respective phases of the dairy industry. As stated in the Articles of Incorporation, "The primary object of this corporation is to establish a Shrine to stimulate, inspire and educate; and to give proper recognition to the importance and dignity of the dairy industry."

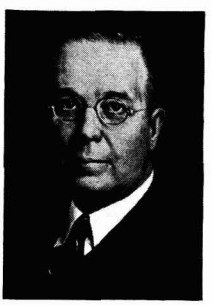
The eligibility requirements for life membership are a constructive interest in some phase of the dairy industry, approval by the board of directors of one's application, and the payment of the membership fee of $25.00.

The present (June, 1955) 798 members represent breeders of dairy cattle, commercial producers, processors, merchandisers, researchers, educators, manufacturers of dairy and farm equipment and supplies, journalists, radio and TV directors, and leaders in many other industries and professions related to dairying.

The home of The Dairy Shrine Club is located opposite the entrance to the grounds of the National Dairy Cattle Congress at Waterloo, Iowa. The club rooms are open week days throughout the year. However, each year during the National Dairy Cattle Congress these rooms are a mecca for the members and their guests, for college, 4-H, and Future Farmer judging teams and their coaches and visiting leaders in dairying and related industries from all states and from many other countries. Furthermore, during the Congress, in a friendly and democratic manner, the members take turns in assisting with the serving of luncheons to fellow members and their guests.

In the club rooms, one finds interesting and important historical records presented in words and in pictures, as well as the portraits of the seven "Guests of Honor" and the sixty "Pioneers" who have received official recognition to date.

The significance and basic philosophy of this portrait gallery are indicated by an experience which I had in Denmark some years ago. When I arrived in that great little country, noted for its productive and thrifty people, its happy homes, good schools, and efficient production and marketing of quality agricultural products, I asked my good friend, the late Professor LARS FREDERIKSEN of the Royal Agricultural and Veterinary College in Copenhagen, to explain how the people of Denmark had been able to accomplish so much with their rather limited resources. He replied by asking me if my stay in Denmark was to be that of a typical American tourist who spends one day in the Tivoli Gardens and one day in the Scala Theatre and then returns home to write and speak on *Denmark, the land of cooperation and quality agricultural products.* When I assured him that I planned to spend a month in his country, he replied that I would find the answer.



H. H. Kildee

One month later I walked with the Professor from the grounds of a Folk School into a hillside park where the people of the community frequently met. As we entered the park, I

noted two statues—one portraying the nation's "History," and the other the "Mother Tongue." Proceeding further, I noted many modest monuments erected not to the Kings and Queens of this, the oldest monarchy in Europe, but to the memory of men and women who as private citizens had made constructive contributions to the human, physical, economic, social, and spiritual resources of their country. As illustrations, there was a monument to MR. and MRS. WILLIAM HANSEN, who started the first cow testing association, now so constructively important in our country as Dairy Herd Improvement Associations; and another to MR. and MRS. APPEL, who started the Folk Schools for which Denmark is famous and which have a very constructive influence on the lives of its citizens. After noting these and other monuments, I turned to Professor Frederiksen and said, "Here is the answer to the question which I asked you weeks ago." Tears rolled down the Professor's cheeks as he replied "This is the answer."

I am told that were I to return to that park, I would find a monument in memory of that constructive leader, my friend, the late Professor Frederiksen.

Thus, it is in this spirit that members of The Dairy Shrine Club meet on Wednesday afternoon each National Dairy Cattle Congress to honor some of the great dairy leaders of the past by hanging their pictures in the Pioneer Room, and also to give appropriate recognition to an outstandingly constructive and influential leader who can be with us as our Guest of Honor of that year.

The programs and activities of the Club are many. Cooperation with colleges of agriculture, the USDA, the American Dairy Science Assoc., the Purebred Dairy Cattle Assoc., and other groups is a part of the club's program. As one of its contributions to the future of dairying, The Dairy Shrine Club sponsors a scholarship fund through which the high man in the Dairy Cattle Judging Contest, held annually in connection with the National Dairy Cattle Congress, is given financial assistance for advanced study in the field of dairying. The activities of the club are determined by 15 directors, elected by the membership and representing all phases of the dairy industry. Needless to state, all officers serve without compensation.

In closing, I wish to express the hope that many who read this will be in The Dairy Shrine Club rooms at 3:00 P.M. on Wednesday, Oct. 5, 1955, when the annual meeting will be held and leaders of the past and present will receive appropriate recognition.

H. H. KILDEE
Dean of Agriculture Emeritus
Iowa State College

LETTERS TO THE EDITOR

Importance of Early Payment of Dues and Journal Subscriptions

I note by the records that it has been the custom to send out renewal notices of dues and subscriptions late in the year and that many delay paying for dues or renewing subscriptions until well after the first of the year. Furthermore, a good deal of follow up work on the part of the Secretary has been necessary. Many times it has been necessary to remove names from the active list for the nonpayment of dues or subscriptions. Often later in the year dues or subscription payments are received from those delinquent, and this necessitates the reinstatement of the names on our records.

It can be easily understood that the above procedure means extra expense to the Association in the way of clerical work, to say nothing about the extra time that it takes the Secretary to carry on his work. Furthermore—and perhaps what is still more important—it makes it impossible for the Editor to accurately estimate the number of Journals it is necessary to print. As a result, we are constantly running out of copies of the issues published in the early months of the year, so that we cannot properly take care of these late renewals or supply the many requests for back numbers.

Membership in the A.D.S.A. is concurrent with the calendar year, and we like to have subscriptions on that basis also, insofar as it is possible to do so. Members will bear in mind that ours is a nonprofit organization, operated for the mutual benefit of all.

This year the Secretary plans to send out renewal notices for memberships and subscriptions in September or the forepart of October.

I am sure, now the situation has been stated, the members will understand that it is for their own good to remit promptly, since they themselves are the Association.

H. F. JUDKINS
Secretary-Treasurer, A.D.S.A.

On "The Cavitation Theory of Homogenization" by McKillop et al.

The work reported in "The Cavitation Theory of Homogenization" by McKillop *et al.* in the March, 1955, issue of *Journal of Dairy Science* was based on principles that are sound.

They dismissed the homogenization effect of cavitation mainly on two counts. The first count was that the homogenization efficiency was not impaired when cavitation was supposedly eliminated. The second count was that visible cavitation in a Venturi tube did not produce efficient homogenization. However, a careful re-

view of the data and calculations may lead to other conclusions.

The coefficient of contraction C_D of the flow at the entrance to the homogenizing surfaces is a factor that determines the possibility of cavitation. Very slight variation in C_D may cause a highly significant pressure change at the contraction. The careful estimation of C_D can hardly be overemphasized. In arriving at a value for the coefficient of contraction, the authors assumed that the pressure at the contraction is zero (Appendix B, McKillop's paper). This assumption may not be advisable for, first of all, the pressure there is the very thing the authors set out to determine. Secondly, this assumption was immediately denied by the subsequent calculations. The pressure at the contraction calculated by McKillop *et al.* was not zero but equal to –592 p.s.i. It should also be pointed out that the value $C_D = 0.775$ calculated and used by the authors is questionable.

Although the authors did not indicate exactly how this $C_D = 0.775$ was obtained, it appears likely that it was obtained by averaging the 15 C_D's of the 15 runs calculated according to Appendix B of their paper. In this particular case, C_D should not be obtained by taking the average of the 15 runs, because many of the runs were deliberately manipulated to have different pressure conditions at the contraction deviating from the basic assumption of their calculation. Very probably the calculations were unapplicable to many of the 15 runs. The divergence of the 15 calculated C_D's seems to support this point of discussion. (See the table at the end.)

Equation 7 on page 277, which was used to calculate the pressure at the contraction, is incomplete. It should contain at least one additional energy term representing the loss due to sudden contraction at the valve entrance B. This loss is due to the sudden expansion after the contraction of the flow. For a flow of constant cross-section after the entrance this loss equals $(1\text{-}C_D^2)\ \frac{V_B^2}{2g}$. In the case of a flow between discs, as in the present case, the situation is complicated by the radial nature of the flow, and the quantity $(1\text{-}C_D^2)\ \frac{V_B^2}{2g}$ is only an approximation. Therefore, Equation 7, corrected to include the loss due to sudden contraction, should only be used to estimate the threshold conditions for cavitation. A negative P_B obtained from Equation 7 corrected is only fictitious. The lowest possible pressure is absolute zero or –14.7 p.s.i. as referred to standard atmospheric pressure. The absolute magnitude of a negative P_B so obtained is meaningless unless cavitation did not occur and the flow remained continuous under tension. It seems inconceivable that a liquid such as milk, which has dissolved gases and numerous fat particles, would hold itself continuous under tension and not cavitate. If cavitation occurs, the conditions in the valve become entirely different from a normal flow, and Equation 7 cannot apply. Therefore, the derivation that 600 p.s.i. back pressure was enough to eliminate cavitation may be very disputable.

From the above discussions, it is evident that reanalysis of the experimental data on back pressure presented by McKillop and associates may bring forth a different interpretation of their results.

First of all, as is done in the original paper, the coefficient of contraction C_D must be determined.

Since the Manton-Gaulin valve is made to have a slightly beveled entrance, it is conceivable that its coefficient of contraction is greater than 0.61, the value for sharp-edged entrance.

It was mentioned previously that the data of McKillop *et al.* when processed according to Appendix B of their paper yield widely different values for C_D.

Of the 15 C_D's only the ones from runs 1 and 5 yield values of P_B relatively closer to the original assumption, i.e., $P_B = 0$, when fed into Equation 7 corrected. However, these two C_D's are still quite far apart from each other. It seems logical to say that the one ($C_D = 0.85$) from run 5 is less reliable than the one ($C_D = 0.67$) from run 1. The reason is that run 5 had narrower valve clearance, higher flow velocity, and possibly would cavitate more than run 1. Both Equation 7 and the equation for C_D would be less applicable to run 5. Using $C_D = 0.67$, one may show by means of Equation 7, corrected to contain the energy lost at the contraction, that P_B, the pressure at the contraction, is still negative. Therefore, in the equation

$$C_D = \frac{Q}{A}\left[\frac{d}{2g\,(P_C - P_B)}\right]^{1/2}$$

the denominator would be slightly larger than when P_B was assumed zero. Consequently, the true value of C_D must be smaller than 0.67.

Since the available experimental data do not allow closer estimation of C_D, we could only set up the upper and the lower limits of C_D at 0.67 and 0.61, respectively.

To estimate the pressure at B, it appears more advisable to work downstream than to work upstream as McKillop *et al.* did. The upstream method involves considerable uncertainty in assigning a proper value to the friction factor and in approximating the loss of energy at B. The downstream method, applying the Bernoulli equation to points C and B, is simpler and more direct. Mathematically,

$$\frac{P_C}{d} = \frac{P_B}{d} + \frac{V_B^2}{2g}$$

$$\text{or } P_B = P_C - \frac{Q^2 d}{8\pi^2 r_B^2 C^2 C_D^2 g},$$

all notations being the same as in McKillop's paper. When all the known values are substituted into it, the equation takes the following form:

$$P_B = P_C - 0.0201\ C^{-2}\ C_D^{-2}$$

The following table shows the values of P_B calculated by means of the above equation for McKillop's 15 sets of data of the Manton-Gaulin homogenizer valve:

It can be seen in the table below that of the 30 values of P_B under method 2 all except three are still negative enough to cause cavitation. Possibly, only in run 4 was cavitation suppressed. Therefore, McKillop's experiments on the effect of back pressure on homogenization efficiency did not seem to yield substantial evidence one way or the other on the role of cavitation in homogenization.

With regard to the Venturi experiments, the generalization of their conclusions should be avoided. Although the destructiveness of cavitation is well known, its mechanism is still a matter receiving extensive investigation. Of special interest to the present controversy is that some investigators *(1, 4)* attribute the destructive effect to microscopic incipient cavitation, which occurs in the boundary layer of flow, rather than large, visible bubbles. The throat of a Venturi tube is round. Its amount of boundary per unit cross-sectional area of the flow is minimum. An ordinary homogenizer valve has about 10 to 50 times as much boundary per unit area as the Venturi tubes used by McKillop *et al.* The significance of boundary requirement in a homogenizing device has been demonstrated by Loo *(2)*. Evidence supporting McKillop's assumption that increasing the number of passes through the Venturi tube would make up for the deficiency in boundary is lacking. It is questionable that repeated homogenization would increase the homogenization efficiency arithmetically. The ineffectiveness of cavitation homogenization by means of a Venturi tube as demonstrated by McKillop *et al.* might be only a matter of technical problem.

CHING CHEE LOO
The Carnation Company
Van Nuys, Calif.

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TABLE 1

Analysis of flow in a Manton-Gaulin homogenizer valve, using experimental data from Table 2 in McKillop's paper

Run No.	Homo. press.	Back press.	Total press.	Valve clearance	Calculated C_D [a]	Calculated P_B		
						Method 1 [b]	Method 2 [c]	
							Using $C_D = 0.61$	Using $C_D = 0.67$
	psig.	*psig.*	*psig.*	*(in.)*		*psig.*	*psig.*	*psig.*
1	500	0	500	0.0093	0.67	−85	−122	−15
2	500	200	700	0.00615	0.87	+116	−720	−470
3	500	500	1000	0.00595	0.75	+425	−520	−260
4	500	1500	2000	0.0063	0.50	+1390	+650	+900
5	1000	0	1000	0.0052	0.85	−38	−990	−650
6	1000	200	1200	0.00445	0.92	+270	−1500	−1050
7	1000	500	1500	0.0043	0.85	+685	−1400	−900
8	1000	1000	2000	0.0044	0.72	+1080	−800	−300
9	1000	1500	2500	0.0044	0.64	+1590	−300	+200
10	1500	0	1500	0.0039	0.94	+254	−2000	−1400
11	1500	200	1700	0.0038	0.91	+508	−2000	−1300
12	1500	500	2000	0.0038	0.84	+805	−1700	−1000
13	1500	1500	3000	0.0038	0.68	+1800	−700	−80
14	2000	0	2000	0.0036	0.87	+425	−2150	−1440
15	2500	0	2500	0.00335	0.85	+1000	−2300	−1450

[a] The values of C_D in this column are calculated according to McKillop's method, i.e. assuming $P_B = 0$.

[b] Method 1 of calculating P_B is to use the C_D obtained by McKillop's method and Equation 7 corrected to contain the energy loss at valve entrance.

[c] Method 2 is to use the following equation for P_B:

$$P_B = P_C - 0.0201\ C^{-2}\ C_D^{-2}$$

OUR INDUSTRY TODAY

Brief Reviews of Current Topics

A New Concept of Parity[1]

D. B. VARNER

Vice-President for Off-Campus Education
Michigan State College

As we survey the long parade of history and the events which have characterized each era, and then imagine that by some magic power we might have been able to select our time, most of us surely would have selected this very period revolving around the mid-point of the 20th century. During the life span of most of us we have lived through two World Wars, we have known a major depression, a destructive drought, and we have seen the rise of the United States of America to a position of world dominance. We have experienced the birth of the United Nations, currently celebrating its tenth birthday at San Francisco; the coming of the Atomic Age, which promises for us an entirely new frontier; we have seen the discovery and utilization of the life-saving antibiotics, and now the Salk polio vaccine. We are a part of the era which has upset the wildest calculations of demographers of only a decade ago; we are a part of the age which has developed the beginnings of the guaranteed annual wage and automation. We are experiencing a new and revitalized interest in the Church; we are enjoying the summit in terms of economic prosperity.

D. B. Varner

Progress, for the most part, in amazing quantities. This is a period characterized by one of our more substantial national magazines as "the American break-through," and there is substantial evidence that we have but begun in this dramatic break-through. In the parlance of the military, the break-through having been achieved, it is now our responsibility to exploit this advantage, to consolidate our gains, and to make ready for the next campaign.

But progress begets problems, and our times are no different. Yet there is somehow much comfort in knowing that while we are a part of the problem, we are also a part of the answer. We would have it no other way.

Agriculture, too, at the mid-point of the 20th Century, has its particular drama as well as its peculiar problems. In agriculture, we, too, are experiencing a "break-through." Standing in 1955, we are in a position to look back over our shoulder toward a decade of progress in American agriculture unparalleled in the history of mankind. We have seen efficiency on American farms in terms of out-put per man hours of in-put rise faster during these ten years than has the efficiency of the rest of the American economy. The next decade is no less promising.

Yet, in the wake of this pattern of progress, we find our problems. We are currently experiencing that peculiar American plague of over-abundance and surplus; we are concerned about periodically depressed prices; we view an alarming picture of under-employment in agriculture; we fret about the distressingly low average annual income for farm families in America.

Again, these are our times. We are the problem and by the same token, we must be the answer. Where, then—scientists in this vast and important dairy industry—where do we go from here? Can we produce workable, practical, and lasting solutions to the problems of our times, or do we default to those whose chief stock in trade is expediency? This must be a major concern of yours—here today this week—but more importantly in the months and years ahead. The solutions do not come by magic formula, nor do they come easily, but only by the creative determination and the consecrated efforts of individuals and groups in our respective environments all over America.

In the search for workable and palatable solutions to such problems of agriculture we have seen developed during the past two decades a concept which is now part and parcel of American agriculture. This is the concept of parity for farmers.

Since this parity concept has become so thoroughly meshed into the American agricultural scene, and because so much time and effort has been devoted to the subject and will be devoted to the subject during the elections of 1956, I should like to direct my comments toward this broad subject too. Let us begin, however, by

[1] Presented before the 50th annual meeting of A.D.S.A. at East Lansing, Michigan, June 21, 1955.

sharing a clear and simple understanding of what is meant by the term parity. Parity means equality. Nothing more—nothing less—nothing mysterious nor magical. The history of the development of this concept has been most interesting and enlightening. Rather than take your time here to review this historical development, we shall leave this for your home-work or your memory. I should like to discuss a parity program for American farmers from a somewhat different point of view—parity, but of a particular variety.

This parity program is much older than the one we hear so much about today. In fact, the program to which I refer had its beginning in 1862—almost 100 years ago. It was initiated by another great President of the United States—Abraham Lincoln. On a cold and dreary day during the midst of the Civil War, this memorable man signed into law one of the controversial measures of the day—the Morrill Act. What was at the time a highly debated issue developed into one of the most significant programs this nation has fostered. The heart of this legislation in 1862 was, once again, the concept of parity. But this was parity of a different kind—it dealt with parity, or equality, of opportunity.

As you know, the Morrill Act as signed by President Lincoln created the land-grant colleges and universities of this nation, and for the first time in the history of the world education had been brought into reach of the common man. Heretofore, education was for the elite—the wealthy. It was directed primarily toward the ministers, the doctors, the lawyers—the professions. This legislation, however, radically altered the pattern of education in this young nation. These land-grant colleges—one in each state and territory—were committed to the principle of providing education for the sons and daughters of the farmers and others engaged in the several industrial pursuits. Moreover, they were to live and flourish on the fundamental premise of serving the people of the states and territories.

The growth of the land-grant colleges and universities in this land has been phenomenal. But while these institutions were growing in terms of students served, they were growing in other and equally sensational areas. Always, however, the parity concept was kept uppermost—parity of opportunity. It mattered not if a boy or girl was born into poverty or misfortune; no one was concerned about the ancestry; all that mattered was the desire for achievement and the ability to perform. Parity of opportunity—this was the contribution of the land-grant college system.

Recognizing early the basic role of agriculture in the nation's economy, these educational institutions became active in seeking solutions to farmers' problems. Research was begun sporadically among these colleges to try to find better answers to such down-to-earth matters as disease and insect control, soil management, better varieties, and improved animal breeding and nutrition. The worth of this approach was officially recognized in 1887 when Congress passed the Hatch Act, authorizing the establishment of Agricultural Experiment Stations in each of the land-grant colleges. These Experiment Stations served well their purpose and they grew rapidly in their contributions to agriculture and in public favor.

Yet, once again, the concept of "parity" reared its head and asked to be recognized. Science was busy at work providing answers to difficult problems of farm people, but only a favored few were able to obtain these results and capitalize upon the knowledge. This was not consistent with the fundamental doctrine of equality of opportunity. In the interests of parity, therefore, the Extension Service was legally formulated in 1914 with the passage of the Smith-Lever law. This made it possible to get into every county the results of the research worker. Here, too—and logically—the land-grant colleges, now widely recognized as "the people's colleges" were looked to as the point for coordination of these twin servants of agriculture—the Agricultural Experiment Stations and the Agricultural Extension Services.

This is a bit of the history of the formation of one of the truly great and unique institutions of this nation. Conceived in the spirit of serving the needs of the people, it has achieved an enviable mark. So far as the functions of its two great agricultural arms—research and extension—are concerned, the record speaks for itself.

America is a land of achievement. This is reflected in our villages, our factories, our homes, our schools—our people. But nowhere does our record of achievement surpass that in agriculture. It has been stated by some of our more prominent students of history that we have made more progress in American agriculture during the past 50 years than the world has known during the past 50 centuries. Few can doubt the substance of this statement when we face the startling facts. We have all heard many times the story of how one American farmer in 1900 could produce enough food and fiber to feed and clothe himself and six other people, but that today one farmer can do this for himself and sixteen of his neighbors. No matter how many times we have heard this story, it is still a stark and dramatic tale of achievement.

For those who prefer a different statement, let's say it this way: In America today, less than 10 per cent of our total population is required for the essential industry of producing food and fiber for our population! The real meaning of this statement is found in the realization that the balance of our population—the other 90 per cent—has been released to build automobiles, homes, airplanes, to enter the pro-

fessions, and to engage in the many other occupations which make up this complex and prosperous society of ours. This is one of the fundamental reasons why America now enjoys the highest standard of living in the world—because our agricultural industry has become so efficient that 90 per cent of our population is free to produce in other areas.

Further evidence of this remarkable record of achievement is found in the fact that the average American today spends only 25 cents from each dollar earned for food for himself and his family. Nowhere else in the world can so much food be bought with so little labor as here in our own United States of America!

I said that the record of agricultural research and education would speak for itself. This it has done. A substantial share of the progress in American agriculture during the past 50 years must be attributed to the findings of our research workers and the ability of the Extension Service to get these findings into the hands of farmers throughout the land. While some would argue as to the impact of this Research-Extension teamwork, it was gratifying to find in Mr. Gilbert Burch's excellent article about our agricultural economy in the June issue of Fortune Magazine this statement:

> "The past quarter-century has seen a breakthrough in farm efficiency that is remarkable even in the remarkable history of American productivity. The story behind the breakthrough goes back exactly a hundred years, when the Michigan and Pennsylvania state colleges were founded and began to assume some responsibility for the farmer's technological progress. The federal government, on the blameless theory that no individual farmer had enough resources to organize major experimental efforts, in effect set up the farmer's research laboratories by subsidizing the agricultural experiment stations of the land-grant colleges and state universities, and later founded the Department of Agriculture with its own research facilities. All these plus the Agricultural Extension Service deserve much if not most of the credit for the significant innovations that have advanced farm productivity and for educating farmers up to them."

Specific examples are too numerous to mention, but none tell the story more dramatically than does the story of hybrid corn. Research work conducted by the U. S. Department of Agriculture and the land-grant colleges covered more than 30 years and cost almost $10,000,000 in total. Today the added income to our farmers because of this development, figured conservatively, is in excess of $750,000,000 annually. A stirring example of the results of this research—extension teamwork! Even more familiar to this group is the story of the development of artificial insemination and its millions of dollars of added income annually to the dairy farmers of America.

But let us concern ourselves no longer with this review of what has happened, but turn to what is happening and what can happen in agriculture.

As we indicated earlier, one of the great issues before the past Congress was the question of "flexible" versus "rigid" price supports. This was but another version of the 20-year debate on "what level parity." Somehow the results of this debate never seem quite satisfying, regardless of which side wins the temporary advantage. Somehow the problems never seem to be settled as a result of this endless political discussion. The American farmer—having been pulled and tugged through these many years of maneuvers—seems to be tiring of the game. And well he might be growing tired. Twenty years is a long stretch for an "emergency approach" to farmers' cost-price problems. Farmers are still convinced that "parity" is an appropriate concept, but many are now raising doubts as to whether a government-guaranteed parity is a workable long-range solution.

I find myself in complete accord with this growing number of farmers. "Parity" is good and proper as a concept, but the parity which made this nation great and this nation's agriculture great was not the issue debated so lustily in the halls of our Congress, but rather was that same parity fostered by the land-grant colleges—parity of opportunity.

It is my firm conviction that the greatest help which can be provided to our farm people today is through a concerted effort to assure parity of opportunity. Let me be more specific. We believe that our farmers in Michigan can be given real and lasting assistance in two major areas: (1) in helping reduce costs of production, and (2) in improving the marketing of these products. These we believe to be fundamental, and many of our farmers are in accord with our thinking. Furthermore, we believe that our Agricultural Experiment Station and our Agricultural Extension Service have a direct responsibility in these two areas, and we are determined to fulfill this responsibility.

In order to get our bearings for this task, two of our most capable research men made a study to find out what results could be obtained if our farmers in Michigan could be induced to put into use those practices which we have already proven to be sound and profitable. Their findings are astounding! In the August, 1954, issue of the Michigan State College Experiment Station Bulletin, this study shows that, with 1953 prices and costs, Michigan farmers using the best-known techniques now available could increase their net returns by $23 per acre of wheat; by $9.50 per acre of oats; by $15 per acre of corn; by $74 per acre of sugar beets; and could save approxi-

mately $10.50 per acre on alfalfa-brome hay. In a separate study made earlier, it was found that if all the dairy farmers in Michigan used the same management practices as the top 10% of our dairy farmers, the total net income to the dairymen of the state would be doubled!

The next step involves great difficulties. Obviously we shall never achieve perfection in the adoption of these best-known practices. We know, too, that any sweeping adoption of these practices would have an effect upon the market. But even so, much can and must be done! This is the challenge of the land-grant college in general and of the Extension Service in particular—this is the challenge of "parity of opportunity." We feel a deep sense of obligation to get this information into the hands of every farmer in the State of Michigan. To do this necessitates substantial changes in our traditional method of operation in the Extension Service.

Recognizing this need for a new approach in Extension, we began 2 years ago to experiment with a new method of Extension teaching. Well aware that the existing load of 1,800 farm families for each county agent was an impossible assignment, and realizing the severe limitations of publicly appropriated funds, we turned to the W. K. Kellogg Foundation in Battle Creek, Michigan, and proposed that they join us in supporting an experimental intensive Extension program in five townships for a five year period. The grant was approved and the program has been in operation for about a year and a half. There is nothing theoretical nor mysterious about this Township Program—it merely brings a county agricultural agent to a township where he can work with 50 to 175 farm families rather than 1,800. This, we contend, will enable us to provide for the first time full parity to these farmers—parity of opportunity!

While it is still too early to pass judgment upon this program, we have many encouraging reports. In view of the time limitation, I shall make reference to only one individual study—a single case, to be sure, but symbolic. Directly from the Township Agent's report, I quote:

> "Mr. X is a farmer, who is a member of our Township Extension Association. Mr. X had a problem of a small farm income. My survey of his business showed that he had only 63 tillable acres, 8 cows, 4 sows, and 25 ewes. Obviously the main thing to suggest to this particular farmer was to increase the size of his farm business. However, the opportunities for doing this were limited. The farm is broken up into three fairly small parcels of land divided by a highway. This created a problem of convenient pasture for the dairy cows. The milk produced on the farm was sold on a condensery market from fair to average producing cows. Expansion in the size of the dairy business was limited to available capital, available pasture, and housing facilities. Only four or five litters of pigs were raised on the farm each year, but Mr. X did well with these few. The sheep did fairly well, but because of their small numbers did not add much to the total farm income.
>
> "The first suggestion made to Mr. X was that of increasing the size of his farm business through the purchasing or the leasing of more land. He was able to rent an additional 100 acres of work land that was good enough to raise plenty of feed crops. He was also able to use some of this land for wheat as a cash crop. With the additional feed raised, he was able to increase his swine enterprise to 12 to 14 litters per year. He also changed the swine breeding program so that he would market his hogs ahead of the usual seasonal price slump. The dairy and sheep enterprises were not expanded, but with improved methods he was able to increase his net income. This was done mainly through the improvement of existing pastures and through more efficient livestock feeding practices. Increased crop yields were brought about by stepping up the rate of fertilizer application to his various crops. This was especially true with the hay and pasture crops on the home farm.
>
> "The gross income of Mr. X's farm the year prior to planning was about $4,030.00. The gross income under the new plan is about $7,200.00. This was accomplished with an increased expenditure of $1,400.00 for tractor fuel, protein feed and fertilizer, leaving a net increase in farm income of $1,800.00."

This degree of success has not and cannot be achieved with every farm family, but this is the story of a real farmer, faced with a real problem, and one who found a real answer. This farmer now knows the full meaning of this concept of parity—he has been given full opportunity to know and apply the best techniques developed by our land-grant college team of research and extension.

But, one may ask, what is the practical meaning of this? To provide this kind of service to the farm people of this nation, would it not cost a fantastic sum? My answer to this question is quite simple. To provide this intensive extension program would cost a substantial sum of money. But America is spending a sizable amount of money on agriculture today and will likely spend more. The question which must be resolved by our farm leaders and statesmen deals with the problem of getting the greatest amount of benefit from each dollar expended.

How much would it cost to provide such a program? Let me answer in terms of Michigan and in terms of existing specific appropriations. If $195,000,000 were appropriated to the Ex-

tension Service by Congress, as is now being appropriated for another program, Michigan's share would be approximately $6,000,000, or enough to employ roughly an additional 1,000 extension agents. This would easily provide a new extension agent for each township in the agriculturally important counties of the state.

Let me make my position clear. I am not criticizing any existing program in agriculture. Neither am I urging a new federal appropriation of $195,000,000 for research and extension in fiscal year 1956. I am, however, suggesting that we in American agriculture might well think through again some of the basic issues with which we are faced.

We said earlier that there are two fundamental ways in which we can assist the farm families in improving their economic position. We have considered some of the prospects of helping through reducing costs of production. The second way involves improved marketing for our farm products. This is a more difficult area, but here, too, we believe that much can be done through an aggressive program of research and extension. Convinced of this, and working with interested farm groups in the state, we have made a beginning in Michigan. We cannot here do more than state the broad outlines for this program.

The Michigan Legislature in 1954 appropriated $294,000 to support an expanded program in marketing research and education. Our marketing research is being directed primarily in the area of product utilization, while our extension program is making a beginning on three fronts simultaneously—marketing education with the farmer himself, with the retail grocer, and with the consumer.

This program has just gotten well underway and it is far too early to make an effective evaluation. Early reports are encouraging and we are optimistic about its future contributions to our farm marketing problems. We have learned, for example, that in our Kellogg Center 3% of our banquet guests drank milk when they had to request it, but that 11% chose milk when given an option; we learned, too, that while many felt that milk vending machines could not compete against carbonated beverage machines, the milk machines have been consistently outselling other beverage machines. From these and other studies, we can but conclude that milk consumption can be increased if a bit of sales effort is expended. Of this we are sure—so far as our marketing program is concerned—it is founded upon a solid basis—research and education—in a continuous effort toward parity of opportunity.

These have been specific examples of some of the things we are doing in Michigan. Similar programs and projects are being conducted in virtually every land-grant college in America.

The point which I have wanted to establish clearly here is that in the midst of all the debate about creating parity for farmers, we may have lost sight of the most productive and fundamental of all parity concepts—that of parity of opportunity. For that young farmer who found through this concept a way to earn for himself and his family an extra $1,800 annually in net income; for another who saved more than $1,000 on his barn construction; for the Michigan corn farmer who reduced by 30 cents per bushel his costs of production; for the fruit grower who earned an extra 20 cents per bushel in the marketing of his apples through the adoption of a simple marketing technique—for these and the many others who have benefited through this newer and intensive approach to their farm problems, you may be sure that they are aware of this different and valuable kind of parity.

The average American farm is a complex business operation. It shall be no less so in the years ahead. Every indication is that farms shall become larger and the capital requirements shall become greater. Science shall continue to make available new methods, techniques, and devices to make agriculture more efficient. On balance, American farmers must be better farmers than ever before in our history. While some are prone to argue that with a current over-supply of certain farm commodities we should go into a "slow-down" on improved efficiency, I cannot subscribe to such a philosophy.

America has attained its role in world affairs and its standard of living because of an ever growing productiveness. Increased productivity is based upon increased efficiency. Agriculture is no exception; and if agriculture is to survive as a part of the free enterprise system, then agriculture must continue to improve at every opportunity its methods. While only a little over 10 per cent of our people today can provide food and fiber for the remaining 90 per cent, it is freely predicted that less than 8 per cent can do this job—and better—by 1970.

As we move into this program where we may exchange ideas and receive a new stimulus, and as we move into the year and decade and half-century ahead, let us bear in mind that we have been privileged to live in an exciting era; that we are part and parcel of the times; we are the problem, we are the hope, and we are the solution. How well we do as individuals shall determine—in the aggregate—how well the dairy industry does; how well the several industries do shall determine how well—in the aggregate—America does. The individual is the all-important element.

It is no overstatement of the case to say that the future of this concept of parity in terms of full opportunity—Lincoln's parity program—shall be determined largely by the effectiveness with which you and your colleagues do your work. The continued success of this approach is vital to the welfare of American agriculture and America.

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JOURNAL OF DAIRY SCIENCE

ABSTRACTS OF LITERATURE

W. O. Nelson, Abstract Editor

ANIMAL DISEASES

545. Farm animals in health and disease. W. R. WOOLDRIDGE. Nature, 175, 4465: 917. 1955.

A review of a book written in 1954 to provide those interested in livestock production with a broad understanding of the health of cattle, sheep, goats, pigs, horses, poultry, and rabbits. It is not a scientific text book, but more of a readable guide for farmers regarding the health of farm animals. It is published by Crosby Lockwood & Son Ltd., London.

R. Whitaker

BOOK REVIEWS

546. Perspectives and Horizons in Microbiology. A symposium edited by SELMAN A. WAKSMAN. Rutgers University Press, New Brunswick, New Jersey. 1955. 219 pp. $3.50.

The subject matter discussed in this book was presented at a symposium arranged in connection with the dedication of the Institute of Microbiology at Rutgers University. An attempt has been made to analyze the present findings to forecast the future of certain aspects of microbiology.

Thirteen recognized authorities contributed to this book. In the first section emphasis is placed on the microbe as a living system. The following topics are discussed; The Microbe as a Whole, Some Aspects of Metapoietic Integrations, Genetics and Microbiology, and Nutritional and Enzymatic Studies on Microbial Mutants. The second section features the biochemical activities of microbes and discusses the following: Microbial and Mold Metabolism, Nitrogen Fixation and Microbial Steroid Transformations. The third section is concerned with the relationship of microorganisms and higher forms of life. The subjects considered are: Some Unsolved Problems in Immunology, The Inhibition of Virus Reproduction by Chemical Substances, Challenging Problems in Antibiotic Research, and Microorganisms and Plant Life.

The material presented is well organized and each author has succeeded in presenting historical facts and future goals in his field of interest. This book should be of value to the advance student or teacher of Microbiology or Biochemistry as it summarizes in a readily readable style some of the various aspects of Microbiology. Most of the chapters have a limited number of references.

A short appendix is devoted to addresses given at the dedication of the Institute of Microbiology. O. W. Kaufmann

547. Milk Fat Globule and Some Associated Phenomena. By NICHOLAUS KING. Commonwealth Agricultural Bureau, Royal Bucks, England.

The author is the Principal Research Officer in the Dairy Research Section of the Commonwealth Scientific and Industrial Research Organization in Melbourne, Australia. He is the outstanding International Authority on the properties and reactions of the milk fat globule. During the past 25 years he has published more than 50 scientific papers on the fat globule and its structural role in the different dairy products.

Dr. King has critically reviewed the classical studies of Palmer and associates who laid a strong foundation for the isolation, chemical composition, and physical chemical behavior of the membrane substances. He has presented the structure of the fat globule as it is known at present and has discussed the gaps in our knowledge of this structure in a helpful manner.

In a clear and concise way he has critically reviewed the literature on the chemical composition of the membrane including the phospholipids, the protein-phospholipid-lipoprotein complex, the high-melting glyceride fraction, the trace constituents such as cholesterol, the carotenoids, vitamin A, xanthine-aldehyde dehydrogenase, phosphatase, aldolase, copper, iron, bound water, and electrokinetic phenomena. Structural relationships in the membrane as related to the phospholipid, the lipoprotein, and the protein layers are presented in some detail.

The effects of processing on the stability of the fat emulsion are discussed, such as churning, whipping, ultra-sonic vibrations, centrifugal separation, homogenization, freezing, heating, drying, and the effects of chemical and biochemical agents.

And finally in the tradition of a biologist, Dr. King emphasizes other membranes that exist in nature such as those in the rubber particles in latex. Here nature has used a similar pattern in building organic structures with orientated

lipid-protein layers. Useful investigational technics in this field also may be applied to studies of the fat globule mechanisms. Similar comparisons are indicated for the structure of blood cells and of cell nuclei.

Dr. King has compiled a monumental treatise on the fat globule which was discovered by Van Leeuweenhoek in milk about 250 years ago.

E. O. Herreid

BUTTER

548. Quality and keeping quality of non-washed butter. F. H. McDowall, J. A. Singleton, and J. J. O'Dea. New Zealand J. of Sci. and Technol., A. **35**, 3: 175. 1953.

Non-washed butter has been compared with washed butter from similar cream under pilot and commercial conditions. Immediately after making the butters were of equivalent grade. They showed similar losses in grade score when held at 14° F. for 4 to 8 months. The bacterial counts were not significantly different at any stage. Where washing is omitted, churning temperature must be low enough to permit adequate control of butter consistency. Eliminating washing increased the curd content of the butter between 0.31 and 0.64%. W. K. Jordan

549. Quality aspects of butter marketing in S. Dakota. E. Feder, et al., S. D. Agr. Expt. Sta., Brookings. Bull. 443. 1955.

In order that the butter industry in S. D. may maintain a competitive position in the butter business, an improvement in quality is necessary. A relationship was found between the quality of the butter produced by any one creamery and their system of processing cream. No relationship existed between size or type of plant and quality. Some creameries suffered considerable financial loss due to underfilling of the shipping boxes which has the weight marked on the carton. R. W. Hunt

CHEESE

550. Salting Cheddar cheese. O. R. Irvine. Can. Dairy Ice Cream J., **34**, 3: 38. 1955.

Proper rate and time of salting aids manufacture of high quality product. The Ontario survey indicates that cheese having between 4.66 and 5.33% salt-in-moisture gave best grades of cheese. Milk containing 3.2 to 3.6% fat should be salted at the rate of 2.25-2.375 lb. of salt per 1000 lb. of milk. Salting should be delayed until at least 20 min. after milling even for fast working curds. The curd and the salt should be between 86-88° F. at salting time.

H. Pyenson

551. Effect on pasteurization and waxing on maturing of Cheddar cheese. J. M. Bain and R. H. Gillan. Can. Dairy Ice Cream J., **34**, 4: 58. 1955.

Eight month observations on Cheddar cheese show that cheese made from clarified milk mature as well or better than cheese made from unclarified milk. Waxing of cheese before mold growth is advantageous as it reduces the shrinkage and preserves the rinds. Cheese that are waxed at 6 to 12 days old mature as well as cheese that are unwaxed and present a more attractive appearance to the purchaser. Waxing of heavily molded cheese is not desirable, as it contributes to rind deterioration. Cheese made in block form cure equally as well as those in cylindrical 90 lb. sizes. H. Pyenson

552. Process for making cheese. G. J. Strezynski (assignor to Faster Food Products Co.). U. S. Patent 2,712,999. 10 claims. July 12, 1955. Offic. Gaz. U. S. Pat. Office, **696**, 2: 234. 1955.

A process for making bakers or other soft unripened cheese from low fat (2%) milk. The milk is coagulated in the usual way with starter at 70-78° F., then heated to 80-100° F. while continuously removing the whey by means of centrifugal force. R. Whitaker

553. Device for extruding balls of Mozelle cheese. V. G. Comparette. U. S. Patent 2,712,693. 7 claims. July 12, 1955. Offic. Gaz. U. S. Pat. Office, **696**, 2: 160. 1955.

A piston-type extruder for making small spherical-shaped portions of Mozelle or other soft pliable cheese. R. Whitaker

554. Cheese cutting apparatus. W. E. Hastings (assignor to Kraft Foods Co.). U. S. Patent 2,711,020. 6 claims. June 21, 1955. Offic. Gaz. U. S. Pat. Office, **695**, 3: 330. 1955.

A device is described for removing the rind from cured cheese. R. Whitaker

CONDENSED AND DRIED MILKS; BY-PRODUCTS

555. L'emploi de la caséine modifée pour la stabilization des peintures au latex (The use of modified casein for stabilization of latex-based paints). G. Genin. Le Lait, **35**, 29. 1955.

Casein partially hydrolysed with typsin was found to stabilize pigments in rubber based paints without causing an increase in viscosity of the paint. The author comments that this might be an important market for casein.

A. W. Rudnick, Jr.

DAIRY BACTERIOLOGY

556. The role of divalent cations in the multiplication of staphylococcal bacteriophages. P. M. Rountree, Royal Prince Alfred Hospital, Sydney, Australia. J. Gen. Microbiol., **12**, 2: 275. 1955.

Certain types of staphylococcal typing phages appear to require divalent cations for both penetration and for later stages of phage synthesis. The addition of a chelating agent after the phage was absorbed to the cells surface interfered with the lethal action of the phage.

The final yield of phage appeared to be directly related to the concentration of calcium ions ($Ca Cl_2$) and the addition of a chelating agent toward the end of the latent period reduced the yield of bacteriophage. Ca appeared to exert maximum effect followed by Mg and Sr.
J. J. Jezeski

557. Factors involved in the production of a novel kind of derangement of storage mechanism in living holotrich, ciliate, protozoa from sheeep rumen. J. M. EADIE and A. E. OXFORD, Rowett Research Inst., Aberdeenshire, Scotland. J. Gen. Microbiol., **12**, 2: 298. 1955.

Highly abnormal appearances were induced in three species of rumen protozoa when incubated with glucose or other fermentable sugar *in vitro* at temperatures of 8 to 12° below normal rumen temperature. Abnormal structure of the storage polysaccharide granules was observed. It was suggested that these abnormal appearances were due to the utilization of polysaccharide by these protozoa rather than because of abnormal synthesis. J. J. Jezeski

558. Studies in the differentiation between human and animal pollution by means of faecal streptococci. K. E. COOPER and F. M. RAMADAN, Univ. of Bristol, England. J. Gen. Microbiol., **12**, 2: 180. 1955.

Faecal streptococci were isolated from the excreta of man, cattle, and sheep after heating (60° for half-hour) and in tetrathionate, tellurite, and thallium salts media. The properties of the various strains indicated that the tellurite medium provided excellent isolation of strains of faecal streptococci and that it appeared to be possible to differentiate between human contamination and animal contamination on the basis of the individual characteristics of the cultures isolated by these methods.
J. J. Jezeski

559. Logarithms to base 2. D. J. FINNEY, T. HAZLEWOOD, and M. J. SMITH, Univ. of Oxford, England. J. Gen. Microbiol., **12**, 2: 222. 1955.

A table is presented of logarithms to the base 2 for use in the graphical representation of the growth of bacterial cultures. It is suggested that a better interpretation of bacterial growth curves can be made using logarithms to the base 2 rather than to the base 10 since each unit on the logarithmic scale corresponds to the equivalent of one division by each of the cells present at the beginning of the experiment interval.
J. J. Jezeski

560. The influence of propagation procedures on the activity of lactic cultures. H. C. OLSON, et al., Okla. Agr. Expt. Sta., Stillwater. Bull. B-446. 1955.

Cultures grown in pasteurized milk which had a high raw count were as active as cultures grown in good quality milk. Butterfat content had no influence on activity of cheese cultures. The S.N.F. content of milk used in propagating cultures had a great influence on the activity of the cultures. A straight line relationship existed between acid production and S.N.F. content. It appears advisable to use milk containing as high as 10-12% S.N.F. Optimum pasteurization temperature for milk to be used for bulk cultures is 165° F. for 30 min. A high rate of inoculation (1.6%) resulted in more active cultures than low (.1) or moderate rates (.4). Cultures should be incubated at 70° F. Storage temperatures are best between 40-50° F. and cultures may be kept 5 days or longer. The addition of a small amount of calcium carbonate to the propagation container greatly prolongs the storage life of the culture. Following storage, cheese cultures should be carried through at least one propagation.
R. W. Hunt

561. Some factors affecting bacterial counts of soft ice milk. W. C. VAN DER ZANT and A. V. MOORE, Dairy Hus. Dept., Texas Agr. Expt. Sta., College Station. Food Technol., **9**, 6: 285. 1955.

The effect of time and temperature of plate incubation using TGEM agar on the bacterial counts of 50 samples of soft ice milk obtained from freezer operators in 19 Texas towns was studied. Coliform counts and counts of proteolytic and lipolytic bacteria were made. An attempt was made to trace the sources of high counts in this product.

Incubation of plates at 25° C. for three days or 21° C. for 4 days gave maximum counts and is recommended for the enumeration of bacteria in frozen desserts. All samples that gave high counts on plates incubated at 5 or 10° C. also showed high counts when the plates were incubated at 25 or 21° C. Only small numbers of thermophilic organisms were found in these samples of soft ice milk. The proteolytic and lipolytic count usually was low in relation to the total count. Inadequate cleaning and sanitizing of equipment at the retail outlet and holding the mix at too high a temperature (above 5° C.) for too long a time were important factors contributing to high bacterial counts in soft ice milk. E. R. Garrison

DAIRY CHEMISTRY

562. Utilization of proteins. C. T. BERG, Dept. of Biochem., Univ. of Iowa, Iowa City. J. Agr. Food Chem., **3**, 575. 1955.

This paper is an interpretative review of current knowledge in the field of protein and amino acid metabolism. S. Patton

563. One-phase solvent mixtures for the separation of amino acids. T. L. HARDY, D. O. HOLLAND, and J. H. C. NAYLER, Med. Chem. Div., Beecham Research Lab., Ltd., Betchworth, Surrey, England, and C. L. Bencard, Ltd., Minerva Road, Park Royal, London N. W. 10, England. Analyt. Chem., **27**, 6: 971. 1955.

Recent trends in filter-paper chromatography of amino acids have been toward the use of smaller chromatograms for more rapid detection or the application of reagents giving rise to specific colors for more precise characterization. The R_f values of the common naturally occurring amino acids on filter paper have been determined using 55 different one-phase solvent mixtures. Selection, by a novel method, of some promising combinations of these mixtures has led to the development of techniques whereby 16 of a mixture of 18 amino acids may be identified rapidly on a single two-dimensional chromatogram. Alternatively all 18 amino acids may be characterized on four separate one-dimensional chromatograms. Closely related amides and peptides have been found to give colors which differ from those obtained with the parent amino acids. B. H. Webb

564. Further observations on a rapid method for determination of solids-not-fat in milk. A. G. LEGGATT, D. W. DINSMORE, and W. H. SPROULE. Can. Dairy Ice Cream J., **34**, 6: 44. 1955.

Ceric sulphate solution (0.01 N) is added to a prepared milk sample. When the blue end point is reached the titre of the milk is obtained. The titre of the milk may be converted into % solids-not-fat by means of a table or by the regression equation: S.N.F. % = 5.19 × titre valve − 1.61.

When the S.N.F. valves obtained by this method were compared with those obtained by the standard method, a standard error of ±.109% was obtained. H. Pyenson

565. Études sur la caséine (Studies of casein). M. BEAU. Le Lait, **35**, 1. 1955.

A dissertation, based on electron microscopic work of others, on the action of rennet and acid on casein. The author points out that the larger the casein micelles, the more rapid the action of rennet. He attributes this to the probability that the larger micelles contain greater amounts of Ca and P. An attempt is made to explain the exact role of Ca and P in the coagulation process; but the conclusion is reached that further work must be done on the qualitative and quantitative functioning of these elements.
A. W. Rudnick, Jr.

DAIRY ENGINEERING

566. Ice maker features speed, strength. ANON. Refrig. Eng., **63**, 6: 73. 1955.

A new ice machine with action so fast that ice ¼-in. thick is frozen and harvested in cycles of ten min. or less is being marketed.

The machine consists of a series of stainless steel tubes, suspended vertically and cooled inside with direct expansion ammonia or Feon. Water is kept flowing down the outside of the tubes with enough agitation to make clear ice. After ice is frozen to desired thickness of ⅛ to ½ in., the water and refrigerant are automatically shut off. Hot gas defrosting starting at the bottom of the tubes releases the ice which slides down the tubes passing over a breaker on its way to the bin or storage room.

Capacities range from ½ ton to 30 tons per 24 hr. L. M. Dorsey

567. Preventive maintenance an offensive action against equipment failure and inefficiency. H. L. MITTEN, JR., Creamery Package Mfg. Co., Fort Atkinson, Wis. Ice Cream Rev., **38**, 11: 58. 1955.

A good preventive maintenance program will assure more trouble-free and economical operation of equipment. Such a program should provide for inspections, cleaning, lubrication, repairs, record keeping, and assignment of responsibility.

The importance of the proper instruction of operators and maintenance personnel is stressed as an important phase of a good maintenance program. Case histories of several failures of equipment are cited to emphasize the importance of operating and maintaining equipment in accordance with directions as supplied by the equipment manufacturer.
W. J. Caulfield

DAIRY PLANT MANAGEMENT AND ECONOMICS

568. Managerial concepts of agriculturalists. G. L. JOHNSON, Ky. Agr. Expt. Sta., Lexington. Bull. 619. 1954.

The research reported herein was prompted by the rapid development of managerial concepts and the need to sort these concepts to determine which are useful to agriculturalists—farmers, teachers, extension workers, and researchers.

This survey of managerial concepts indicates that management's main task is adjusting a business to imperfect knowledge and change. The five steps in this process are: observation, analysis, decision making, action, and acceptance of responsibility for action. Historically, farm management research has been directed toward furnishing information about production problems. This study indicates that research should be conducted on ways and means of increasing the skill with which the five managerial tasks are performed.

It was shown also that farm managers face problems in 5 fields: existing production methods, prices, innovations, social, political, and economic institutions, and personalities. Results from Montgomery county, which are probably applicable in most areas, show that the extension service has been effective in providing information about production methods, but less effective in furnishing information on innovations and institutions, and noneffective in furnishing information on personality problems. The implication of the above concepts are about the same for farm management teachers as for the extension workers. R. W. Hunt

569. Labor cost on retail milk routes in Springfield, Mass. H. G. SPINDLER, Mass. Agr. Expt. Sta., Amherst. Bull. 478. 1954.

Of the conumer dollar paid to a retail milk dealer, ½ is spent by dealer for processing and delivery cost. In the Boston market (1952), with milk at 23.7¢/qt, the dealer's margin for processing and delivery was 10.3¢. Of the total cost to the dealer, including receiving, pasteurization, bottling, storage, and delivery, over ½ consists of labor, and 1/3 is assigned to route men's wages. On a qt. basis, a change of 3¢ is needed to cover labor costs.

This study was divided into 3 segments: (1) physical route characteristics, (2) dollar values and costs and (3) factors affecting cost per unit.

Under (1) the average route is 26 mi., includes 121 stops and services 155.9 customers of whom 29.3 live above the 1st floor. Delivery hours averaged 46.3/wk, with relief men working 7 hr/wk. The load averaged 516.6 units of which 92.5% is milk products in qt. containers. There are 57.2 units delivered per hr., 4.3 truck stops, and 3.3 per customer.

Segment (2) showed the sales value of the weekly load to be $790.02 with an average value per unit of 24.8¢ (milk at 22.5¢/qt) and a delivery value of $14.15/hr weekly wage of drivers is $77.99, about ½ is salary and ½ as commission on collections. The average driver wage is $1.80/hr and is 12.7¢/dollar sales.

Factors affecting cost per unit are units delivered per customer and value of units delivered. No relationship is apparent between the truck stop and number of units delivered.

R. W. Hunt

570. Butterfat loss control in the milk plant. H. F. DEPEW, Natl. Dairy Products Co., Inc., N. Y. Milk Dealer, **44**, 9: 159. 1955.

In a milk plant a butterfat loss of 1 to 1½% can be considered normal. Fat loss figures range from 0.20% in one plant to over 5% in another. These losses are discussed in relation to (1) The receiving operation, (2) The processing operation from the raw milk storage tanks to the cooler, (3) Cooler breakage (4) Route shortages, (5) Unaccounted, and (6) Inaccurate figures.

C. J. Babcock

571. Mechanized payroll accounting. K. L. STRICKLER, Wayne Cooperative Milk Producers, Inc., Fort Wayne, Ind. Milk Plant Monthly, **44**, 6: 24. 1955.

Based on payroll records for 82 routes and about 4,000 producers, it was found that completely mechanized record keeping was impractical and costly. Machine accounting on payrolls only, saves thousands of dollars yearly. Examples of the daily worksheets and of machine-written producers' payroll are given.

C. J. Babcock

572. Microfilming. D. MERLIN. Milk Dealer, **44**, 9: 54. 1955.

Customer bills, settlement sheets, customer checks, payroll records and producer weigh cards are a few of the items being preserved with microfilm equipment by cost-conscious dairy firms. The film is acceptable for government audit. The main advantages are: (1) It gives the customer a day to day record of her purchases, (2) It saves space in the storing of records, and (3) It saves the drivers from making out new bills, because the totals are added up at the end of the month. After the bills are microfilmed in the office, they are either mailed or delivered by the routeman.

C. J. Babcock

573. Carrier for milk containers. S. I. BATKIN. U. S. Patent 2,711,922. 21 claims. June 28, 1955. Offic. Gaz. U. S. Pat. Office, **695**, 4: 562. 1955.

A carrier for two cartons of milk.

R. Whitaker

574. Carton carrier. H. A. TOMARIN (assignor to Loroco Industries Inc.). U. S. Patent 2,712,959. 2 claims. July 12, 1955. Offic. Gaz. U. S. Pat. Office, **696**, 2: 226. 1955.

A carrier for two cartons of milk.

R. Whitaker

575. Saving dollars thru oil re-use. ANON. Ice Cream Rev., **38**, 11: 52. 1955.

Savings amounting to $25,000 per yr. have been achieved by the Greyhound Bus Co., by the re-use of oil. Through a re-refining process 85 out of each 100 gal. of oil are saved for re-use by this one company.

It is pointed out that the re-refined oil should not be confused with filtered or reclaimed oil. In the re-refining process the drained oil is subjected to processes similar to those employed in refining virgin oil. The re-refined oil can be used just as satisfactorily as new oil for lubricating purposes.

Plants for re-refining oil are located in 32 states, and processed about 80,000,000 gal. of lubricating oil last yr. The estimated cost of re-refining oil is about 20¢ per gal. Ice cream plants could, in many cases, effect savings of considerable magnitude by saving oils drained for their trucks and then have the oil re-refined.

W. J. Caulfield

576. Increasing output per worker by coordinating production with sales demand. G. H. HOLDER, Hershey Creamery Co., Harrisburg, Pa. Ice Cream Rev., **38**, 11: 60. 1955.

Output per worker can be increased by solving two basic problems which are the responsibility of management. The first of these problems is the careful selection of flavors and items to be produced and the second is inventory control.

The addition of new items or new flavors increases change over time and decreases output

per worker. Every effort should be made therefore, to confine production to those items and flavors which can be produced in sufficient volume to return a fair profit. If new items are constantly being introduced change over time may exceed straight production time. Failure to drop slow moving items or flavors can have the same effect.

Inventory control is essential to intelligent production planning. Without adequate inventory control, production must be planned in a haphazard manner with the result that there are shortages of some items which will necessitate abrupt and costly changes in the production schedule. Good production planning can be achieved only when current sales figures are known and when there is a current inventory which will show the available stock by items and by flavors. Production then can be planned intelligently to meet the needs of the sales department and with an increased output per worker. W. J. Caulfield

FEEDS AND FEEDING

577. Alfalfa production experiments 1950-1954. P. C. SANDAL and J. F. JACKS, Ark. Agr. Expt. Sta., Fayetteville. Rpt. Series 48. 1955.

The field work was conducted on Newtonia loam which is a common Ozark upland soil in the Fayetteville area and on Sharkey series which are Delta-type soils in the Osceola area. Of the commercial varieties tested, Buffalo proved best because of its superior yield, good recovery, stand longevity, and resistance to bacterial wilt. The variety Ranger, though resistant to wilt, did not yield as well as Buffalo. For short-term stands, the non-bacterial-wilt-resistant varieties Atlantic, Okla. Common, and Kan. Common may be used. These varieties should not be used when establishing a stand on soils infested with the bacterial wilt organism or for long-term stands. The Argentine variety and the non-hardy varieties of Chilean, African, and Indian are not recommended for use in Ark. because of their unreliable forage yields and susceptibility to winter killing.
R. W. Hunt

578. Studies of the secretion of milk of low fat content by cows on diets low in hay and high in concentrates. V. The importance of the type of starch in the concentrates. C. C. BALCH, D. A. BALCH, S. BARTLETT, Z. D. HOSKING, V. W. JOHNSON, S. J. ROWLAND, and J. TURNER, NIRD, Univ. of Reading, England. J. Dairy Research, **22**, 1: 10. 1955.

Three comparable groups of cows were fed three types of concentrate mixture to determine their effect in reducing fat content of milk when the hay intake was restricted. It was found that when flaked maize made up 50% of the concentrate fed there was a much greater depression in the fat content of milk compared to when maize meal or oats and barley made up 50% of the concentrate. The effect is thought to be due to the effect that the starch from flaked maize has on the flora of the reticulorumen. J. D. Donker

GENETICS AND BREEDING

579. A study of variation in twin cattle. III. Growth. J. W. B. KING and H. P. DONALD, Agr. Research Council, An. Breed. Research Org., Edinburgh, Scotland. J. Dairy Research, **20**, 1: 1. 1955.

Three types of related female calves (monozygotic twins—MZ; dizygotic twins—DZ, and pairs of half sisters—HZ) were grown under uniform conditions and noted to relate differences arising within and between pairs in growth rate, i.e. weight and height at withers. It was found that concordance of data within pairs increased in the order HZ, DZ, MZ. Although the degree of variation within pairs of MZ twins was considerably less than for other animals, the authors point out that the 'statistical efficiency' arrived at by these comparisons do not give true assessments of the value of one-egg twins as experimental animal.
J. D. Donker

HERD MANAGEMENT

580. Method of milking by high vacuum. A. BAJEMA (assignor to N. V. "Ahex"). U. S. Patent 2,712,298. 5 claims. July 5, 1955. Offic. Gaz. U. S. Pat. Office, **696**, 1: 52. 1955.

A teat cup of a milking machine, designed to operate at a vacuum of at least 600 mm. Hg.
R. Whitaker

ICE CREAM

581. Lactose crystallization. D. C. CHUNN. Can. Dairy Ice Cream J., **34**, 5: 32. 1955.

The author discusses the process of lactose crystallization in relation to the causes and cures of sandiness in ice cream. The outline relates the connection between concentration, temperature, and solubility of lactose and the likelihood of its forming crystals.
H. Pyenson

582. Stickholders. D. LURIE and B. STERN (assignors to Joe Lowe Corp.) U. S. Patent 2,711,338. 2 claims. June 21, 1955. Offic. Gaz. U. S. Pat. Office, **695**, 3: 410. 1955.

A device is described for holding sticks to be inserted in frozen novelties manufactured in molds in a brine tank. R. Whitaker

583. Automatic batch weighing of mix ingredients. ANON. Ice Cream Rev., **38**, 11: 50. 1955.

A system for accurately weighing multiple ingredients going into an infant food is described. In this installation, a 1000 gal. pasteurizer rests on the weighing unit. As ingredi-

ents are added to the pasteurizer a pressure is exerted upon the diaphragm in the load cell unit, which in turn is transposed into ounces, pounds, or tons. A system of controls is used which will either shut off the flow of one ingredient and start the flow of another or they will indicate when to do so manually.

This installation has reduced operating costs and has resulted in more accurate weighing of the various ingredients going into the end product. It is believed that this system of weighing multiple ingredients could be used to good advantage in the ice cream industry.

W. J. Caulfield

MILK AND CREAM

584. Effect on quality of dairy products of various types of milk cans. R. N. GIROUX, L. R. BRYANT, and W. H. SPROULE. Can. Dairy Ice Cream J., **34**, 1: 36. 1955.

In a study of cream, butter made from it, and fluid whole milk in aluminum, stainless steel, or new tinned steel cans, it was found that there were no significant differences between them. Rusty tinned steel cans increased iron content of cream or milk stored in them. Cream stored in slightly rusted cans developed more acidity and undesirable flavors occurred more frequently during the storage period.

Butter and cream stored in slightly rusty cans, scored lower and deteriorated faster than products stored in cans in good condition. No differences could be found in the vitamin A and carotene content of cream or butter from any of the storage cans. There was no difference in the riboflavin or ascorbic acid content of milk stored in the various cans. H. Pyenson

585. Quality and iron contamination of dairy products and thiobarbituric acid test. R. N. GIROUX, L. R. BRYANT, and W. H. SPROULE. Can. Dairy Ice Cream J., **34**, 2: 44. 1955.

In cream and butter high T.B.A. tests correspond to lower flavor scores but this only holds true in a large number of samples. There was no significant relationship in whole milk between flavor scores and the T.B.A. test. Iron contamination in dairy products has a definite effect upon the magnitude of the results of T.B.A. tests on milk, cream, and butter.

H. Pyenson

586. Bulk handling of milk. A. M. PEARSON. Can. Dairy Ice Cream J., **34**, 5: 35. 1955.

The bulk tank system should make a better producer from a good one but will not make a good producer from a poor one. Its use should improve the bacteriological quality of milk, but, unless care is taken, will produce a lower quality flavorwise. The best bulk tank system is one used along with an easily sanitized pipe line. The psychrophilic count should be given more consideration when setting up control methods for bulk tank handling. Present sediment tests are of little value when applied to the bulk tank system. More efficient milk production on the farm is the results from the use of bulk tank systems. H. Pyenson

587. Dispensing quality milk. E. J. FINNEGAN, E. M. BABB, JR., G. C. WASSUM, and G. C. GRAF, Va. Poly. Inst., Blacksburg. Milk Plant Monthly, **44**, 6: 27. 1955.

A 17-month study has shown that there is no appreciable difference in the sanitary quality of milk in ½-pint bottles and milk dispensed by bulk dispensers. The study of dispenser operations also showed that a separate can washer should be provided at the milk plant to be used only for cans that will contain pasteurized milk. Such cans should be pre-scrubbed by a unit containing a power brush. Data are presented showing: (1) Total counts on milk from refrigerated bulk dispensers as compared with bottled milks of the same grade from the same source, (2) Total bacterial count, milk temperatures, and age of milk stored in refrigerated bulk dispensers at retail outlets, and (3) A comparison of milk bottle and dispenser can operations by time motion analysis.

C. J. Babcock

588. A plant study of bulk milk dispenser operations. E. J. FINNEGAN, E. M. BABB, JR., G. C. WASSUM, and G. C. GRAF, Va. Polytech. Inst., Blacksburg. Milk Dealer, **44**, 9: 64. 1955.

Data are presented showing: (1) Total counts on milk from refrigerated bulk dispensers as compared with bottled milks of the same grade from the same source, (2) The psychrophilic, mesophilic, and thermophilic bacteria counts on dispenser milk versus bottled milk, (3) The total bacteria counts, milk temperatures, and age of milk stored in refrigerated bulk dispensers at retail outlets, and (4) Standard time and motion analyses of bulk milk dispenser operations. The data show that there is no appreciable difference in the sanitary quality of milk dispensed in ½ pint milk bottles and milk dispensed by bulk dispensers.

C. J. Babcock

589. Method for treatment of fluids requiring sterilization or pasteurization. W. H. COULTER. U. S. Patent 2,712,504. 5 claims. July 5, 1955. Offic. Gaz. U. S. Pat. Office, **696**, 1: 105. 1955.

A method of producing sterilized or pasteurized milk, which consists of evaporating raw milk, heating it by continuously mixing it with sufficient hot water under pressure to raise the temperature of the blend to the desired pasteurizing or sterilizing temperature, then holding for a desired holding period, then blending the pasteurized or sterilized product continuously with sterilized cold water to reduce the temperature and complete standardization, and finally cooling indirectly under sterile conditions. The process also may con-

sist of treating unevaporated milk in the same manner, but evaporating all of the added water from the final product under suitable sanitary conditions. R. Whitaker

590. Water driven or hydraulic cream whipping device. G. Von Elm. U. S. Patent 2,712,-926. 2 claims. July 12, 1955. Offic. Gaz. U. S. Pat. Office, **696**, 2: 217. 1955.

A cream whipper driven by a small turbine-type motor attached to a kitchen cold water faucet. The exhaust water is discharged over the outside of the container to keep it cool.
R. Whitaker

MILK SECRETION

591. The rate of secretion of milk and fat. G. L. Bailey, P. A. Clough, and F. H. Dodd, NIRD, Univ. of Reading, England. J. Dairy Research, **22**, 1. 22. 1955.

An attempt was made to determine the effects that residual milk in the udder had on subsequent yields and composition of milk. Further, the secretion rate of milk and butterfat for various milking intervals was arrived at by eliminating the effect residual milk had on the milk secreted during an interval by assuming there was no change in the residual at the beginning of the interval to the end of the interval under one of their milking schemes.

Five cows were milked on each of two milking schedules, each of which involved between-milking-intervals of 3, 6, 9, 12, 15, and 18 hr. In the first series each individual milking followed one with the same milking interval that it had and one of each of the other intervals (37 milkings/cow). In a second series of milkings, several consecutive milkings with the same milking interval were made on a given schedule of changing intervals. The series was then reversed to minimize lactation trends. In this series there were included 92 milkings about half of which were not used because of change-over effects when changing milking interval.

The 1st series demonstrated the extent of the effect that changing intervals had on changes in milk yield and fat content in particular. When short intervals followed after long milking intervals the milk was considerably richer than if the opposite condition held, e.g. long interval following after a short interval. The second series showed that increase in milking interval decreased secretion rate in a curvilinear manner, but with considerable variation shown in the shape of plotted curves from the five individual cows. Fat secretion appeared to be less affected by increase in the time of milking interval as the butterfat percentage of milks from longer intervals was higher than from the short intervals provided that the milk in question was not one influenced by the residual milk from a different time interval than the one in question. There was evidence presented to show that milk yield was influenced by only one previous milking interval while fat yields were a reflection of at least two or three previous milking intervals. J. D. Donker

NUTRITIVE VALUE OF DAIRY PRODUCTS

592. Vitamin D milk needs your push. K. G. Weckel, Univ. of Wis., Madison. Milk Plant Monthly, **44**, 6: 16. 1955.

Vitamin D milk has been the medium through which an important improvement in the nation's health has taken place. The development of Vitamin D milk as a product, and the significance of its acceptance by the consumer, is in great need of review by all dairymen. The development of Vitamin D milk was one of the important developments through which nation-wide attention was given milk as a food for health. It is estimated that 90% of the bottled milk in large metropolitan areas, 60% in secondary areas, and 30-50% in smaller communities is fortified with Vitamin D. It is further estimated that 90-95% of all the evaporated milk distributed in this country is fortified with Vitamin D.

Dairymen should review the significant role of Vitamin D as: (1) It is important that the new generation of children know what Vitamin D means to them, (2) It is important to recognize there are important shifts in population composition; there are more elderly people as well as very young, and (3) It is important to recognize there are new generations to whom the Vitamin D story must be retold.
C. J. Babcock

PHYSIOLOGY AND ENDOCRINOLOGY

593. Physiological effects of environment on domestic animals. H. L. Garver, Agr. Eng. Research Br., Agr. Research Serv., USDA. Refrig. Eng., **63**, 6: 64. 1955.

A general review of environmental factors in the physiology of plants and animals. Cows will produce as much milk at 0° F. as at 70° F., but at 60° F. the respiration rate increases. When the air temp. reaches 90° F. milk production decreases materially, and water and feed consumption goes down as does evaporation. When outside temp. persist at or above 106° F. for several hr., the animal is likely to die. The reason why loss of animals does not occur when temp. run well above 100° F. is that they build up considerable reserve during the lower night temp. Cows suffered less at 100° F. in the day time when the night temp. were 60 ° F. than they did when the day temp. were 90° F. and the night temp. 70° F.

The lag in animal response to changing high air temp. was less with rising temp. than with dropping temp. Respiration rates responded fastest. Surface and rectal temp. had about 1-hr. lag with rising air temp. and an appreciably greater lag with falling air temp. Total

vaporization rates lagged maximum and minimum air and room dew point temp. by about 2 hr. These characteristic lags are of importance in predicting the effects of rapid environmental changes such as when releasing a cow from warm stable to colder outside temp.

The sky is an important factor in animal comfort. Cows in the laboratory at 90° F. show definite thermal stress while those outside at the same temp. seem perfectly happy. The sky acts as a radiation absorber.

Production suffers little in either dairy cows or poultry until the average 24-hr. temp. exceeds 75° F. While they do adjust themselves to rather wide ranges of climatic conditions they need to be shielded from sudden changes.

The author indicates the need for additional research and points out that while costly it can be the agent for future economic gains.

L. M. Dorsey

594. The recorded butterfat content of bulk milk from a herd of White Fulani cattle. N. TASKER, Dept. Local Industries Northern Nigeria. J. Dairy Research, **22**, 1: 16. 1955.

The bulk milk from a herd of 50 White Fulani cattle was tested over a period of 12 mo. for butterfat content by the Gerber method. Three hundred forty-three morning and 343 evening samples were compared. The herd was milked at 6:30 a.m. and 4:30 p.m. The mean a.m. butterfat was 6.29% and the p.m. 6.56%. There was considerable day to day variation (as much as 2.0%). Attempts were made to associate butterfat content of the milk to various climatic conditions. It appeared that there was a higher fat content and less variation between days and a.m. and p.m. samples when the temperatures were lowest with the least day to night differences. This coincides with the period of maximum grazing thought to be the primary factor affecting the fat content of the milk.

J. D. Donker

595. Sleep in ruminants. C. C. BALCH. Nature, **175**, 4465: 940. 1955.

A careful study of cows and sheep showed that normal healthy ruminants sleep little, if at all. When it does occur, it is of light and transient nature. For proper rumination, an upright position appears necessary, as well as time and consciousness.

R. Whitaker

SANITATION AND CLEANSING

596. In-place cleaning of sanitary pipe lines. E. M. PETRIE. Can. Dairy Ice Cream J., **34**, 3: 48. 1955.

Immediately after processing, flush lines and equipment thoroughly with 100° F. water. Arrange the circuit for circulation by disconnecting branch lines and cap the openings. Remove valve plugs and other special fittings, brush clean, and replace. In circuits in which the processing temperature does not exceed 100° F., circulate daily a solution of a mildly alkaline equipment cleaner and then rinse by pumping water at 120° F. through the circuit. Once a week circulate a solution of acid milkstone remover following the alkaline compound circulation. In hot milk circuits (over 100° F.), circulate daily a solution of acid milkstone remover, rinse, and circulate a solution of highly alkaline cleaning material. Rinse with warm water. Just prior to use, the entire circuit is rinsed with a sanitizing solution.

H. Pyenson

597. Milk waste disposal. N. D. WOLLINGS. Can. Dairy Ice Cream J., I. **34**, 5: 27. 1955, and II. **34**, 6: 27. 1955.

Part I outlines the problem in Ontario including information on the source and character of milk wastes. Part II discusses the principal methods of milk waste disposal based upon laboratory and plant scale investigations.

H. Pyenson

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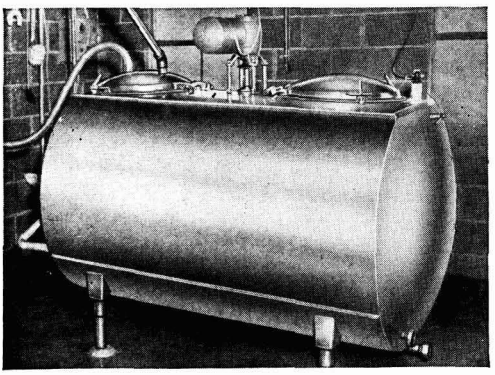

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