JOURNAL OF DAIRY SCIENCE

Contents

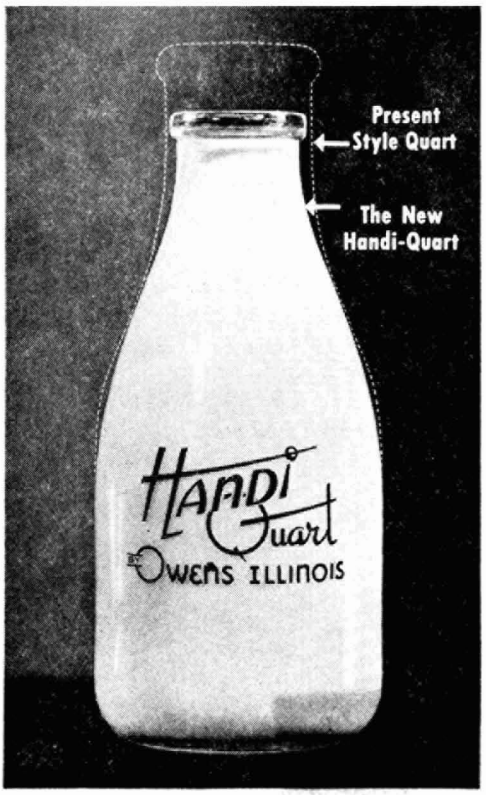
Vol. XXIV, No. 9, September, 1941

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION

Milk—all liquid, even molten glass—when poured forms a "teardrop." That's Nature's way of evenly distributing liquid mass, of insuring best distribution of thickness and weight.

Here's the New...

OWENS-ILLINOIS Handi-Quart



The new O-I Handi-Quart is a natural "teardrop," modified to traditional milk bottle shape. Its distribution of glass in neck, shoulders and sidewalls, plus exclusive bridge-truss bottom construction, makes it milk's most modern, low-weight, streamlined *Salespackage.* Available either as private mold or with applied color lettering; also in pints and half-pints. The O-I Handi-Quart brings these distinct advantages.

FOR THE CONSUMER

1. *Easy to handle*
2. *Easy to pour from*
3. *Space-saver in refrigerator*

FOR DAIRYMEN

1. *A distinct "merchandising" package*
2. *Substantially lower bottle cost*
3. *Maximum capping economy*
4. *Minimum operating change to use it*
5. *Savings in handling and load-weight*
6. *A "natural" for store trade*

OWENS ILLINOIS

Complete Dairy Service

WHERE QUALITY PREDOMINATES

JOURNAL OF DAIRY SCIENCE

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

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

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

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

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

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

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

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

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

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

JOURNAL OF DAIRY SCIENCE

VOLUME XXIV SEPTEMBER, 1941 NUMBER 9

COWS' URINE AS A FERTILIZER FOR BLUEGRASS PASTURES

W. B. NEVENS

Illinois Agricultural Experiment Station, Urbana, Illinois

Most dairy farmers recognize the fact that dairy cows' urine has some value as fertilizer, but as a rule, its true value is not appreciated and it is not as well conserved and utilized in crop production as the solid portion of the excreta. The object of the investigation reported herewith was to call attention to the high value of cows' urine as a fertilizer by demonstrating its effects upon bluegrass pasture.

The urine of dairy cows normally contains one-third to one-half of the nitrogen and three-fourths or more of the potassium in the excreta (feces and urine) of these animals. As much as 12 to 16 pounds of nitrogen and 10 to 12 pounds of potassium may be found in the urine for every ton of feces excreted (6).

Only a few reports of experimental studies of the value of urine as a fertilizer for pastures are to be found in the literature.

Curtiss (1) reported that the application to bluegrass pasture of 4000 pounds of urine containing .7 per cent nitrogen, .167 per cent potash, and .033 per cent phosphorus, increased the yield of grass 26.5 per cent, or equivalent to 650 pounds of hay per acre.

Ernest (2) states that "Danish experiments with urine have shown that the effect of an autumn application was only 30 to 40 per cent that of a spring application." (Abstract taken from Pieters (8).)

Falke (3) found that the effect of fertilizers on naturally established pastures was to increase "the percentage of protein as well as the digestibility of the protein except that Plot 8 which received urine rather than nitrate of soda fell below the others in production." (Abstract taken from Pieters (8).)

Zacharewiez (10) reported that the use of liquid manure, superphosphate, complete chemical fertilizer, and stable manure, increased the yields of a meadow 17 per cent, 48 per cent, 78 per cent, and 69 per cent, respectively, based upon the yields of check plots.

Received for publication April 1, 1941.

EXPERIMENTAL METHODS

Four plots, each 2×2 rods in size, were laid out in a well-sodded and nearly level part of a 4.5-acre bluegrass pasture. Short posts were set at the corners of each plot and the plots were separated from each other by 1-rod borders. No fencing other than the posts was used so that the cattle grazing in the pasture had free access to all of the plots. Reinforced wire cages approximately $4' \times 4'$ in size were used to protect sampling areas within each of the plots (Fig. 1). Cages were also placed in the pasture nearby to facilitate the sampling of a control area.

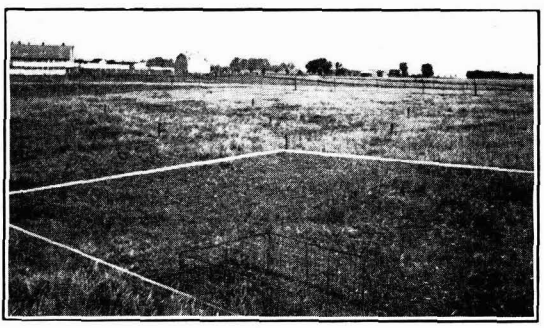


FIG. 1. The fertilized plots (marked by short posts) were grazed closely while the grass on the unfertilized portions of the pasture headed out. Plot 4 (marked by white lines) is in the immediate foreground. Plot 1 in the background shows but little more intensive grazing than the unfertilized pasture. *Photographed July 4, 1939.*

The first samples of the season were harvested immediately prior to turning the cattle to pasture. Only one area on each plot was harvested on the first sampling date. During the taking of the first samples, two wire cages were placed at each sampling location. One of these was placed over an area just harvested. The forage taken from this area the following month comprised only the forage produced by one month's growth. This was designated the "A" sample.

On each sampling date a cage was placed over a representative portion of the open pasture. The forage harvested from this protected area the following month formed the "B" sample. It comprised not only forage produced during the one month's growth, but also the forage on the area at the time the protecting cage was put in place the previous month. Hence, in computing the yields by the "B" method, the amounts of forage on the open pasture the month previously as determined from the "C" samples were subtracted from the "B" samples.

The "C" samples consisted of harvests of forage from the open, or unprotected, portion of each plot on each harvest date. These samples indicate

only the amounts of forage on the pasture at the time of harvest and used alone do not represent yields.

The samples were harvested by the use of a metal frame and grass shears (7). The metal frame was 44″ × 44″ in size and 1½″ high. It was braced by cross rods. A flat sliding bar laid over the top formed a guide for the shears to insure cutting of the forage at the same height each time.

The forage was collected in cloth sacks and taken to the laboratory where it was at once separated by careful hand sorting into weed and grass portions. Each portion was resacked in tared cloth sacks, weighed, and dried in a constant-temperature electrically-heated oven at 95°–100° C. The grass portion, which consisted almost entirely of Kentucky bluegrass (*Poa pratensis*), was analyzed for its nitrogen content.

The urine was collected from high-producing dairy cows into clean pails during the act of urination. It was applied by hand within a few hours after collection by means of garden sprinkling cans. In most cases it was applied undiluted. Because of a low moisture content in the surface soil, the urine applied May 13, 1939, was mixed with an equal volume of water with the object of preventing injury to the grass.

Applications of urine were made in April, May, and June of 1939, and in May and June of 1940. The rates of application in pounds per acre to Plots 1, 2, 3, 4, and 5 were 1250 pounds, 2500 pounds, 3750 pounds, 5000 pounds, and 0 pounds, respectively. The first treatment in 1940 was delayed until after samples of the forage had been taken, in order to determine if there was a carryover effect of the previous year's treatment. The nitrogen content of the different lots of urine ranged from 1.068 per cent to 1.29 per cent and the potassium content from 0.91 per cent to 1.22 per cent.

EXPERIMENTAL RESULTS

Heavy applications of nitrogenous fertilizers to grasses sometimes cause "burning," an injury which may temporarily retard growth or in some instances completely kill the plants. No burning, or injury, of the grass was noted following the application of urine except after the treatment made June 8, 1940. In spite of apparently ample moisture in the soil from a recent rain, some burning of the grass occurred in the two most heavily fertilized plots, especially on the small areas from which samples had been harvested two days before. The urine aplied on that date carried more than 1 per cent nitrogen and approximately the same percentage of potassium, or slightly more than 20 pounds of each of these elements per ton of urine. The applications were such that larger quantities of nitrogen and potassium were applied annually than is customary in the use of commercial fertilizers.

Striking differences were found in the protein content of the grass harvested from the various plots (tables 1 and 2). Several generalizations may be drawn from the data, viz.:

TABLE 1

Composition of samples harvested from bluegrass pasture plots in 1939

Plot No.	Date of harvesting samples									
	May 5		June 7		July 5		Aug. 8		Sept. 11	
	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter
	per cent	*cent per*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
					"A" Samples					
1	36.0	18.4	40.3	12.5	33.3	14.8	35.7	14.4	40.6	14.6
2	36.5	19.2	44.3	14.1	*	*	.....	14.8	.....	15.6
3	32.1	21.2	37.4	18.7	31.7	16.4	26.3	17.4	35.7	16.1
4	32.7	21.6	40.7	16.3	34.7	18.6	36.4	19.1	39.0	16.6
5	30.8	16.7	38.9	10.6	36.5	12.6	33.3	15.0	38.0	16.7
					"B" Samples					
1	36.0	18.4	41.7	11.0	44.5	10.8	50.0	10.3	43.3	11.3
2	36.5	19.2	47.7	10.8	39.1	12.5	41.0	11.6	39.5	13.9
3	32.1	21.2	39.3	14.8	34.8	14.7	43.1	12.5	41.2	16.8
4	32.7	21.6	43.7	16.5	35.4	18.3	40.4	15.1	39.3	16.9
5	30.8	16.7	44.2	9.5	42.0	10.2	49.4	10.1	41.5	13.8

* Cage moved by cattle; no sample.

TABLE 2

Composition of samples harvested from bluegrass pasture plots in 1940

Plot No.	Date of harvesting samples									
	May 2		June 6		July 5		Aug. 12		Sept. 26	
	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter	Dry matter content	Protein in dry matter
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
					"A" Samples					
1	25.0	17.7	29.8	11.9	31.5	13.4	34.1	12.6	33.3	18.6
2	25.0	27.0	27.5	12.0	26.4	16.1	30.8	12.7	35.3	21.6
3	17.6	19.6	29.1	14.1	29.1	17.5	33.3	13.3	33.3	19.4
4	21.2	18.4	27.8	13.7	31.7	17.6	27.3	12.8	35.7	23.8
5	24.4	16.8	24.1	10.5	37.0	12.1	.....	11.0	37.5	17.4
					"B" Samples					
1	25.0	17.7	31.1	9.0	36.9	10.2	48.1	8.6	52.0	12.7
2	25.0	27.0	29.4	10.9	37.1	10.9	45.4	9.4	50.0	*
3	17.6	19.6	29.1	11.8	35.5	16.1	48.2	8.8	42.9	17.1
4	21.2	18.4	30.9	11.1	37.1	13.3	45.9	13.4	40.0	17.4
5	24.4	16.8	33.3	8.3	44.7	7.4	36.6	9.4	54.5	13.4

* Sample lost.

(a) In most instances the protein content of the grass on the treated plots was higher than that of the untreated, and the larger the amount of urine applied, the higher the protein content. Exceptions occurred during nearly dormant conditions of the pasture in August and September of both years, and in several instances the protein content of Plot 3 was higher than that of Plot 4.

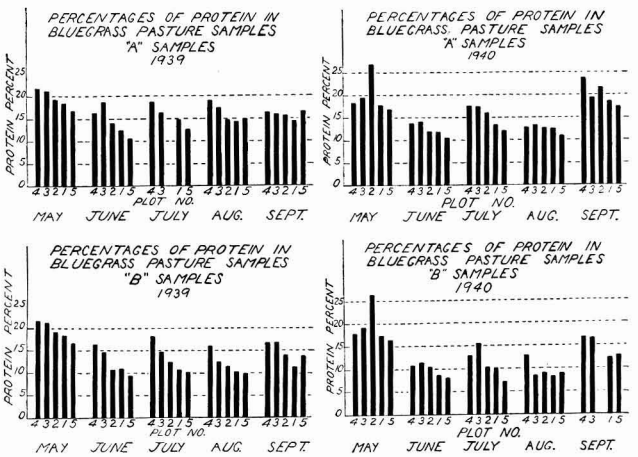


FIG. 2. Treatment of bluegrass pasture plots with cows' urine increased the protein content of the grass over that of the control area (Plot 5), and during the early part of the season, the heavier the application, the higher the protein content of the grass.

(b) The protein content of the A samples was higher than that of the B samples. This is attributed to the fact that the A samples represented only new growth, while the B samples comprised both new growth and older forage. In comparing the analyses of the A and B samples given in tables 1 and 2, it should be noted that the analyses of the samples harvested May 5, 1939, and May 2, 1940, have been listed under both A and B samples in order to facilitate comparison of the A and B samples with the first samples of the season. Following the terminology used in this report, these first samples were neither A nor B samples, but were C samples.

(c) The protein content declined rapidly with advancing development of the plants and dry weather. Rainfall during the summer months of 1940 was less than during the corresponding period of 1939 (table 3) and the protein content of the samples harvested in the summer of 1940 was somewhat less. Light showers during the latter part of August, and in September, 1940, stimulated some new growth with a consequent rise in the protein content of the harvest made Sept. 26, 1940. In this experiment a renewed growth induced by rain seems to have been fully as potent a factor or an even more important factor than fertilization in enhancing the protein content of the grass.

TABLE 3

*Rainfall at Urbana, Illinois**

Month	Average 1889–1940 incl.	1939	1940
	inches	*inches*	*inches*
April	3.53	5.39	3.96
May	3.87	1.19	4.53
June	3.73	6.17	5.04
July	3.08	1.73	0.95
August	3.34	6.38	2.80
September	3.22	0.32	0.48
October	2.43	2.54	1.93
Total for year	35.03	38.05	30.60

* University of Illinois Cooperative Weather Bureau.

(d) There was a carryover effect of the urine treatments of 1939 which lasted not only throughout the sampling period but was also evident in the samples harvested May 2, 1940. The unusually high protein content found for Plot 2 on May 2, 1940, is unexplained even after a repetition of the analysis. However, even after leaving out of consideration this unusually high figure, the protein content of the grass from the other three plots was found to be substantially higher than that of Plot 5, the control area. As pointed out above, the first application of urine in 1940 was not made until after these samples had been harvested.

TABLE 4

Yields of dry matter and amounts of dry matter in open pasture on bluegrass pasture plots in 1939

Method of determination	Amounts per acre of dry matter				
	Plot No.				
	1	2	3	4	5
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*
"A" grass	3143	3095	3435	4310	2317
"A" weeds	161	38	308	292	259
Total	3304	3133	3743	4602	2576
"B" grass	4083	3110	3857	3984	2771
"B" weeds	162	26	614	16	49
Total	4245	3136	4471	4000	2820
"C" grass	3726	2511	2170	1685	4519
"C" weeds	16	6	114	97	32
Total	3742	2517	2284	1782	4551

The yields of dry matter in the forage are shown in tables 4 and 5. The yields as determined by the A method, or the harvests of the new growth (tables 4 and 5), were larger for the treated plots (Nos. 1–4) than for the control plot (No. 5). Also, the June and July harvests of 1939 indicated that the larger the application of urine the larger the yield of dry matter in

the bluegrass. Low rainfall in July and also during the latter part of the pasture season of both years was followed by such low yields that no direct relation between method of treatment and yield was apparent.

TABLE 5

Yields of dry matter and amounts of dry matter in open pasture on bluegrass pasture plots in 1940

Method of determination	Amounts per acre of dry matter				
	Plot No.				
	1	2	3	4	5
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*
"A" grass	3402	3694	2980	3759	2041
"A" weeds	65	97	567	486	97
Total	3467	3791	3547	4245	2138
"B" grass	3013	4180	4018	2268	1103
"B" weeds	0	97	728	339	470
Total	3013	4277	4746	2607	1573
"C" grass	4309	3564	1684	3531	3790
"C" weeds	97	65	113	292	48
Total	4406	3629	1797	3823	3838

The yields as determined by the B method (*i.e.*, B samples—C samples of previous month) are for the most part in substantial agreement with those determined by the A method, particularly with respect to the higher yields of the treated plots than of the untreated. Considering the small size of the areas harvested in sampling, the agreement of the two methods seems remarkably good. The merits of these methods of determining yields have been discussed by Fuelleman and Burlison of this Station (4, 5).

Plots 1–4 were nearly bare from July to September, 1939, and during this period the amounts per acre of forage on these plots were less than on Plot 5, the control plot. Probably this closely grazed condition of the treated plots in the fall of 1939 accounted for smaller yields from them than from Plot 5 in May, 1940. A summary of the yields for 1940 is given in table 5. In spite of low yields of Plots 1–4 in May, 1940, the yields of these plots for the season, as determined by both the A and the B methods, were much higher than for the check plot.

The palatability of the grass on the urine-treated plots was apparently greater than that of the untreated portions of the pasture. Within a few weeks after the cattle were first turned to pasture in 1939, it was evident that Plot 4 and a little later Plot 3 were being grazed more heavily than the other plots, or the untreated pasture. A short time after, Plot 2, and finally Plot 1, were given more attention by the cattle. On the treated plots the grass was grazed closely except around droppings, while on the borders between the plots and the rest of the pasture the grass headed out (Fig. 1). It appears from the data that there was a direct relationship between the

protein content and the palatability of the bluegrass, *i.e.*, the higher the protein content, the greater the palatability.

SUMMARY AND CONCLUSIONS

Four small plots of Kentucky bluegrass were treated in April, May, and June of 1939, and again in May and June of 1940, with applications of cows' urine at rates ranging from 1250 pounds to 5000 pounds per acre at each application. A control area was untreated. Samples of the grass were harvested monthly from May to September, inclusive.

Although the urine contained more than 1 per cent nitrogen and in most cases more than 1 per cent potassium, the heavy applications were, as a rule, not harmful to the forage.

The protein content of the grass on the treated plots was higher than that of the grass on the control area, and in most instances, the heavier the application of urine, the higher the protein content.

The protein content of the A samples, representing recent growth, was higher than that of the B samples, which included both older forage and recent growth. Advancing development of the plants and renewed growth induced by rains were important factors affecting the protein content of the grass, the former causing a decline and the latter an increase in protein content.

The effect of the first year's spring treatment with urine on the protein content of the grass was evident during the remainder of the pasture season and also in May of the following year.

The yields of the urine-treated plots were higher than that of the untreated pasture and there was a tendency toward higher yields from the more heavily treated plots.

The palatability of the grass, as evidenced by close grazing by cattle, was higher on the urine-treated plots than on the untreated pasture and the greater the protein content of the grass, the greater the intensity of grazing.

ACKNOWLEDGMENT

This paper constitutes a report of an investigation of pasture improvement methods conducted cooperatively by the Departments of Agronomy, Animal Husbandry, and Dairy Husbandry, University of Illinois. The assistance and counsel of members of these Departments is hereby gratefully acknowledged. The chemical analyses reported were made under the direction of Mr. J. M. Lindgren of the Applied Chemistry Testing Laboratory of the University of Illinois.

REFERENCES

(1) CURTISS, C. F. Restoring Pastures. Iowa Agr. Exp. Sta., Bul. 32. Pp. 467–469. 1896.

(2) ERNEST, E. The Application of Farmyard Manure to Cultivated Pastures. (Trans. title.) Landtmannen., **20**: 311. 1936.

(3) FALKE, F. Investigations on the Effect of Fertilizing on Pastures and Meadows. (Trans. title.) Diss. Leipzig. 1904.

(4) FUELLEMAN, R. F., AND BURLISON, W. L. Pasture Yields and Consumption under Grazing Conditions. Jour. Amer. Soc. Agron., **31**: 399–412. 1939.

(5) FUELLEMAN, R. F. AND BURLISON, W. L. A Comparison of Yields and Composition of some Illinois Pasture Plants. Jour. Amer. Soc. Agron., **32**: 243–255. 1940.

(6) HARSHBARGER, K. E., AND NEVENS, W. B. The Distribution of Elements of Fertility between Feces and Urine in Dairy Cattle. Amer. Soc. Anim. Prod. Proc., 58–61. 1938.

(7) NEVENS, W. B., AND KUHLMAN, A. F. A Method of Harvesting Samples of Pasture Forage. JOUR. DAIRY SCI., **18**: 793–794. 1935.

(8) PIETERS, A. J. A Digest of some World Pasture Research Literature. Bur. Plant Indust., U. S. Dept. Agr. 1937.

(9) VAN DOREN, C. A., BURLISON, W. L., GARD, L. E., AND FUELLEMAN, R. F. Effect of Soil Treatment and Grazing Management on the Productivity, Erosion and Run-off from Pasture Land. Jour. Amer. Soc. Agron., **32**: 877–887. 1940.

(10) ZACHAREWIEZ, E. Influence of Chemical Fertilizers on the Product of Natural and Artificial Meadows. Prog. Agr. et vit. 26. 1896. Abstract from Exp. Sta. Rec., 8, 775, 1896–97.

RANCIDITY STUDIES ON MIXTURES OF RAW AND PASTEURIZED HOMOGENIZED MILK*

P. B. LARSEN, G. M. TROUT AND I. A. GOULD
Department of Dairying, Michigan State College, East Lansing, Michigan

When raw milk is homogenized there is an immediate and continued rise in the titratable acidity (1, 4), accompanied by the development of a rancid flavor. Pasteurization of the milk prevents rancidity from developing. The phenomenal development of rancidity in homogenized raw milk has been attributed to the action of lipase normally present in all milk, through activation of the lipase itself, through the creation of new surfaces more susceptible to lipase action, or through the increased surface area of the fat globules. This lipolytic response to the homogenization of raw milk is recognized by the market milk industry to the extent that pasteurization is a closely allied process to the homogenization of milk for bottling purposes.

Even though pasteurized milk will not develop rancidity upon homogenization, nevertheless, information is available indicating that rancidity may be induced in this pasteurized milk by the addition of raw homogenized milk. For example, Dorner and Widmer (2) stated that "mixtures of pasteurized and homogenized cream or milk with raw milk, raw skim milk, or raw cream become rancid." Gould and Trout (3) have demonstrated that in mixtures of homogenized raw and unhomogenized pasteurized milk lipolysis proceeded to a greater extent than if the fat splitting had been calculated as having occurred only in the raw product.

In the study herein presented combinations of homogenized and unhomogenized raw and homogenized and unhomogenized pasteurized milk were made to ascertain under what conditions and to what extent rancidity would occur.

EXPERIMENTAL PROCEDURE

Raw milk was secured from the College milk supply which was composed largely of mixed milk from herds of several producers as well as that from the College herd. Lots of the milk were prepared which consisted of unhomogenized raw, homogenized raw, unhomogenized pasteurized and homogenized pasteurized milk. Homogenization was at 2500 pounds pressure, with the milk at approximately 100° F. in the case of the raw milk and at the pasteurization temperature in the case of the pasteurized milk. Pasteurization was conducted at 145° F. for thirty minutes.

The following mixtures of milk were prepared: (a) unhomogenized raw milk with homogenized pasteurized milk at a rate so that the samples con-

Received for publication April 2, 1941.
* Journal Article 515 (n. s.) from the Michigan Agricultural Experiment Station.

tained 0, 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 99, and 100 per cent of raw milk; (b) homogenized raw milk with homogenized pasteurized milk in the same proportions as stated above; and (c) unhomogenized raw milk with homogenized raw milk in the same ratios as in (a) and (b). These samples were titrated for increases in acidity, conveniently expressed as lactic acid, with 0.05N NaOH, and were studied organoleptically for the development of rancid flavor immediately after processing and preparing the various mixtures and after 1, 3, 7 and 10 days of storage at 35° to 40° F. The increase in titratable acidity was determined by subtracting the acidity of the unprocessed raw milk after the various storage periods from the titratable acidity of the mixtures after similar storage. The degree of rancidity was expressed numerically as follows: 0, no rancidity; 1, questionable; 2, slightly rancid; 3, distinctly rancid; 4, pronounced rancid. The numerically averaged flavor scores represent the average scores of two or more judges.

EXPERIMENTAL RESULTS

Lipolytic activity in mixtures of unhomogenized raw and homogenized pasteurized milk. The acidity data obtained from this series are portrayed in figure 1. The flavor results are shown in table 1.

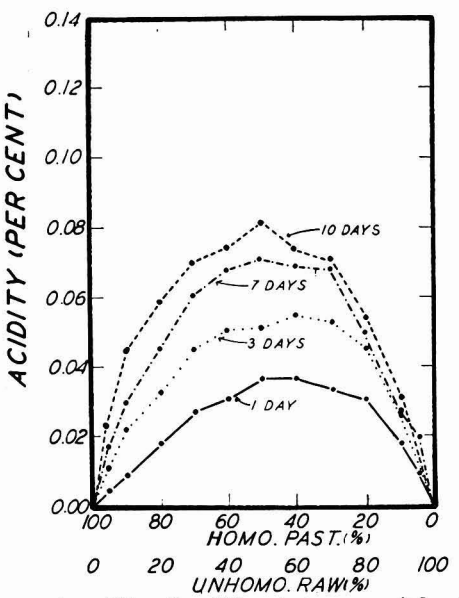


FIG. 1. The increase in acidity after different storage periods when unhomogenized raw milk was added to homogenized pasteurized milk in different proportions.

After three to five days storage, a slight increase in acidity over the control lot was noted in the homogenized pasteurized milk which contained as

little as one per cent of unhomogenized raw milk. When 5 per cent of unhomogenized-raw milk was added to the homogenized pasteurized milk an increase in acidity was observed after one day of storage. As the percentage of unhomogenized raw milk in the homogenized pasteurized milk was increased up to 50 per cent, a progressive increase in the titratable acidity occurred. The maximum increase in acidity was encountered when the ratio of unhomogenized raw milk to homogenized pasteurized milk was approximately one to one. Beyond this point, increased increments of unhomogenized raw milk resulted in a progressive decrease in acidity from the maximum. Small quantities of homogenized pasteurized milk in unhomogenized raw milk, such as one and three per cent, were sufficient to produce an increase in acidity after one to three days of storage, but seemed only slightly more effective in producing an increase in acidity than similar quantities of unhomogenized raw milk in the homogenized pasteurized milk.

TABLE 1

Development of rancidity due to lipolysis in milk made by mixing unhomogenized raw milk with homogenized pasteurized milk. (Average of three trials)

Sample		Rancidity* after			
% Unhomo. raw	% Homo. pasteurized	1 day	3 days	7 days	10 days
0	100	0.00	0.00	0.00	0.00
1	99	0.00	0.00	0.33	0.67
5	95	0.00	0.33	1.00	2.67
10	90	0.33	1.00	2.33	2.67
20	80	2.00	2.67	3.33	3.67
30	70	2.00	3.00	3.33	3.67
40	60	2.33	4.00	4.00	4.00
50	50	2.67	4.00	4.00	4.00
60	40	2.67	4.00	4.00	4.00
70	30	2.33	4.00	4.00	4.00
80	20	2.67	3.00	3.33	3.67
90	10	2.00	2.00	3.00	3.33
95	5	0.67	0.33	1.33	3.00
99	1	0.00	0.00	0.33	0.33
100	0	0.00	0.00	0.00	0.00

* Flavor intensity designated by numerical values ranging from 0 (no rancidity) to 4 (pronounced rancidity).

A questionable rancid flavor was detected in some samples of homogenized pasteurized milk containing one per cent of unhomogenized raw milk after 7 to 10 days of storage, whereas the flavor was pronounced in those samples which contained five per cent of unhomogenized raw milk after the same storage period. A further increase in the percentage of unhomogenized raw milk added to the homogenized pasteurizd milk caused a more intense rancid flavor to develop and also produced the flavor more rapidly. All the samples containing from 10 to 90 per cent of unhomogenized raw milk developed a

pronounced rancid flavor upon storage, with the flavor being definite after one day of storage in mixtures of 20 per cent or more. When the sample contained less than 10 per cent of homogenized pasteurized milk in unhomogenized raw milk the speed and intensity of the rancid flavor development was decreased.

Lipolytic activity in mixture of homogenized raw and homogenized pasteurized milk. The acidity data obtained from mixtures of homogenized raw and homogenized pasteurized milk are presented graphically in figure 2

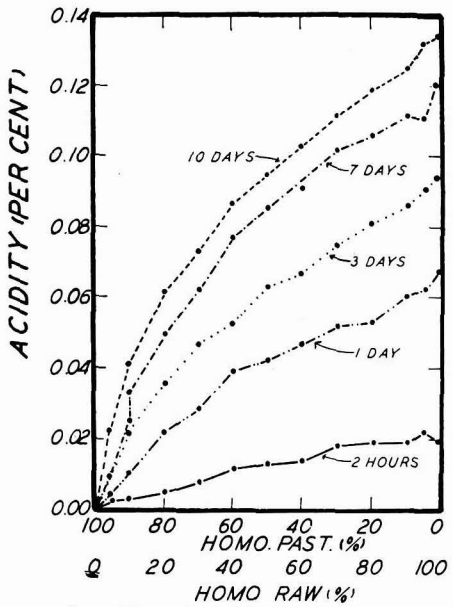


FIG. 2. The increase in acidity after different storage periods when homogenized raw milk was added to homogenized pasteurized milk in different proportions.

and the flavor results are presented in table 2.

When the homogenized raw milk was added to homogenized pasteurized milk, the acidity developed progressively as the increments of homogenized raw milk were increased. In the previous experiment the maximum acidity development occurred when the unhomogenized raw milk and homogenized pasteurized milk were mixed at a ratio of 1 : 1 In this experiment the maximum acidity developed in the 100 per cent homogenized raw milk. The slightly accelerated and persistent rate of lipolysis with such mixtures might be expected inasmuch as the maximum fat globule surface areas produced by the condition of the experiment were present throughout the series since both lots were homogenized. The development of rancid flavors, in general, closely followed the changes in titratable acidity.

TABLE 2

Development of rancidity due to lipolysis in milk made by mixing homogenized raw milk with homogenized pasteurized milk. (Average of three trials)

Sample		Rancidity after			
% Homo. raw	% Homo. pasteurized	1 day	3 days	7 days	10 days
0	100	0.00	0.00	0.00	0.00
1	99	0.00	0.00	0.00	0.67
5	95	0.00	1.33	1.66	2.33
10	90	0.00	1.66	3.00	3.33
20	80	1.33	2.67	3.67	4.00
30	70	1.33	3.00	4.00	4.00
40	60	2.00	3.67	4.00	4.00
50	50	2.67	3.67	4.00	4.00
60	40	3.33	3.67	4.00	4.00
70	30	3.33	3.67	4.00	4.00
80	20	3.67	4.00	4.00	4.00
90	10	3.67	4.00	4.00	4.00
95	5	3.67	4.00	4.00	4.00
99	1	4.00	4.00	4.00	4.00
100	0	4.00	4.00	4.00	4.00

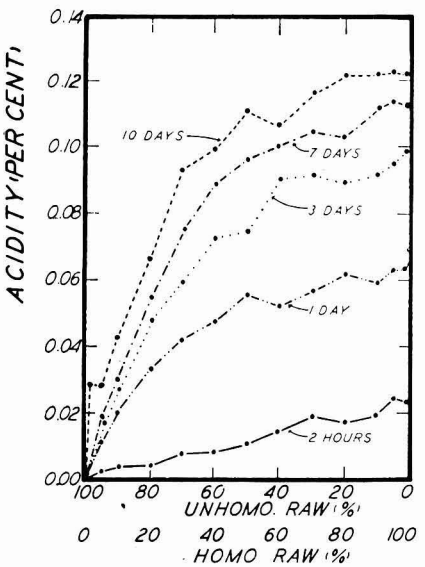


FIG. 3. The increases in acidity after different storage periods when homogenized raw milk was added to raw milk in different proportions.

Lipolytic activity in mixtures of unhomogenized and homogenized raw milk. The results secured when unhomogenized and homogenized raw milk were mixed in various proportions are shown by figure 3 and in table 3.

The same general trend in the development of rancidity and increased

acidity was noted in this series as with the second series. There seemed to be one exception, however; the acidity developed at a slightly faster rate as the percentage of homogenized raw milk in the unhomogenized raw milk increased up to 50 per cent, beyond which the increase was neither so rapid nor so great.

TABLE 3

Development of rancidity due to lipolysis in milk made by mixing raw milk with homogenized raw milk. (Average of three trials)

Sample		Rancidity after			
% Homo. raw	% Homo. pasteurized	1 day	3 days	7 days	10 days
0	100	0.00	0.00	0.00	0.00
1	99	0.00	0.00	0.00	0.00
5	95	0.00	1.00	1.00	2.00
10	90	1.50	2.00	2.00	2.50
20	80	2.00	2.50	3.00	3.50
30	70	2.00	3.50	3.50	3.50
40	60	2.00	4.00	4.00	4.00
50	50	2.00	4.00	4.00	4.00
60	40	2.00	4.00	4.00	4.00
70	30	4.00	4.00	4.00	4.00
80	20	4.00	4.00	4.00	4.00
90	10	4.00	4.00	4.00	4.00
95	5	4.00	4.00	4.00	4.00
99	1	4.00	4.00	4.00	4.00
100	0	4.00	4.00	4.00	4.00

Likewise, a slightly more intense rancid flavor was noted at one and three days in mixtures of homogenized raw with raw milk than similar mixtures with homogenized pasteurized milk. However, at the 10-day storage period, little difference was noted in the intensities of rancid flavor at comparable concentrations of homogenized raw milk.

DISCUSSION AND SUMMARY

A rancid flavor and an increase in acidity were found to develop readily on storage when raw milk was mixed with homogenized pasteurized milk. The results secured confirm earlier work (2, 3), that lipolytic activity is not confined solely to homogenized raw milk but to homogenized pasteurized milk as well provided active lipase is present. The maximum increase in acidity occurred when the ratio of raw milk to homogenized pasteurized milk was approximately one to one. As the percentage of raw milk in the homogenized pasteurized milk increased above 50 per cent, the increase in titratable acidity was found to be correspondingly less. When only a small percentage of the sample was homogenized pasteurized milk, very small increases in acidity occurred. These increases in titratable acidity were closely associated with the development of a rancid flavor.

The fact that the greatest increases in acidity in mixtures involving pasteurized milk occurred when the milk was approximately 50 per cent unhomogenized raw and 50 per cent homogenized pasteurized indicates that the amount of increased surface or increased surface activation caused by homogenization and the amount of lipase added by the raw milk are of approximately equal importance in the development of rancidity in homogenized milk. It would appear, therefore, that increases in acidity and the development of rancidity in homogenized raw milk are dependent upon the factors concerned with the increased surface and not upon an activation of lipase by homogenization.

Further evidence of the equal importance of the fat surfaces and the amount of lipase present is shown by the fact that when homogenized raw milk was added to homogenized pasteurized milk the rate of increase in acidity was only slightly greater than when unhomogenized raw milk was mixed with homogenized pasteurized milk. If lipase is activated by homogenization it would seem that these increases should have been considerably faster than those noted. The greater increase which did occur in the homogenized raw and homogenized pasteurized milk mixtures might be explained by the fact that all of the fat had been subjected to homogenization so that there was more fat surface exposed upon which the lipase could act than in the raw milk and homogenized pasteurized milk mixtures in which only a portion of the fat had been subjected to homogenization. In the latter case the amount of lipase added by the raw milk seemed to be the limiting factor in the development of rancidity. The lipase added to the homogenized pasteurized milk in the form of unhomogenized raw milk appeared to be just as effective in causing rancidity as was the lipase added by the homogenized raw milk.

From these studies it would seem that homogenized pasteurized milk contaminated with raw milk is as susceptible to lipolysis as homogenized raw milk. In addition, these results indicate the possibility if controlling the extent of the development of rancidity through the use of proper mixtures of homogenized pasteurized and raw milk.

CONCLUSIONS

Rancidity developed readily in mixtures of milk composed of (a) unhomogenized raw milk and homogenized pasteurized milk, (b) homogenized raw milk and homogenized pasteurized milk, and (c) unhomogenized raw milk and homogenized raw milk.

The development of rancidity seemed to be equally dependent upon the amount of lipase present and upon the amount of acceleration afforded by the newly created surfaces.

REFERENCES

(1) DORNER, W., AND WIDMER, A. Rancissement du lait par l' homogénésation. Le Lait, **11**: 545–564. 1931.

(2) DORNER, W., AND WIDMER, A. Homogenization and Milk Rancidity. Milk Plant Monthly, **21**: 7, 50–57, 86, 88. 1932.

(3) GOULD, I. A., AND TROUT, G. M. Lipase Action in Mixtures of Raw and Pasteurized Homogenized Milk. Mich. Agr. Expt. Sta. Quart. Bul. **22**: 2, 101–105. 1939.

(4) HALLORAN, C. P., AND TROUT, G. M. Effect of Viscolization on Some Physical and Chemical Properties of Milk. Abs. Proc. Amer. Dairy Sci. Assoc. 27th Ann. Meeting. 1932.

EFFECT OF CERTAIN FACTORS UPON LIPOLYSIS IN HOMOGENIZED RAW MILK AND CREAM*

I. A. GOULD

Department of Dairying, Michigan State College, East Lansing, Michigan

The acceleration of lipase action in raw milk by homogenization is now generally accepted. This acceleration has been attributed by some to increased surface area afforded the lipase by the breakdown of the fat globules and by others to a re-surfacing of the fat globules by material more susceptible to lipolytic action. Irrespective of the actual cause for the enormous and rapid rate of lipolysis in homogenized milk, evidence is accumulating which indicates that factors which affect lipase action in normal milk may not have the same effect on lipase activity in the homogenized product. A limited amount of information illustrating these differences has already been published. Additional evidence is presented in this paper.

Lipolytic action on fat in homogenized milk has been previously studied (3, 4, 7). Gould and Trout (4) found the acid degree of the fat (expressed in milliliters of N/1 NaOH per 100 grams of fat) to increase four-fold to six-fold within a few minutes after homogenization, and to increase on an average of 1,652 per cent within 24 hours. The author (3) observed considerable lipolysis to have occurred in fat obtained from milk homogenized at temperatures of 105 to 135° F., whereas slight fat splitting occurred in milk homogenized at 145° F. These temperatures are considerably above those which have been found to be effective in greatly inhibiting lipase action in normal unhomogenized milk (9, 10, 11, 12).

Lipase action in homogenized milk is apparently not affected by temperature activation which brings about marked changes in normal milk (6, 7). Krukovsky and Sharp (7) believe the difference is due to the fact that in the homogenized product the "lipase is already in the active state as a result of the resurfacing of the milk fat. . . ."

Another point of difference between lipase activity of normal and homogenized milk pertains to the temperature coefficient. Krukovsky and Sharp (7) found the temperature coefficient of the lipase action to differ depending upon whether the fat globules were normal or whether they had been "resurfaced." Fat globules with natural surfaces showed more rapid lipolysis with lower temperature whereas a reverse condition occurred with the emulsified fat.

A relationship between oxidative changes in the fat and lipolysis in normal milk is indicated by Davies (1) and Krukovsky and Sharp (8). Davies found peroxide formation to occur simultaneously with lipase action; the

Received for publication April 2, 1941.

* Journal Article 518 (n. s.) from the Michigan Agricultural Experiment Station.

peroxides being formed from oxidation of oleic acid which was freed by the fat splitting enzyme. This worker also found copper to be effective in inhibiting lipase activity, with 2 p.p.m. reducing lipolysis by approximately 70 per cent. Herrington and Krukovsky (5) found lipase action was reduced about 20 per cent by 0.2 and 0.4 p.p.m. of copper. Later, Krukovsky and Sharp (8) showed that the inactivating effect of copper, even in amounts of 2 to 8 p.p.m., was almost entirely prevented by removing the dissolved oxygen in the milk. They further found that the removal of oxygen increased the resistance of normal milk lipase to inactivation by heat. In earlier work, Dorner and Widmer (2) were unable to prevent rancidity in homogenized milk by removal of oxygen. However, rancidity was prevented by addition of carbon dioxide, but this was thought to be due to increases in the acidity of the milk by the gas.

In the study herein reported, results are presented which deal with the lipolysis which occurs in homogenized raw milk or cream and with the influence of certain factors upon the rate and extent of the lipolytic action.

EXPERIMENTAL PROCEDURE

Milk used in these trials was mixed-herd milk secured from the College creamery. Homogenization was at 500–1000 pounds pressure by means of a stainless-steel, commercial-size viscolizer. Milk or cream was homogenized at approximately 100° F., and a similar temperature was used when the raw milk was separated. To stop lipolysis following processing and storage, the milk or cream was pasteurized at 148–150° F. for 30 minutes. When a storage period was involved, a temperature of approximately 40° F. was used unless otherwise specified.

All measurements to determine lipolysis were conducted on the fat. Fat for analysis was obtained by churning the cream, followed by centrifuging and filtering the melted butter oil. The free fatty acids were measured by direct titration with 0.1 N NaOH using the procedure described previously (4). The values are expressed as acid degrees (the number of milliliters of 1.0 N NaOH per 100 grams of fat).

Although churning in many cases was comparatively difficult due both to homogenization and also to the subsequent lipolysis which frequently occurred, nevertheless, it was always possible to secure sufficient fat for the determinations. Perhaps the greatest churning difficulty was encountered with those samples containing relatively large quantities of formalin, this effect doubtless being partly due to the action of formalin on the proteins.

Peroxide values were determined by the Wheeler method (13), and the results are expressed as peroxide number (the millimols of peroxide oxygen in combination with one kilogram of fat).

EXPERIMENTAL RESULTS

Influence of copper on lipolysis. In this experiment, copper was added as a solution of copper sulfate to make concentrations in the milk of 2, 6 and 10 p.p.m. The copper was added to the milk before homogenization in certain trials and following homogenization in others. The results of several trials are shown in table 1.

TABLE 1

*Lipolysis in fat from homogenized milk as influenced by added copper**

Sample	Hours	Trial No.				Ave.
		1	2	3	4	
Control	0	3.67	4.55	3.40	4.20	3.96
	24	11.70	18.10	14.55	14.30	14.66
	72	14.30	23.70	15.20	19.60	18.20
2 p.p.m. Cu	24	12.15	18.80	15.95	13.20	15.03
	72	14.40	25.50	17.30	16.80	18.50
6 p.p.m. Cu	24	11.75	16.95	13.15	11.15	13.25
	72	15.00	24.60	15.20	14.50	17.20
10 p.p.m. Cu	24	11.75	18.80	12.60	13.25	14.10
	72	14.70	24.60	14.50	16.10	17.48

* Values expressed as acid degrees. Copper added following homogenization in first two trials and before homogenization in last two trials.

These results show the copper to have no significant effect on the extent of lipolysis whether added prior to, or subsequent to, homogenization. The acidity values for the copper-containing samples were practically the same as the control samples in every trial after 24 and 72 hours. Average values of the four trials show no distinct trend in fat acidity to accompanying increases in the copper content. The failure of copper, even in comparatively large amounts, to inhibit lipolysis in homogenized milk is at variance with the results reported by others for lipase action in the unprocessed product.

Influence of sodium chloride on lipolysis. Information is lacking concerning the influence of NaCl on lipolysis in homogenized milk or cream, although Pfeffer, *et al.* (10) report that NaCl was found to inhibit lipolysis in the unhomogenized product. Because of the scarcity of information on this subject, trials were conducted in which different concentrations of NaCl were added to homogenized raw cream In these trials, NaCl was added to the cream, at the rate of 0, 2, 5, and 8 per cent and the cream stored for 72 hours. The results are illustrated by figure 1.

This figure shows NaCl to have an inhibiting effect upon fat splitting, with the effect increasing directly with the salt concentration. The broken line represents the acid degree of the fat at the time of adding the salt. The results show that both the 5 and the 8 per cent levels were sufficient to inhibit lipolysis practically completely. If the 8 per cent concentration is taken

to be 100 per cent efficient in preventing lipase activity, then the calculated efficiencies of the 2 and 5 per cent levels would be 41 and 94 per cent respectively. On the basis of these findings it would appear that the lipase activity in homogenized milk or cream is retarded and even prevented by NaCl.

Influence of formalin on lipolysis. The recent work of Herrington and Krukovsky (5) dealing with the use of formalin in unhomogenized normal milk indicates that even small quantities of this chemical reduced the lipase action to a small fraction of its original value and that larger amounts were

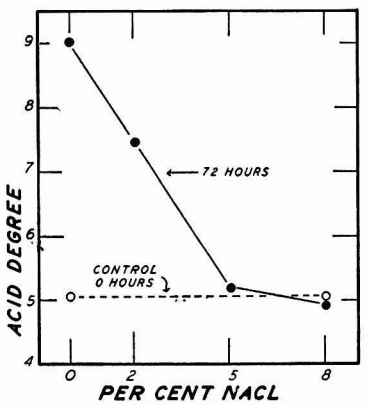


FIG. 1. The influence of sodium chloride on lipolysis in homogenized raw cream.

no more effective. Since the influence of formalin on lipolysis in homogenized milk or cream has not been studied, an experiment was conducted in this connection. Milk was warmed to 100° F., homogenized, and separated. The cream was standardized to 15 per cent fat and divided into 6 lots. These lots were treated as follows: Lot 1—Control—stored 0 hour; Lot 2—Control—stored 72 hours; Lot 3—5 ml. formalin per 3 pounds cream, stored 0 hour; Lot 4—1 ml. formalin per 3 pounds cream, stored 72 hours; Lot 5—3 ml. formalin per 3 pounds cream, stored 72 hours; Lot 6—5 ml. formalin per 3 pounds cream, stored 72 hours. The ratios of the formalin to cream were about 1:1350, 1:450, and 1:250. The results are presented in table 2.

These results show formalin in the amounts used to have no inhibitive effect upon the fat splitting action. The average values show the control lot to have changed from an acid degree of 4.97 to 8.25 within the 72 hour period, whereas the lot containing 1 ml. formalin underwent approximately the same extent of change and those with 3 and 5 mls. of formalin averaged even greater fat splitting during storage. A higher degree of lipolysis in the samples containing 3 and 5 mls. of formalin resulted in two of the three trials conducted.

TABLE 2

*Lipolysis in fat from homogenized milk as influenced by formalin**

Trial No.	Storage period (hours)					
	0		72			
	Formalin (ml.)		Formalin (ml.)			
	0	5	0	1	3	5
1	5.15	4.85	8.25	7.95	11.25	11.40
2	4.05	4.75	8.00	7.75	8.30	7.65
3	5.70	5.60	8.50	8.50	10.80	10.15
Avg.	4.97	5.07	8.25	8.07	10.12	9.73

* Formalin concentration as milliliters per 3 pounds of cream. Values expressed as acid degrees.

Influence of storage temperature on lipolysis. Dorner and Widmer (2), by using direct titration methods on homogenized milk, came to the conclusion that lipolytic activity varied directly with the storage temperature. Since the direct titration on the milk is a less sensitive method of measuring the acidity as produced by lipase activity, it appeared desirable to study the influence of storage temperature by means of fat titration. Therefore, an experiment was conducted in which 20 per cent cream was homogenized and then divided into four lots. Lot 1 was pasteurized at once; Lot 2 was stored for 72 hours at approximately 0° F., Lot 3 was stored for 72 hours at 35° F., and Lot 4 was stored for 72 hours at approximately 70° F. All of the samples were treated with a small amount of formalin (2 ml. per gallon), immediately following pasteurization to prevent excessive bacterial changes during storage. The results are illustrated by figure 2.

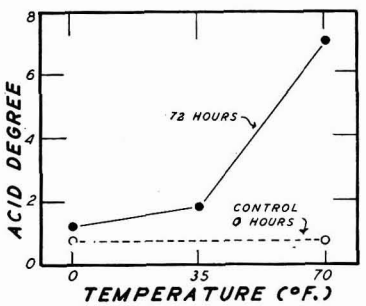


FIG. 2. The influence of the storage temperatures on lipolysis in homogenized raw cream.

These results show the lipase activity in homogenized cream to vary directly with the storage temperature. However, the average increases in free fatty acids at the two lower temperatures were slight, amounting to approximately 0.5 and 1.15 acid degrees for the 0° F. and the 35° F. tem-

peratures, respectively. Much greater lipase activity occurred at 70° F., with the acid degree increasing approximately 6.25 during the 72-hour period. Thus, the lipolytic activity was practically doubled between 0° F. and 35° F., and had increased approximately 12 fold at 70° F. These results had been secured prior to the appearance of the paper by Krukovsky and Sharp (7) dealing with "resurfaced" fat globules, but the same conclusions may be drawn even though the results were secured by somewhat different means, *i.e.,* that lipolysis in homogenized milk displays a normal temperature coefficient.

Influence of pasteurization of different milk fractions on lipolysis. Dorner and Widmer (2) found that when heated homogenized milk was mixed with raw skim milk the product became rancid. They concluded therefore that the causative agent was in the milk serum. Pfeffer, Weckel and Jackson (10) report similar conclusions for unhomogenized milk. In both of these studies the workers were actually referring to milk plasma rather than to milk serum. To study the problem of homogenized milk from the standpoint of changes in the acidity of the fat, trials were conducted in which fractions of 40 per cent cream and skim milk were remixed to make milk testing approximately 6 per cent. This prepared milk was then homogenized. In one lot the cream was pasteurized prior to mixing with the skim milk, in another lot the skim milk was pasteurized, whereas a third lot (the control) consisted of a mixture of the raw cream and raw skim milk. Fat acidity determinations were made at 0, 24, and 72 hours. The results are shown by figure 3.

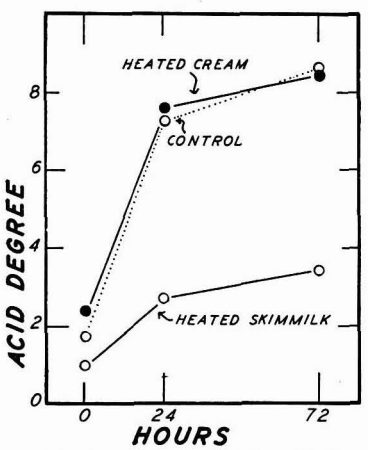


FIG. 3. The influence of heating cream and skimmilk fractions on lipolysis accelerated by homogenization.

This figure shows that although the heating of the skim milk markedly reduced the extent of lipolysis, a similar treatment of the cream had but

slight influence. It may be observed that the rate and amount of lipolytic action was not greatly different between the control lot and the lot in which the cream portion was heated. The fat acidity in the lot in which the cream was heated increased approximately 3.5 fold and the fat acidity in the control samples increased approximately 4.9 fold, thus indicating a somewhat greater increase in lipolysis in the latter. However, the actual percentage increase on the basis of the value at the 0-hour period may be of only secondary importance. For example, the change in fat acidity in the lot containing the heated skim milk amounted to approximately a 3.3 fold increase. Since the value at the 0-hour period was comparatively low, being approximately one-half that of the other lots at the same period, the total increase was much smaller than in the other lots. The increase during the 72 hour period in acid degrees amounted to 2.43 for the heated skim milk lot, as contrasted with 6.1 and 6.85 for the heated cream and control lots, respectively. The lipolysis which resulted when the skim milk fraction was pasteurized is doubtless due to the lipolytic activity of the plasma portion of the raw cream.

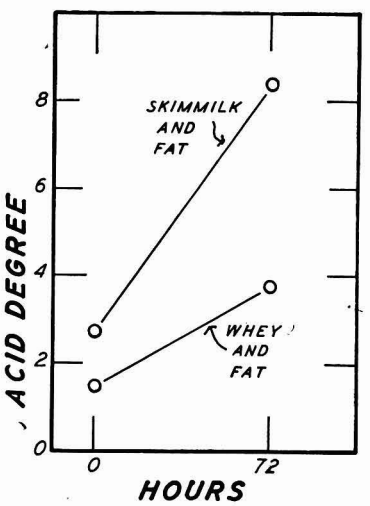


FIG. 4. Differences in lipolysis when fat is dispersed in skim milk and whey.

Influence of fractions of milk plasma on lipolysis. In this experiment, efforts were expended to determine the difference between skim milk and whey in affecting "homogenization" lipolysis. Raw skim milk was divided into two lots. In one lot the casein was precipitated by rennin and the whey filtered free of the coagulated protein. Melted butter oil secured from pasteurized cream was added both to the skim milk and the whey fractions to make a product testing approximately 4 per cent fat. The two lots were then homogenized, and fat was obtained for titration at 0 and 72 hours of storage. The results are portrayed by figure 4.

This figure shows greater lipolysis to occur in the case of skim milk-fat combination, although the whey-fat lot exhibited considerable lipolytic activity. The acid degree of the fat in the whey lot increased from 1.49 to 3.87, an increase of approximately 2.6 fold, whereas the acid degree change in the fat of the skim milk lot was from 2.69 to 8.44, an increase of about 3.1 fold. The fact that the whey was found to exhibit considerable lipolytic activity is at variance with the suggestion of Dorner and Widmer (2) to the effect that whey probably does not contain the agent which caused homogenized raw milk to become rancid. The results of this study do indicate, however, that a considerable portion of the lipolytic activity of milk is removed with the casein.

Relationship of lipolysis to oxidative changes in the fat. The results of Davies (1) and Krukovsky and Sharp (8) with lipase in normal milk indicate that oxidative changes are also involved with the lipolytic action. However, these workers found normal milk lipase to be inhibited by copper, whereas the results presented earlier in this paper show copper to be ineffective in preventing lipolysis in homogenized milk. This indicates that there may be no relationship between oxidative changes and lipolysis in the case of homogenized raw milk.

To determine if oxidative changes were occurring simultaneously with lipolysis, peroxide determinations* were conducted on the fat in the majority of the trials which were made in connection with this study. A summary of the results is given in table 3.

TABLE 3

Peroxide numbers of fat which has undergone different degrees of lipolysis

Number of samples	Acid degrees	Peroxide numbers	
		Average	Range
19	4 or less	0.32	0.00–0.65
4	4.1–6.0	0.31	0.14–0.50
19	6.1–8.0	0.39	0.01–1.00
5	8.1–10.0	0.32	0.15–0.60
35	10.1 or more	0.24	0.04–0.85

The results in this table offer evidence that lipolytic activity, accelerated by homogenization, is not related to oxidative changes, at least under the conditions of this experiment. The peroxide values were not significantly altered by marked changes in the degree of fat splitting and all of the values were relatively low indicating no appreciable amount of fat oxidation. On the basis of these results, it would appear that lipolysis in homogenized raw milk proceeds independently of oxidative changes in the fat.

* Credit is due Mr. R. C. Townley, graduate assistant in Dairy Manufactures, for the peroxide determinations.

DISCUSSION AND SUMMARY

The results secured in this study show that lipase action which occurs in homogenized raw milk usually reacts to external factors differently than does the lipase in normal milk. Other workers (1, 5, 8) have shown normal lipase activity to be greatly inhibited by copper, whereas in the studies herein presented, no such influence was detected in homogenized raw milk. Further, the work of Davies (1), and Krukovsky and Sharp (8) indicates oxidative changes occur simultaneously with, or perhaps precede, normal lipase action, but in these studies on "homogenization" lipolysis, no oxidative changes could be detected by means of the peroxide determinations, even though large amounts of fat splitting had occurred.

The fact that formalin had no inhibiting effect on lipolysis in homogenized raw milk would indicate that the lipase action in this product is different from that of normal milk, since Herrington and Krukovsky (5) found that formalin markedly lowers the lipase action in normal milk. However, Tarassuk (12) reported a study of milk from one cow in which formalin did not influence the activity of the lipase. On the basis of their formalin studies, Herrington and Krukovsky (5) expressed the belief that there are two lipases in milk, one of which is not affected by formalin. Dorner and Widmer (2) had previously suggested the presence of two lipases, one of which is extremely heat labile and which produces a sharp, bitter taste and marked acidity changes. These findings may indicate that the lipase in homogenized milk is different from the one responsible for the major portion of lipolytic activity in normal milk. However, additional proof of this is needed before definite conclusions may be drawn.

Further results of this study show that increasing the NaCl content decreases the lipolysis, whereas the lipase activity is increased by increases in the storage temperatures. Heating of the cream and skim milk fractions indicates that the lipase agent follows the plasma phase. Further, the lipolysis in a prepared fat-skim milk product was greater than in a similarly prepared mixture of fat and whey, although the fat dispersed in the whey did undergo appreciable splitting.

CONCLUSIONS

Lipolysis in homogenized raw milk is not affected, in all cases, by the same factors which have been found to influence the rate of fat splitting in normal milk. Whether these variations are due to different lipases or whether merely due to physical or physico-chemical changes involving the fat globules has yet to be definitely determined.

REFERENCES

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

(2) DORNER, W., AND WIDMER, A. Homogenization and Milk Rancidity. Milk Plant Monthly, 21: 7, 50–56, 86, 88. 1932.

(3) GOULD, I. A. Lipolysis in Raw Milk. Influence of Homogenization Temperature. Indus. and Engin. Chem., 32: 876–877. 1940.

(4) GOULD, I. A., AND TROUT, G. M. The Effect of Homogenization on Some of the Characteristics of Milk Fat. Jour. Agr. Res., 52: 1, 49–57. 1936.

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

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

(7) KRUKOVSKY, V. N., AND SHARP, P. F. Effect of the Properties of the Fat and of the Fat Globule Surface on Lipolytic Activity in Milk. JOUR. DAIRY SCI., 23: 11, 1109–1118. 1940.

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

(9) MATTICK, E. C. V., AND KAY, H. D. A Lipase (Tributyrinase) of Cow's Milk. I. Occurrence, Method of Estimation and Relationship to Lactation Cycle. Jour. Dairy Res., 9: 58–71. 1938.

(10) PFEFFER, J. C., JACKSON, H. C., AND WECKEL, K. G. Observations on the Lipase Activity in Cow's Milk. JOUR. DAIRY SCI., 21: 5, Abstr. 143. 1938.

(11) SHARP, P. F., AND DETOMASI, J. A. Increase in Non-Lactic Acidity in Raw Cream and Its Control. Internatl. Assoc. Milk Dealers, Lab. Sec. Proc. 25th Ann. Conv., pp. 3–20. 1932.

(12) TARASSUK, N. P. Rancid-flavored Milk: Its Cause and Control. Internatl. Assoc. Milk Dealers, Lab. Sec. Proc. 32nd Annual Convention, pp. 153–160. 1939.

(13) WHEELER, D. H. Peroxide Formation as a Measure of Autoxidative Deterioration. Oil and Soap., 9: 89. 1932.

OXIDATION-REDUCTION POTENTIALS AND THE OXIDIZED FLAVOR IN HOMOGENIZED MILK*

P. B. LARSEN, I. A. GOULD AND G. M. TROUT

Department of Dairying, Michigan State College, East Lansing, Michigan

Various workers have observed that homogenization tends to stabilize milk against oxidative changes (2, 3, 7, 11, 12, 13), but the mechanism by which the stabilization is produced has not been definitely ascertained. Ross (7), Dahle (1), and Thurston (11) expressed the belief that the adsorbed layer around the fat globules is the protective agent involved in homogenization. Earlier, Tracy, Ramsey and Ruehe (12) indicated that certain physical changes in the milk were involved which might have made the oxidized flavor less detectable.

Efforts have been made to correlate oxidation-reduction potentials with oxidized-flavor development. However, the results secured by Thurston (9), Greenbank (6), Webb and Hileman (14), and Fox (4) indicate that the potential values were not a definite indication of the tendency of normal milk to become oxidized. More of a relationship between oxidation-reduction potentials and oxidized-flavor development would be expected when the oxidation is induced by copper since Tracy, Ramsey and Ruehe (12), Gebhardt and Sommer (5), Thurston (9), Webb and Hileman (14), and Swanson and Sommer (8), found copper to cause a rise in the potential.

Although the role of homogenization in the control of flavor has been previously studied, no consideration has been given to the oxidation-reduction changes which may occur in homogenized milk under different conditions. Consequently, this study was conducted with the view of ascertaining these changes.

EXPERIMENTAL PROCEDURE

Mixed-herd milk obtained from the College creamery was used in the major portion of these studies. Pasteurization was accomplished at 143–145° F. for 30 minutes in stainless steel equipment. The milk was homogenized at the pasteurization temperature and at 2500 pounds pressure with a new style commercial-size viscolizer. The milk was cooled at once and stored at 34–40° F.

When copper was used, it was added as a weak solution of copper sulfate following the pasteurization and homogenization of the milk.

Oxidation-reduction potentials were determined by means of a Beckman pH meter using a bright platinum wire electrode in circuit with a saturated calomel cell. Usually about fifteen to twenty minutes were required before constant results could be obtained.

Received for publication April 2, 1941.

* Jour. Art. 516 (n. s.) from the Michigan Agricultural Experiment Station.

Organoleptic examinations were made by at least two experienced milk judges. The samples were numbered in such a manner that their identity remained unknown to the judges. The intensity of the oxidized flavor was indicated as follows: 0—no flavor; 1—questionable; 2—slight; 3—distinct; 4—strong.

EXPERIMENTAL RESULTS

Preliminary studies. A large number of preliminary trials were conducted in which milk was utilized which was normally susceptible to oxidized-flavor development. This milk was secured direct from the College farm. The results of these preliminary experiments showed the unhomogenized milk to become oxidized on storage, whereas the homogenized milk did not develop this defect. However, there was no significant difference in the oxidation-reduction (Eh) of the unhomogenized and homogenized milk, both of these milks tending to increase in potential during storage. These preliminary trials were the basis for additional studies.

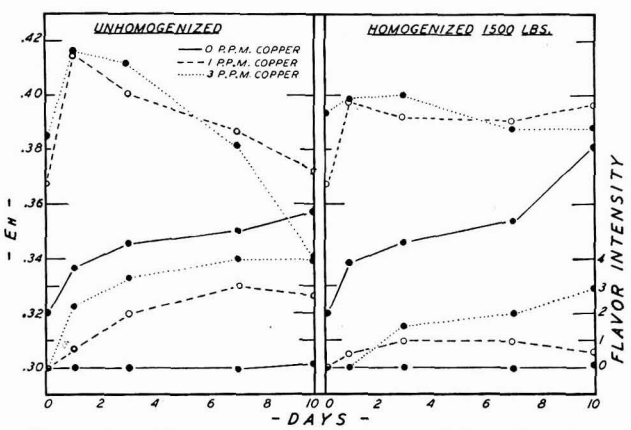


FIG. 1. Changes in oxidation-reduction potentials and flavor in unhomogenized and homogenized milk containing added copper. (Homogenization pressure 1500 pounds. Lower three curves represent flavor intensity.)

Oxidation-reduction potentials and oxidized flavor in copper-treated homogenized and unhomogenized milk. In these experiments trials were conducted in which the oxidized flavor was induced by the addition of copper to milk which was normally not susceptible to oxidation. Copper was added in concentrations of 0, 1, and 3 p.p.m. to homogenized and unhomogenized milk. Homogenization pressures used were 1500 and 2500 pounds.

The results of the trials in which the milk was homogenized at 1500 pounds pressure are shown in figure 1. Results are shown both for the unhomogenized and for the homogenized milk.

This figure shows the close similarity between the Eh values of the

unhomogenized and homogenized milk, irrespective of the differences in flavor changes. The lots which contained no added copper show a gradual change upward during the ten-day period. This occurred both in the homogenized and unhomogenized product. The addition of copper, either 1 p.p.m. or 3 p.p.m., markedly increased the potential of the milk. The most abrupt Eh rise in the copper-contaminated samples occurred during the first day; thereafter, the potential tended to decrease, with the decrease being especially noticeable in the unhomogenized milk.

From the standpoint of flavor, the unhomogenized milk to which copper was added developed distinct to strong oxidized flavors before the third day, with the 3 p.p.m. samples becoming oxidized within 24 hours. The untreated-unhomogenized milk remained practically free of oxidized flavor during this 10-day period. The untreated-homogenized milk, likewise, was free from oxidized flavor during the storage period, and the milk containing 1 p.p.m. of added copper showed only an extremely slight tendency towards oxidation. However, the 3 p.p.m. of copper were sufficient to overcome the stabilizing ability of 1500 pounds of homogenization as shown by the fact that the samples containing this amount of copper gradually developed a higher intensity of the oxidized flavor during storage. The oxidized flavor in the homogenized milk developed more slowly and to a lesser extent than in the unhomogenized milk similarly treated with copper.

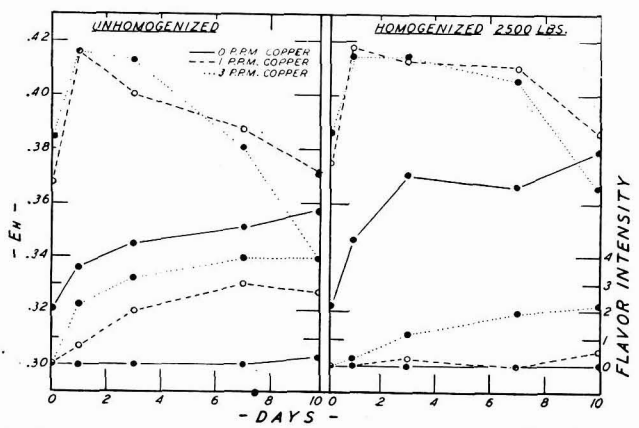


FIG. 2. Changes in oxidation-reduction potentials and flavor in unhomogenized and homogenized milk containing added copper. (Homogenization pressure 2500 pounds. Lower three curves represent flavor intensity.)

The results secured when 2500 pounds of pressure were used are illustrated by figure 2. These results are not greatly different from those in which 1500 pounds pressure was used. Again, the Eh values for the homogenized milk were similar to those for the unhomogenized, with the

copper causing marked increases in the potential in both cases. Flavor changes were also similar between these trials and those shown in figure 1. The 2500 pounds pressure was sufficient to prevent the development of the oxidized flavor in the presence of 1 p.p.m. of added copper but was unable to protect entirely the milk when 3 p.p.m. of copper were used. It should be emphasized in this connection that the copper was added following homogenization; thus the flavor stabilizing ability of the homogenization process is less than if the copper had been added prior to the pressure treatment (7, 13).

In general, the results illustrated in figures 1 and 2 show that oxidation-reduction potential changes are not definitely related to copper-induced oxidized flavor when homogenization is involved. The addition of copper does increase the potential in homogenized milk, whereas the oxidized flavor may or may not develop, depending on the protective power of the homogenization process.

SUMMARY AND CONCLUSIONS

Homogenization of milk tends to stabilize the milk against oxidation but has no influence on changes in the oxidation-reduction potentials. Trends in Eh were similar regardless of homogenization.

The mechanism by which homogenization prevents or retards oxidized-flavor development would appear not to be associated with oxidation-reduction potentials.

REFERENCES

(1) DAHLE, C. D. Preventing the Oxidized Flavor in Milk and Milk Products. Milk Dealer, 27: 5, 68. 1938.

(2) DAHLE, C. D., AND PALMER, L. S. The Oxidized Flavor in Milk from the Individual Cow. Pa. Agr. Expt. Sta. Bul., 347. 1937.

(3) DOAN, F. J., AND MINSTER, C. H. The Homogenization of Milk and Cream. Pa. Agr. Expt. Sta. Bul., 287. 1933.

(4) FOX, W. K. The Relationship of Lecithin Content of Milk to the Development of Oxidized Flavor. M. S. Thesis, Mich. State College. 1937.

(5) GEBHARDT, H. T., AND SOMMER, H. H. The Solubility of Metals in Milk. I. The Solubility of Copper Under Various Conditions. JOUR. DAIRY SCI., 14: 416–446. 1931.

(6) GREENBANK, G. R. Control of the Oxidized Flavor in Milk. Internatl. Assoc. Milk Dealers, Lab. Sect. Proc. 29th Ann. Conv., 101–116. 1936.

(7) ROSS, H. E. Homogenization as a Preventive of Oxidized Flavor. Milk Plant Monthly, 26: 5, 40–2, 44. 1937.

(8) SWANSON, A. M., AND SOMMER, H. H. Oxidized Flavor in Milk. II. The Relation of Oxidation-reduction Potentials to Its Development. JOUR. DAIRY SCI., 23: 7, 597–614. 1940.

(9) THURSTON, L. M. Oxidized Flavor in Milk. Internatl. Assoc. Milk Dealers, Lab. Sect. Proc. 28th Ann. Conv., 121–141. 1935.

(10) THURSTON, L. M. Theoretical Aspects of the Causes of Oxidized Flavor Particu-

larly from the Lecithin Angle. Internatl. Assoc. Milk Dealers, Lab. Sect. Proc. 30th Ann. Conv., 143–152. 1938.

(11) THURSTON, L. M., BROWN, W. C., AND DUSTMAN, R. B. Oxidized Flavor in Milk. II. The Effect of Homogenization, Agitation, and Freezing of Milk on Its Subsequent Susceptibility to Oxidized Flavor Development. JOUR. DAIRY SCI., 19: 11, 671–682. 1936.

(12) TRACY, P. H., RAMSEY, R. J., AND RUEHE, H. A. Certain Biological Factors Related to Tallowiness in Milk and Cream. Ill. Agr. Expt. Sta. Bul., 389. 1933.

(13) TROUT, G. M., AND GOULD, I. A. Homogenization as a Means of Stabilizing the Flavor of Milk. Mich. Agr. Expt. Sta. Quar. Bul., 21: 1, 21–31. 1938.

(14) WEBB, R. E., AND HILEMAN, J. L. The Relation of the Oxidation-Reduction Potential of Milk to Oxidized Flavor. JOUR. DAIRY SCI., 20: 1, 47–57. 1937.

LIVE WEIGHT OF COW AT VARIOUS STAGES OF LACTATION IN RELATION TO MILK-ENERGY YIELD

W. L. GAINES

Illinois Agricultural Experiment Station, Urbana, Illinois

In connection with the postulate previously advanced (1) that milk-energy yield per unit live weight is independent of live weight, it seems desirable to emphasize that the postulate is based on live weight at the start of the lactation and milk-energy yield for the first 8 months of the lactation. The 8-months feature avoids complications of advanced pregnancy, and probably affords as good a biological measure of dairy development as any longer period of the same lactation, even in farrow cows.

What is the relation of live weight to the 8-months yield, and how is it affected by the stage of lactation at which live weight is measured? In the present paper some published data by Dawson, Kopland and Graves (2)[1] are utilized in answer to the above question, particularly with reference to the effect of stage of lactation at which live weight is measured.

ANALYTICAL PROCEDURE AND RESULTS

Another way of expressing the above postulate is to say that yield is proportional to live weight, and the conformity of observed data to the postulate may be tested by fitting the equation, $FCM = aW^b$, (FCM = milk-energy yield in pounds of 4 per cent milk per day for the partial lactation; W = live weight of cow in pounds). If the exponent b, turns out to be 1, it indicates FCM is proportional to W; if more than 1, large cows yield more per unit live weight than small ones; if less than 1, small cows yield more per unit live weight than large cows. Primary interest with the present data (2) however is to see how the exponent, b, is affected by stage of lactation at which live weight is measured. From the published data live weight is taken at the first month of lactation; the second month of lactation; and so on to and including the twelfth month of lactation, with finally live weight as an average of the 12 monthly weights.

The exponent, b, in the equation, $FCM = aW^b$, has been determined by fitting a straight line, $FCM = a' + b'W$ and approximating b as, $b = b'(\overline{W}/\overline{FCM})$, where the overscore indicates the mean.[2] The values of b thus derived are given in table 1.

Received for publication April 4, 1941.

[1] The authors have generously supplied the monthly fat percentage data, supplementing their Table 11, which permit the computation of monthly milk-energy yields.

[2] On the theory that FCM/W is a fundamental criterion of dairy development, it is desirable to have FCM/W for individual cows and lactations. In case the individual FCM/W's have been fitted with the equation, $FCM/W = a'' + b''W$, (as in 3, fig. 1), b in the power equation may be approximated as $b = 1 + b''(\overline{W}/\overline{FCM/W})$. The derivation of these approximations will be explained in a later paper.

TABLE 1

*Relation of live weight in pounds (W) at various stages of lactation to partial lactation milk-energy yield (FCM)**

Month of lactation	Live weight, W			Correlation, r_{WFCM}		Value of b in $FCM = aW^b$†	
	Lowest	Highest	Average	10-mo.	8-mo.	10-mo.	8-mo.
1	1125	1399	1284	0.62	0.70	1.11	1.07
2	1140	1346	1236	0.64	0.67	1.47	1.32
3	1164	1374	1243	0.64	0.68	1.56	1.41
4	1172	1345	1250	0.66	0.67	1.70	1.49
5	1174	1334	1251	0.61	0.58	1.72	1.39
6	1133	1331	1250	0.52	0.54	1.21	1.07
7	1151	1342	1255	0.49	0.51	1.18	1.05
8	1156	1348	1261	0.25	0.25	0.71	0.60
9	1180	1369	1271	0.13	0.12	0.35	0.28
10	1207	1424	1290	0.32	0.34	0.69	0.63
11	1203	1469	1311	0.37	0.43	0.72	0.72
12	1261	1505	1343	0.30	0.38	0.60	0.64
Av.	1195	1342	1271	0.53	0.57	1.41	1.29

* This table is based on 11 records of 8 Holstein cows (2). The cows were fed exclusively on alfalfa hay throughout (consuming up to 48 pounds per cow per day). Because of deferred breeding the 10-months partial lactation FCM is included, in addition to the 8-months, since no cow carried a calf more than 169 days during the 10-months partial lactation. All cows were in the second or later lactations. The last line of the table deals with W as an average of the 12 monthly W's.

† The formula for deriving b, as given in the text, shows that in the power equation the exponent, b, is (approximately) the linear regression in terms of the means. The coefficient of correlation, r, is the linear regression in terms of the standard deviations. In the 8-months partial lactation, for example, the FCM series is identical for each of the 12 months, and any differences in the r/b ratios, as between months, must arise in differences in variability in live weight ($\sigma_w/\overline{W}$) as between months.

From the last column of table 1 it is observed that the exponent, b, in the power equation, is 1.07 where live weight is measured in the first month of lactation; reaches a high of 1.49 where live weight is measured in the fourth month of lactation; and reaches a low of .28 where live weight is measured in the ninth month of lactation. The relation of yield to live weight is greatly affected by the stage of lactation at which live weight is measured.

It will be noted that the coefficients of correlation between weight and yield follow a somewhat different cycle of changes than b. The highest correlation is found at the first month of lactation. On the whole it appears that if a single live weight determination is made at each lactation, the most desirable time is during the first month after calving. Furthermore, for practical use in the field (in distinction to experimental work), it seems that this one point of measurement in each lactation may be quite adequate.[3]

[3] The postulate that FCM/W is independent of W (8-months FCM and first-month W) is set up as a philosophy of what may reasonably be expected as between dairy cows of varying sizes, rather than as a statement of what now prevails among dairy cows. While the present 11 records are too few in number to be at all conclusive, statistically, they do afford an instance of observation in which FCM/W, within herd and within breed,

SUMMARY AND CONCLUSIONS

Eleven records of Holstein cows are fitted with the equation, $FCM = aW^b$, in which W is live weight measured successively at monthly intervals during the lactation period, and FCM is milk-energy yield for the first 8-months of the lactation period. There is a vast difference in the resulting value of b (.28 to 1.49), according to the stage of lactation at which live weight is measured. FCM and W are most closely related where live weight is measured in the first month of lactation ($r = .70$).

The above records and other experimental evidence indicate that, within a dairy breed and within a herd (comparable environment) FCM is proportional to the 1.07 power of live weight, where live weight is measured in the first month of lactation. Both practical and biological considerations indicate the desirability of estimating live weight of the cow in the first month of each lactation in D.H.I.A. and similar milk-recording work. Measuring live weight in this way, it appears sound to measure lactation performance of the cow at each lactation in terms of FCM/W, that is, milk-energy yield for the 8-months partial lactation per unit live weight in the first month of the lactation.

REFERENCES

(1) GAINES, W. L. Correction Factors and Germ Plasm in Dairy Cattle Breeding. Amer. Soc. Anim. Prod. Proc., 53–54. 1935.

(2) DAWSON, J. R., KOPLAND, D. V., AND GRAVES, R. R. Yield, Chemical Composition and Feeding Value for Milk Production of Alfalfa Hay Cut at Three Stages of Maturity. U.S.D.A. Tech. Bul. 739. 1940.

(3) GAINES, W. L. Live Weight and Milk-energy Yield in Holstein Cows. JOUR. DAIRY SCI., 23: 3, 259–265. 1940.

(4) GAINES, W. L., RHODE, C. S., AND CASH, J. G. Age, Live Weight and Milk-energy Yield in Illinois Cows. JOUR. DAIRY SCI., 23: 10, 1031–1043. 1940.

---

is substantially independent of W, that is, referring to the observed fact that FCM is proportional to the 1.07 power of live weight.

Another similar instance is afforded by a previous analysis (3) of 66 records of Holstein cows (heavily grain fed) reported by the Cornell Station, including accurate initial live weight and partial lactation milk-energy yield for 280 or 259 days. From these records (3, fig. 1) applying the method of footnote 2, it is found that $b = 1.07$, as an average. That is, in these experimental records, also, FCM is proportional to the 1.07 power of live weight.

The only other records, based specifically on first-month weight and 8-months yield, known to the writer consist of a more numerous (1152) but less accurate body of D.H.I.A. records, in which it was found (4, footnote 3) that within herd and within breed (Holstein or Jersey) FCM was proportional to about the $\frac{3}{4}$ power of live weight. It now comes to light that the scale of the chest-girth live-weight tape used in estimating live weight was erroneous, grossly over-estimating the weight of large cows and grossly underestimating the weight of small cows. It appears likely that removal of this bias in the weight estimate would result in showing in these records also that FCM was proportional to the first-month live weight (rather than the $\frac{3}{4}$ power of weight).

THERMODURIC BACTERIA IN MILK. III. THE EFFECT OF CHANGING AGAR AND TEMPERATURE OF INCUBATION FOR PLATE COUNTS ON THE PROBLEM OF THERMODURIC BACTERIA IN MILK

J. L. HILEMAN, CLARENCE MOSS AND BETTY STEAD
Dairymen's League Co-Operative Association, Inc., Syracuse, N. Y.

In 1939 the American Public Health Association (1) adopted a much richer medium than had hitherto been used as the standard for plate counts of bacteria in milk. It has also been proposed that the temperature of incubation for the plates be reduced from 37° C. to 32° C. (2). Several investigations of the effect of the new medium on counts of various dairy products have been published (3, 4, 5, 6, 7, 8). These investigations do not clearly show whether the per cent increase in count is different in the case of raw milk than it is in the case of pasteurized milk, although several investigations on a medium similar to the new standard medium (tryptone glucose skimmilk agar) indicate that pasteurized milk gives a much greater per cent increase in count than does raw (9, 10, 11). Similarly, the work of Kelly shows that lowering the temperature of incubation from 37° C. to 32° C. causes a greater per cent increase in count with pasteurized milk than with raw milk (12). These reports would seem to indicate that either enrichment of the agar or lowering of the temperature of incubation would tend to favor the growth of thermoduric bacteria. However, the comparisons available in the literature are not direct comparisons of counts on the same milk before and after pasteurization, and there is, in general, little known about the history of the samples. For that reason it seemed desirable to determine the effect of these variations in methods of enumerating bacteria on the counts on the same milk both before and after pasteurization, so that it would be possible to state clearly the effect of changing the method of counting on the number of thermoduric bacteria disclosed and on the per cent of the total organisms counted in the raw milk which are reported to be thermoduric.

EXPERIMENTAL

The work reported here was done in a bottling plant receiving approximately 70,000 pounds of milk daily from about 300 producers. One hundred lots of milk were examined. For each lot, about 300 gallons of raw milk were drawn into a glass-lined pasteurizer, and after agitation a sample was withdrawn in a sterile vial by dipping the vial (held in a clamp) into the milk. The milk in the pasteurizer was heated to 143°–144° F. (61.6°–62.2° C.), held for 30 minutes, and cooled in the pasteurizer to about 130°

Received for publication April 14, 1941.

F. (54.4° C.). A sample of this pasteurized milk was withdrawn in a sterile vial, quickly cooled in ice water, and used for a bacteria count.

The raw milk samples were divided into three portions. One was used for a bacteria count while raw. A second was pasteurized in the laboratory at 143°–144° F. for 35 minutes. A third was pasteurized in the laboratory at 160.5°–161.5° F. (71.4°–71.9° C.) for 16 seconds. Heating to pasteurizing temperature required about 27 minutes in the plant pasteurization, 4 minutes in the laboratory low-temperature pasteurization, and 2.5 minutes in the laboratory high-temperature pasteurization. Cooling was very rapid in both laboratory pasteurizations, and cooling to 130° F. in the plant required about 5 minutes.

Four plates were made on each sample, or 1600 plates for the 100 lots of milk. Two of the four plates were poured with the old standard nutrient agar, and two with tryptone glucose extract milk agar, both media being made from Difco Dehydrated products. One plate with each agar was incubated at 37° C., the other at 32° C., the incubation period being very close to 48 hours. A Quebec Colony Counter was used in counting colonies. Adequate blanks were made to assure sterility of all materials.

The experiments covered a period from October, 1940, through January, 1941. Because of the large amount of space that would be required to show in detail each of the 1600 counts, averages were made of the counts on the

TABLE 1

Averages of bacteria counts per milliliter on 100 lots of milk when raw and after pasteurization by three methods, when determined on two agars and at two temperatures of incubation

Treatment of milk	Method of counting		Bacteria per milliliter	Per cent of count on old agar at 37° C.	Per cent of count on new agar at 32° C.	Per cent of raw milk count (or per cent of thermodurics)
	Designation	Description				
Raw	A	Old agar at 37° C.	72,830	100.0	57.4	.....
	B	Old agar at 32° C.	101,230	138.9	79.8	.....
	C	New agar at 37° C.	90,540	124.3	71.3	.....
	D	New agar at 32° C.	126,820	174.1	100.0	.....
Pasteurized in the plant at 61.6° C. for 30 minutes	A	Old agar at 37° C.	6,725	100.0	26.5	9.2
	B	Old agar at 32° C.	13,769	204.7	54.2	13.6
	C	New agar at 37° C.	15,045	223.7	59.2	16.6
	D	New agar at 32° C.	25,395	377.6	100.0	20.0
Pasteurized in the laboratory at 61.6° C. for 35 minutes	A	Old agar at 37° C.	4,806	100.0	21.9	6.5
	B	Old agar at 32° C.	11,577	240.8	52.7	11.4
	C	New agar at 37° C.	12,226	254.3	55.7	13.5
	D	New agar at 32° C.	21,932	456.3	100.0	17.2
Pasteurized in the laboratory at 71.6° C. for 16 seconds	A	Old agar at 37° C.	5,319	100.0	24.3	7.3
	B	Old agar at 32° C.	12,568	236.2	57.5	12.4
	C	New agar at 37° C.	12,512	235.2	57.2	13.8
	D	New agar at 32° C.	21,853	410.8	100.0	17.2

raw and the three kinds of pasteurized milk, as determined on the two agars and at the two temperatures of incubation. These average counts are shown in table 1 in the first or left-hand column.

The second column is designed to show the numerical relationship between the counts on the old agar at 37° C. and the counts by the other three methods of counting.

The third column is similar to the second, except that it shows the relationship between the count on the new agar at 32° C. and the counts by the other three methods of counting. If it is assumed that the count on the new agar at 32° C. gives the maximum possible count, or a count that approaches all of the organisms present (an assumption that is certainly not entirely justified), then the figures given in the third column represent the percentage of the total organisms present that will grow under the conditions specified.

The fourth or right-hand column shows the per cent of the organisms present in the raw milk, as determined by the four methods of counting, that will survive each of the three methods of pasteurization.

It is possible, on the basis of the counts made by the four methods, and designated in table 1 as A, B, C and D, to divide the organisms growing on the plates into four groups (shown in table 2 as classes 1, 2, 3 and 4), as follows:

1. Those that will grow on the old agar at 37° C. This is obviously the total count on the old agar at 37° C.
2. Those that require the temperature of incubation to be reduced from 37° C. to 32° C. but do not require enrichment of the agar. This is the difference between the count on the old agar at 32° C. and that on the old agar at 37° C. or (B–A).
3. Those that require enrichment of the agar but not reduction of the temperature of incubation. This is the difference between the count on the new agar at 37° C. and the count on the old agar at 37° C. or (C–A).
4. Those that require both enrichment of the agar and reduction of the temperature of incubation. This is a more complicated calculation, involving all four counts. It is done as follows:
    a. If A, the count on the old agar at 37° C., is subtracted from C, the count on the new agar at 37° C., the result is the effect on the count of changing the agar at 37° C. This may be expressed at (C–A).
    b. If B, the count on the old agar at 32° C., is subtracted from D, the count on the new agar at 32° C., the result is the effect on the count of changing the agar at 32° C. This may be be expressed as (D – B).
    c. If there are present any organisms requiring both that the

agar be enriched and the temperature of incubation be lowered before growth will occur, then (D – B) will be greater than (C – A), and the difference between these two values will give the number per milliliter of such organisms present.

d. Then the number of organisms of class 4 is given by (D – B) – (C – A), which is equivalent to (D + A – B – C). Thus, the number of organisms of this class was determined by adding D and A, and from that sum subtracting both B and C.

Table 2 shows the result of making the calculations described in the preceding paragraph. The four columns of figures have the same significance as in table 1.

TABLE 2

Numbers per milliliter of four classes of organisms in 100 lots of milk when raw and after pasteurization by three methods, when determined on two agars and at two temperatures of incubation

Treatment of milk	Class number	Description of class of organism	Number per milliliter	Per cent of number growing on old agar at 37° C.	Per cent of number growing on new agar at 32° C.	Per cent of number in raw milk (or per cent of thermodurics)
Raw	1	Grow on old agar at 37° C.	72,830	100.0	57.4	.....
	2	Require 32° C. but not new agar	28,400	38.9	22.4	.....
	3	Require new agar but not 32° C.	17,710	24.3	14.0	.....
	4	Require both new agar and 32° C.	7,880	10.8	6.2	.....
Pasteurized in the plant at 61.6° C. for 30 minutes	1	Grow on old agar at 37° C.	6,725	100.0	26.5	9.2
	2	Require 32° C. but not new agar	7,044	104.7	27.7	24.8
	3	Require new agar but not 32° C.	8,320	123.1	32.8	46.9
	4	Require both new agar and 32° C.	3,306	49.1	13.0	41.9
Pasteurized in the laboratory at 61.6° C. for 35 minutes	1	Grow on old agar at 37° C.	4,806	100.0	21.9	6.5
	2	Require 32° C. but not new agar	6,771	140.8	30.9	23.8
	3	Require new agar but not 32° C.	7,420	154.4	33.8	41.8
	4	Require both new agar and 32° C.	2,935	61.0	13.4	37.2
Pasteurized in the laboratory at 71.6° C. for 16 seconds	1	Grow on old agar at 37° C.	5,319	100.0	24.3	7.3
	2	Require 32° C. but not new agar	7,249	136.2	33.2	25.5
	3	Require new agar but not 32° C.	7,193	135.2	32.9	40.6
	4	Require both new agar and 32° C.	2,092	39.2	9.6	26.5

DISCUSSION

Examination of the data in tables 1 and 2 would seem to justify the following conclusions:

1. Either lowering of the temperature of incubation from 37° C. to 32° C., or enriching the agar, or making both changes simultaneously, results in a higher bacteria count with either raw or pasteurized milk (table 1).
2. With either raw or pasteurized milk, changing both temperature of incubation and composition of the agar simultaneously results in a greater increase in count than making either change alone (table 1).
3. The per cent increase in count due to any of these changes in methods of enumeration is from two and one-half to five times as great with pasteurized milk as with raw milk (table 1).
4. The most logical explanation of this difference between raw and pasteurized milk would seem to be as follows:
    a. Only a few of the raw-milk organisms that can grow on the old agar at 37° C. are capable of surviving pasteurization. The three methods of pasteurization used gave 6.5, 7.3 and 9.2 as the per cent of thermoduric bacteria among these raw-milk organisms of Class 1 (table 2).
    b. Of the bacteria in raw milk which require that the temperature of incubation be reduced, or that the medium be enriched, or that both changes be made before growth is possible on the plates, relatively large percentages are thermoduric. The fourth or right-hand column of table 2 shows that, in the milk examined, there were from 24 to 46 per cent of thermoduric bacteria among these raw-milk organisms of Classes 2, 3 and 4.
5. The discussion immediately above means that changing from the old standard method of making plate counts in any one of the three ways studied results not only in higher total counts on both raw and pasteurized milk, but also results in a greater percentage of the organisms counted in the raw milk being classified as thermoduric. Thus, with all three methods of pasteurization used, the per cent of thermoduric bacteria (table 1) was more than twice as great when using the new agar at 32° C. as when using the old agar at 37° C.
6. The organisms requiring for their growth both that the old agar be enriched and that the temperature be reduced from 37° C. to 32° C. (Class 4 in table 2) are obviously capable of growing only under rather restricted environmental conditions. That being the case, it might be expected that they would not be as numerous as other organisms capable of growing under a wider range of conditions. It is

interesting to note (table 2) that organisms of Class 4 actually do form the smallest of the four classes in both the raw milk and the milk pasteurized by each of the three methods.

7. Laboratory high-temperature, short-hold pasteurization tends to give higher counts than does laboratory low-temperature, long-hold pasteurization (table 1).
8. As the method of enumeration is changed so as to give higher and higher counts, the difference in count between milk pasteurized by the two laboratory methods decreases.

There is in the literature evidence tending to support conclusions one to five above (9, 10, 11, 12), and also conclusion seven (13, 14, 15, 16, 17, 18, 19, 20, 21, 22). It seems probable, therefore, that these conclusions have a fairly broad applicability to many milk supplies, although an effective campaign to reduce to a very low point the number of thermoduric bacteria in a given milk supply might alter the picture somewhat. Any idea as to how broadly conclusions six and eight could be applied to other milk supplies must await further investigation by other workers and with other milk supplies.

It should be pointed out that the calculations on which table 2 is based imply the assumption that there were in the samples no organisms growing at 37° C. but not at 32° C., or growing on the old but not on the new agar. That assumption, of course, is not entirely justified, but how many such organisms occurred in the samples examined could not be determined by the methods used.

The control and elimination from milk supplies of thermoduric bacteria is costing the dairy industry and the milk producer large sums of money. The problem assumes even greater magnitude when Departments of Health *lower* the number of bacteria they will allow in pasteurized products, as has been done recently in several localities. To illustrate this, a reduction during 1940 in allowable bacteria count in pasteurized milk from 50,000 to 30,000, or a decrease of 20,000, appears to be a reduction of 40.0 per cent. However, if this is compared with June, 1939, before the new agar became official, the picture is considerably changed. Table 1 shows, for the average of 100 comparisons on commercially pasteurized milk, an increase of from 6,725 to 15,045 bacteria per milliliter, or 123.7 per cent in changing from the old to the new agar at 37° C. At this rate, a sample that would have shown a count of 50,000 bacteria per milliliter in June of 1939 would have a count of 111,850 at present. Therefore, enforcement of a standard calling for a maximum of 30,000 per milliliter at the present time actually means a reduction of 73.1 per cent as compared with two years ago. If the temperature of incubation is also changed, another increase in count, of even greater magnitude, will occur, which will increase still more the difficulty and expense of keeping the bacteria count of pasteurized milk at very low levels.

SUMMARY

Data on 100 lots of milk examined both before and after pasteurization shows that lowering the temperature of incubation for plate counts from 37° C. to 32° C. or changing from the old standard agar to tryptone glucose extract milk agar, or making both changes simultaneously, not only results in higher counts on both raw and pasteurized milk, but also results in a higher percentage of the organisms counted in the raw milk being classified as thermoduric. Three different methods of pasteurization all gave this same result.

REFERENCES

(1) American Public Health Association. Standard Methods for the Examination of Dairy Products. 1939.

(2) PEDERSON, C. S., AND YALE, M. W. Effect of Temperature of Incubation upon Agar Plate Counts of Milk. Amer. Jour. Pub. Health, 24: 477. 1934.

(3) ABELE, C. A. Results of Bacterial Plate Counts of Milk on Three Media and at Two Temperatures of Incubation. Amer. Jour. Pub. Health, 29: 821. 1939.

(4) ABELE, C. A., AND DAMON, S. R. A Comparison of Plate Counts of Raw Milk on the Old Standard Nutrient Agar and on the New Standard T.G.E.M. Agar. Jour. Milk Tech., 2: 222. 1939.

(5) ABELE, C. A. Findings in Comparative Studies of Old and New Culture Media. Jour. Milk Tech., 3: 24. 1940.

(6) NELSON, F. E. The Effect of the New Standard Milk Agar on the Plate Count of Dairy Products. Jour. Bact., 39: 263. 1940.

(7) LIND, H. E. Symposium on Tryptone-glucose-extract-milk Agar. Jour. Milk Tech., 3: 208. 1940.

(8) DIXON, DOROTHY. Symposium on Tryptone-glucose-extract-milk Agar. Discussion. Jour. Milk Tech., 3: 210. 1940.

(9) BOWERS, C. S., AND HUCKER, G. J. The Composition of Media for the Bacteriological Analysis of Milk. N. Y. (Geneva) Agr. Expt. Sta. Tech. Bul. 228. 1935.

(10) BOWERS, C. S., AND HUCKER, G. J. Further Studies of the Composition of Media for the Bacteriological Analysis of Milk. Amer. Jour. Pub. Health, 26: 350. 1936.

(11) PHELAN, J. F. Some Effects of the Proposed New Bacteriological Techniques. JOUR. DAIRY SCI., 19: 385. 1936.

(12) KELLY, E. Report of Collaborator on Cooperative Work with Proposed Changes in Medium and Temperature of Incubation. Internatl. Assoc. Milk Dealers, Lab. Sect. Proc., 29: 50. 1936.

(13) KRUEGER, P. F. Short-time Pasteurization—A Sanitarian's View. Internatl. Assoc. Milk Dealers Assoc. Bul., 31st year: 334. 1939.

(14) ANONYMOUS (Editorial). Advantages of High-temperature, Short-time Pasteurization. Dairy Indus., August, 1938.

(15) DOTTERER, W. D. High Temperature Short Time Pasteurization. Dairy Mfrs. Confs., Univ. Wisconsin, p. 163. 1939.

(16) DOTTERER, W. D. Short Time High Temperature Pasteurization—A Milk Dealer's View. Internatl. Assoc. Milk Dealers, Assoc. Bul., 31st year: 332. 1939.

(17) PARFITT, E. H. Some Bacteriological Problems Involved in High-temperature Short-time Pasteurization. Ann. Rept. N. Y. State Assoc. Dairy and Milk Insps., 13: 195. 1939.

(18) QUIN, J. D., AND BURGWALD, L. H. High Short Holding and Long Low Holding. Milk Plant Monthly, 22 (2): 26. 1933.

(19) WORKMAN, W. T. Discussion of a paper by E. H. Parfitt. (See reference 17.) Ann. Rept. N. Y. State Assoc. Dairy and Milk Insps., 13: 212. 1939.

(20) YALE, M. W. Bacteriological Studies of a High-temperature, Short-time Pasteurizer. N. Y. (Geneva) Agr. Expt. Sta., Tech. Bul. 207. 1933.

(21) PRUCHA, M. J., AND PARFITT, E. H. High Temperature Pasteurization. Manual Dairy Mfrs. Confs., Univ. Illinois, p. 213. 1938.

(22) HILEMAN, J. L., AND LEBER, HENRY. High-temperature, Short-time Pasteurization and Its Practical Application to the Dairy Industry. Jour. Milk Tech., 4: 128. 1941.

THE DETERMINATION OF FAT IN THE PRESENCE OF FREE FATTY ACIDS. II. DIFFERENCES IN THE BEHAVIOR OF INDIVIDUAL ACIDS IN THE MOJONNIER TEST

MORTIMER P. STARR
Brooklyn College, Brooklyn, New York*
AND
B. L. HERRINGTON
Cornell University, Ithaca, New York

In a previous report (8) we demonstrated that approximately 24 per cent of a mixture of fatty acids which resembled completely hydrolyzed butterfat was extracted in the Mojonnier test and determined as butterfat. This substantiated earlier reports (1, 4) of low Mojonnier fat tests in rancid dairy products, and indicated, also, that not all of the free fatty acid was retained in the ammoniacal layer. In those experiments, we used a mixture of free fatty acids which resembled that which would have resulted from the hydrolysis of butterfat by a *non-specific* lipase. Davies (2) states that ". . . the lipases are . . . specific in their action . . . thus lipases from various sources will show different rates of liberation of free fatty acids and a different distribution of such acids, although it is recognized that it is the unsaturated acids, *e.g.*, oleic acid, which are liberated in greatest amount. . . ." For this reason, data on the recovery of individual fatty acids would be of some value in interpreting the decrease in fat test when examining rancid samples by the Mojonnier method.

EXPERIMENTAL

Quantities of a butter oil, which had been prepared from a fresh, high quality, unsalted, sweet-cream butter, and which contained 99.1 per cent of Mojonnier-extractable fat, were weighed into Mojonnier flasks. To each flask was added a weighed amount of *one* of the following fatty acids: butyric, lauric, myristic, palmitic, stearic, oleic. The stoppered flasks were then warmed in a water bath to melt the contents, shaken to mix the fat and acid, and then examined for "fat content" by means of the conventional Mojonnier test for butter (5). The data obtained in this manner are shown in table 1.

These data confirm our previous report that a certain fraction of free fatty acid is extracted and determined as butterfat when rancid butterfat is examined by the Mojonnier method for fat.

The quantity of free fatty acid which is extracted depends upon the nature of the fatty acid. Undoubtedly a number of more-or-less obvious

Received for publication April 16, 1941.

* Contribution 34 from the Department of Biology.

TABLE 1

Mojonnier analyses of samples consisting of butter oil plus a free fatty acid

No.	A	B	C	D	E	F	G
	Fat. Corrected weight of Mojonnier extractable fat in butter-oil	Fatty acid	Total sample (A + B)	Recovered by extraction	Fatty acid not recovered		Average
					(C − D)	$\frac{E \times 100}{B}$	
	mg.	*mg.*	*mg.*	*mg.*	*mg.*	%	%
				Oleic			
1	472.9	0.0	472.9	472.9			
2	379.0	107.6	486.6	408.8	77.8	72.3	
3	339.9	160.0	499.9	384.0	115.9	72.4	
4	195.5	271.6	467.1	269.3	197.8	72.8	
5	0.0	909.0	909.0	128.0	781.0	(86.0)*	72.5
				Stearic			
6	349.4	0.0	349.4	349.4			
7	279.5	29.7	309.2	285.7	23.5	79.1	
8	387.4	60.8	448.2	400.9	47.3	77.8	
9	190.6	220.5	411.1	239.7	171.4	77.7	
10	0.0	177.1	177.1	38.6	138.5	78.2	78.2
				Palmitic			
11	195.6	0.0	195.6	197.5			
12	469.4	0.0	469.4	470.0			
13	375.8	67.1	442.9	390.4	52.5	78.2	
14	200.0	66.5	266.5	215.1	51.4	77.3	
15	275.0	114.3	389.3	302.4	86.9	76.0	
16	363.3	157.5	520.8	403.2	117.6	75.3	
17	256.2	177.3	433.5	297.8	135.7	76.5	
18	0.0	121.9	121.9	28.2	93.7	76.9	76.7
				Myristic			
19	352.0	0.0	352.0	352.0			
20	286.8	57.7	344.5	291.4	53.1	92.0	
21	182.8	311.7	494.5	208.0	286.5	91.9	
22	0.0	223.4	223.4	1.0	222.4	(99.6)*	92.0
				Laurie			
23	278.2	0.0	278.2	278.2			
24	345.1	25.5	370.6	346.7	23.9	93.7	
25	316.7	119.6	436.3	325.3	111.0	92.8	
26	358.9	152.8	511.7	368.6	143.1	93.7	
27	0.0	169.6	169.6	1.2	168.4	(99.3)*	93.4
				Butyric			
28	369.5	67.6	437.1	369.3	67.8	100.3	
29	0.0	182.3	182.3	0.6	181.7	99.7	100.0

* Values in parentheses are excluded from the averages for reasons given in text.

factors are instrumental in causing these differences. Certain of these factors have been studied and will be discussed in turn; *viz.*, the hydrolysis of easily-dissociated ammonium soaps, the extraction of fatty acids thus liberated, and the loss of these extracted acids by volatilization.

The presence of ammonia in the ether extracts *before* evaporation may be demonstrated by means of Nessler's reagent. However, since ammonia is found, also, in the ether extract of a lipid-free control, the ammonia is not necessarily extracted in the form of an ammonium soap, and it is probable that the positive Nessler test may be traced to the extraction of some ammonia by the ether. Since no ammonia can be found in the lipid residue *after* evaporation of the ether, the volatile ammonia is probably driven off when the ether is evaporated. In this connection, one should not ignore the possibility that the ammonium soap was extracted but was decomposed by the heating afterward. Even $(NH_4)_2SO_4$ is reported to lose ammonia at 120° C. and, in some cases, even as low as 80° C. (7).

Since the residues in the fat dishes do not contain ammonia, it is evident that the fatty acid increment is free fatty acid and not the ammonium soap. This would be expected since these soaps are salts of the weak base, ammonium hydroxide, and the weak fatty acids. Extensive hydrolysis probably occurs in aqueous solution with the liberation of free fatty acids.

Indirect evidence for such an hydrolysis might be obtained by comparing the behavior of ammonium hydroxide with the behavior of a much stronger base. Lithium hydroxide seemed suitable for this comparison. It is a much stronger base than ammonia (the normal solutions are dissociated to the extent of 63 per cent and 0.4 per cent respectively (3)); and it yields soaps which are insoluble in ether but quite soluble in methyl alcohol (6).

These two bases were compared by running a series of analyses of cottonseed oil-oleic acid mixtures. The ammonia method yielded high results (approximately 27 per cent of the oleic acid was recovered), the lithium method gave the theoretical value for neutral fat alone. This difference is attributed to differences in the degree of hydrolysis of the respective soap solutions rather than to differences in the solubility of the soaps because we were unable to detect the presence of ammonia in the extracted lipid residues by means of Nessler's reagent.

We do not, however, advocate the substitution of lithium hydroxide for ammonium hydroxide in the Mojonnier test because troublesome emulsions may be formed and because the strongly alkaline lithium hydroxide may cause the saponification of some kinds of fat.

A further study of the data of table 1 shows that the recovery of fatty acid in the Mojonnier test varies with the molecular weight of the acid. This may be explained, in part, on the basis of differing distributions between the two solvents, and to differing volatilities of the extracted fatty acids. The solubility of fatty acids in water decreases with increasing

molecular weight. It should be expected, then, as is shown in table 1, that in the distribution of these acids between water and ether, a greater percentage of the acids of high molecular weight will be extracted by the ether than of acids of low molecular weight.

The acids of low molecular weight are more volatile than those of high molecular weight. The influence of volatility in reducing the recovery of certain free acids was shown by the following experiments:

Quantities of fatty acids and of butter oil were weighed directly into tared fat dishes; 50 ml. of ethyl ether and 50 ml. of petroleum ether were added and mixed with the lipids. The mixture was then heated on the Mojonnier fat plate to drive off the ethers, dried in the fat oven, cooled and weighed as in the conventional Mojonnier procedure. Some data obtained in this manner are recorded in table 2.

TABLE 2

The loss of fatty acid by volatilization during evaporation of the ethers in the Mojonnier fat test

No.	A	B		C	D	E	F
	Fat. Dry weight of butter oil	Fatty acid		Total sample (A + B)	Recovered after evaporation of ether	Fatty acid not recovered	
		Name	Weight			(C − D)	$\frac{E \times 100}{B}$
	mg.		*mg.*	*mg.*	*mg.*	*mg.*	%
101	555.0	.....	0.0	555.0	555.1	.....	.....
102	419.7	Oleic	43.8	463.5	458.4	5.1	12.0
103	419.7	Oleic	143.0	562.7	560.1	2.6	2.0
104	0.0	Oleic	194.1	194.1	168.2	25.9	13.0
105	443.3	Stearic	150.1	593.4	593.1	0.3	0.2
106	0.0	Stearic	145.1	145.1	143.8	1.3	1.0
107	421.0	Palmitic	41.1	462.1	459.0	3.1	8.0
108	0.0	Palmitic	52.3	52.3	30.7	21.6	42.0
109	494.7	Myristic	225.8	720.5	716.1	4.4	2.0
110	0.0	Myristic	217.8	217.8	193.3	24.5	11.0
111	486.5	Lauric	76.7	563.2	542.7	21.5	28.0
112	0.0	Lauric	51.1	51.1	0.0	51.1	100.0
113	0.0	Butyric	182.3	182.3	0.6	181.7	100.0
114	0.0	.....	0.0	0.0	0.1	.....	.....

These data show that the recovery of fatty acids in the Mojonnier test is influenced by the volatility of the acid. They also show that the volatility of the acids is reduced considerably by the presence of neutral fat. This probably accounts for the apparent discrepancies recorded in table 1; *i.e.*, the high results in "amount of fatty acid not recovered" from samples 5, 22 and 27. In each of these cases, no neutral butterfat was present in the original sample. In those samples, a proportionately greater quantity of the extracted free acid was volatilized during the ether evaporation and, in this manner, a greater quantity of the fatty acid was "not recovered."

SUMMARY

The Mojonnier test does not recover equal percentages of the various free acids which may be present in the butterfat. This is due, in part at least, to variations in the amount of different acids volatilized when the sample is heated to remove the ether.

It seems probable that the recovery of free acids by the Mojonnier method can be traced to hydrolysis of the ammonium soaps with the subsequent extraction of the liberated acid. The degree of hydrolysis would depend upon the nature of the acid, but it might be reduced in all cases by the substitution of a stronger base for the ammonia. Lithium hydroxide offers some promise, but its saponifying action must be studied more carefully before it can be recommended.

REFERENCES

(1) BIRD, E. W., AND BREAZEALE, D. F. Chemistry of Butter and Butter Making. I. A Comparison of Four Methods for the Analysis of Butter with an Explanation of a Discrepancy Found to Exist in Fat Determinations. Iowa Agr. Expt. Sta. Tech. Bul. **144**: 353–382. 1931.

(2) DAVIES, W. L. The Chemistry of Milk. p. 59. New York. 1936.

(3) HODGMAN, C. D. *Editor-in-chief*. Handbook of Chemistry and Physics. 24th edition. p. 1385. Cleveland. 1940.

(4) HOLLAND, R. F. A Study of Composite Milk Samples. Master's thesis, Cornell University. 1938.

(5) MOJONNIER, T., AND TROY, H. C. The Technical Control of Dairy Products. 2nd edition. Chicago. 1925.

(6) SEIDELL, A. Solubilities of Inorganic and Organic Compounds. 2nd edition. New York. 1919, 1928.

(7) SMITH, W., *in* MELLOR, J. W. A Comprehensive Treatise on Inorganic and Theoretical Chemistry. **2**: 698. London. 1927.

(8) STARR, M. P., AND HERRINGTON, B. L. The Determination of Fat in the Presence of Fatty Acids. I. The Mojonnier Test of Mixtures of Free Fatty Acids and Butterfat. JOUR. DAIRY SCI., **24**: 165–168. 1941.

BUTTERFAT AND SILAGE CAROTENOIDS*

B. CONNOR JOHNSON, W. H. PETERSON AND H. STEENBOCK
Department of Biochemistry, College of Agriculture, University of Wisconsin, Madison

Virtanen (12), Uuranen (11) and Peterson *et al.* (7, 8) observed that the apparent carotene content of silage prepared with acids was in many cases greater than that of the fresh material from which it had been made. The reason for these high values was found by Quackenbush, Steenbock and Peterson (9) to be the presence of pigments produced from xanthophyll by the action of silage acids. These pigments were carried along with carotene in the petroleum ether-ethanol procedure but could be separated from the carotene and from each other by chromatographic means. In some silages they made up 40 per cent of the so-called carotene, but unlike carotene they had no vitamin A potency.

It was the object of the present experiments to determine the extent to which the non-carotene pigments in "acid silages" would appear in butter produced from the milk of cows fed these silages. If these pigments were secreted into milk, they would be calculated as carotene and would give a false value to the vitamin A potency of the milk.

It was observed by Palmer and Eckles (6) that both carotene and xanthophyll occurred among the pigments of butter, but by far the greatest portion of the total pigment was carotene. Karrer and Schöpf (5) identified chromatographically lutein and zeazanthin as well as carotene in butter. Gillam and Heilbron (3) found β-carotene and small amounts of α-carotene, kryptoxanthin and lycopene in the butter fat from cows which had received rations containing these pigments.

It is evident as stated by Strain (10) that the carotenoids of butter are dependent upon those in the ration of the cow, but they are present in different proportions in butter probably because carotene is much more readily absorbed than the other pigments.

EXPERIMENTAL

Butter was made in the winter of 1939 and again in 1940 from the milk of two groups of cows which had received respectively phosphoric acid alfalfa silage and molasses alfalfa silage for four months. Butter produced on summer pasture was used each year as a control. The butter samples were stored at a temperature below 0° C. and when required for analysis were melted and freed from water and solid matter by filtering through absorbent cotton. They were saponified under nitrogen, and the non-

Received for publication April 25, 1941.
* Published with the approval of the Director of the Wisconsin Agricultural Experiment Station.

saponifiable matter was extracted with peroxide-free ether. The ether solution was washed several times with ice water, dried by freezing out the water with dry ice, evaporated to dryness in vacuum, and the residue taken up in 2 to 3 cc. of purified petroleum ether (Skelly-solve B). The solution was kept cool at all times and evaporated under vacuum in order to minimize isomerization as reported by Carter and Gillam (1) and by Zechmeister and Tuzson (13). The resultant solution was chromatographed through $CaCO_3$ or MgO columns. In most of the work $CaCO_3$ proved to be superior.

The pigments were fractionated as follows: The petroleum ether solution was forced into a uniformly packed column of adsorbent by means of air under a pressure of 15–25 pounds. The column was then washed with petroleum ether under continued pressure until the bands of carotene, acid-formed pigments and xanthophylls had separated. The bands of carotene and acid-formed pigments were washed through and collected separately. Then the xanthophyll bands were washed through with a 10 per cent solution of absolute alcohol in petroleum ether and collected together. The pigments were determined quantitatively in three groups: 1) carotene, 2)

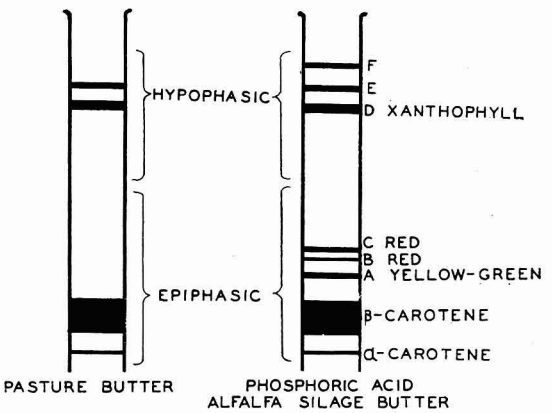


FIG. 1. Chromatograms of carotenoid pigments in butter fat.

pigments A, B, C (the so-called acid-formed pigments, Fig. 1), and 3) pigments D, E, F (the hypophasic xanthophyll pigments). The total pigment was first calculated as carotene by determining the intensity of spectral absorption in petroleum ether solution with a 440 mμ filter in the Evelyn photelometer. After chromatographing, each fraction was read at 440 mμ in petroleum ether and expressed as carotene. The sum of these values was found to account for 95 to 97 per cent of the original values. Only the pigments which it seemed most important to identify were separated from the mixture.

To reveal the phasic distribution of the pigments a petroleum ether solu-

tion of the non-saponifiable fraction was extracted with 90 per cent methanol and the resulting two fractions were chromatographed from petroleum ether solution as before. In the case of the silage butters the carotene and the acid-formed pigments were found to be epiphasic while the xanthophylls were hypophasic.

RESULTS

The pigments which had been isolated chromatographically were identified so far as possible by determining their absorption maxima. The spectra were photographed in either petroleum ether or carbon bisulfide, with the use of a Hilger spectrograph. The wave lengths of the band maxima are given in table 1. The red acid-formed pigments (pigments B and C, Fig. 1) did not give distinct bands even in concentrated solution. In both petroleum ether and in carbon bisulfide, absorption was general over a wide range and the values given are, therefore, only approximate. It is possible that these pigments are still mixtures of degradation products.

TABLE 1

Absorption maxima of pigments isolated from butter

Pigment	In petroleum ether (mμ)	In carbon bisulfide (mμ)
α-Carotene { isolated	477, 444, 416	
α-Carotene { accepted value	478, 447.5	
β-Carotene { isolated	483, 452, 425	519, 482, 450
β-Carotene { accepted value	483.5, 452, 426	521, 485.5, 451
Yellow-green, acid-formed, pigment A	454, 428, 403	489, 454, 428
Red, acid-formed, pigment B	(495, 459, 425)?	
Red, acid-formed, pigment C	(453, 433)?	(480)?
Xanthophyll { isolated		508, 473, 445
Xanthophyll { accepted value		508, 475, 445

Traces of α-carotene were found in the butters only when relatively large amounts of butter (100 gms.) were used in one analysis. This finding agrees with that of Gillam and El Ridi (2) who reported the α-carotene content to be less than 0.3 per cent of the β-carotene content in the butters which they examined.

The amounts of the pigment in each of the three groups for the phosphoric acid and the molasses alfalfa silage butters and for pasture butter are given in table 2. These figures are averages of the values obtained in 1939 and in 1940. From this table it appears that: 1) There is more carotene in pasture butter than in silage butter because of the higher carotene content of the pasture. However the ratio of carotene in butterfat to that in forage shows that carotene is absorbed just as well from silage as from pasture. 2) There are no acid-formed pigments in pasture and thus none

in pasture-butter. There are, as shown by Quackenbush *et al.* (9), more acid-formed pigments in acid silage than in molasses silage and, as would be expected, there are more acid-formed pigments in butter produced on phosphoric acid silage than on molasses silage. 3) While the acid-formed pigments seem to be rather readily absorbed and transferred into the butterfat, the xanthophyll pigments appear to be so poorly absorbed that there is about the same amount of xanthophyll pigments in butters irrespective of the amount in the ration.

TABLE 2

Amounts of pigments found in butter (2 year averages)

Type of butter	Pigments in butter fat				(b) Carotene in forage	Ratio a/b
	Total	Xantho-phylls	Acid-formed	(a) Carotene		
	γ/gm.	γ/gm.	γ/gm.	γ/gm.	γ/gm.	
Pasture	11.0	2.2	0.0	8.8	250	0.035
Molasses alfalfa silage	9.0	2.2	0.7	6.1	140	0.043
Phosphoric acid alfalfa silage	8.5	2.0	1.0	5.5	120	0.046

Table 3 gives the distribution of the three groups of pigments expressed as per cent of the total pigments. In an analysis of the phosphoric acid alfalfa silage butter the 12 per cent of the acid-formed group was found to be made up of 3.4 per cent of the greenish-yellow pigment A and 8.6 per cent of the red pigments B and C.

TABLE 3

Distribution of pigments in butter (2 year averages)

Type of butter	Percentage of total pigments		
	Carotene	Acid-formed pigments	Xanthophylls
	%	%	%
Pasture	80	0	20
Molasses alfalfa silage	68	8	24
Phosphoric acid alfalfa silage	65	12	23

In order to obtain true values for the carotene content of milk the non-carotene pigments should be removed before the reading is taken. It would appear that the diacetone alcohol method of Hegsted *et al.* (4) might be applicable to milk and butter as well as to silage for the separation of the carotene and acid-formed pigments.

The above data should not be interpreted as denying the value of these forages for increasing the carotene content of winter milk, since only a part of the increased color is due to non-carotene pigments. Although no data

were obtained for butters produced by cows on hay-corn silage rations, it is probable that the percentage of non-carotene pigments in such butters would be as high as when the cows are fed molasses silage. Corn silage usually has a lower pH than molasses silage and hence a larger proportion of acid formed pigments would probably be present and presumably transmitted to the milk.

SUMMARY

Besides carotene and xanthophyll, pigments formed by the action of acids in silage are carried over into the butter fat of the milk. The usual methods of carotene analysis on butter fat do not distinguish between carotene and non-carotene pigments. By chromatographic methods the distribution of pigments in butters from cows on different forages was found to be as follows: pasture, 80 per cent carotene, 20 per cent non-carotene; molasses alfalfa silage, 68 per cent carotene, 32 per cent non-carotene; phosphoric acid alfalfa silage, 65 per cent carotene, 35 per cent non-carotene.

REFERENCES

(1) CARTER, G. P., AND GILLMAN, A. E. The Isomerization of Carotenes. III. Reconsideration of the Change β-carotene to ψ α-carotene. Biochem. Jour., **33**: 1325–1331. 1939.

(2) GILLAM, A. E., AND EL RIDI, M. S. The Carotene of Milk Fat (Butter). Biochem. Jour., **31**: 251–253. 1937.

(3) GILLAM, A. E., AND HEILBRON, I. M. The Carotenoids of Butter. Biochem. Jour., **29**: 834–836. 1935.

(4) HEGSTED, D. M., PORTER, J. W., AND PETERSON, W. H. Determination of Carotene in Silage. An Improved Method. Indus. and Engin. Chem., Analyt. Ed., **11**: 256. 1939.

(5) KARRER, P., AND SCHÖPF, K. Trennung von Vitamin-A, Carotin und Xanthophyllen. Helvetica Chim. Acta., **15**: 745. 1932.

(6) PALMER, L. S., AND ECKLES, C. H. Carotin—The Principal Natural Yellow Pigment of Milk Fat; Its Relations to Plant Carotin and the Carotin of the Body Fat, Corpus Luteum and Blood Serum. Jour. Biol. Chem., **17**: 191–210. 1914.

(7) PETERSON, W. H., BOHSTEDT, G., BIRD, H. R., AND BEESON, W. M. The Preparation and Nutritive Value of A.I.V. Silage for Dairy Cows. JOUR. DAIRY SCI., **18**: 63–78. 1935.

(8) PETERSON, W. H., BIRD, H. R., AND BEESON, W. M. Chemical Changes in the Making of A.I.V. Alfalfa Silage and Nutritive Qualities of Milk Produced Therefrom. JOUR. DAIRY SCI., **20**: 611–623. 1937.

(9) QUACKENBUSH, F. W., STEENBOCK, H., AND PETERSON, W. H. The Effect of Acids on Carotenoids. Jour. Amer. Chem. Soc., **60**: 2937–2941. 1938.

(10) STRAIN, H. H. Carotene. XI. Isolation and Detection of α-carotene and the Carotenes of Carrot Roots and of Butter. Jour. Biol. Chem., **127**: 191–201. 1939.

(11) UURANEN, E. Spectrophotometric Method in Biochemical Research. Acta Chem. Fennica, **7A**: 49. 1934.

(12) VIRTANEN, A. I. Über die Konservierung der Vitamine im Viehfutter. Biochem. Ztschr., **258**: 251–256. 1933.

(13) ZECHMEISTER, L., AND TUZSON, P. Isomerization of Carotenoids. Biochem. Jour. **32**: 1305–1311. 1938.

MENSTRUATION FREQUENCY AND ITS RELATION TO CONCEPTION IN DAIRY CATTLE[1]

GEORGE W. TRIMBERGER
Dairy Husbandry Department, University of Nebraska, Lincoln

Among mammals, there is a marked variation in regard to menstruation and its relationship to conception. Examination of the literature reveals that the time in the sexual cycle at which menstruation takes place is well established in the different species but there is a marked individuality that is observed for each one and sometimes even within the species.

The human being (1, 7) is reported to have an exceptionally long menstruation period which lasts from two to eight days with an average of five days. If the occurrence is regular, the beginning of the menstrual period is half way between successive ovulations and is closely associated with estrus. Marshall (5), Howell (4), Schmaltz (7), and Reynolds (6), all agree that in the human, the mucous membrane thickens to several times normal as pre-menstrual congestion takes place. Although menstruation in the human being is a phenomenon of the uterus, and blood will escape only from the surface of that organ, the other reproductive organs share to some extent the vascular congestion exhibited by the uterus during this period. The congested capillaries of the uterus break down or rupture in the superficial regions of that organ. The blood discharged at menstruation may be due to these small capillary extravasations and also to a process of diapedesis or seepage made possible by the congestion. Sometimes, when menstrual flow is very profuse in the human, there may be a considerable loss of surface epithelium. The vessels in the deeper tissue remain intact and none of the fluid is found free in the deeper tissue of the stroma. Howell (4) states that menstruation is a sign that fertilization has not taken place from the previous ovulation but Schmaltz (7) gives evidence that it is possible to have a certain amount of menstrual flow following fertilization.

Usually the experienced dog breeder knows that a bitch will, in most cases, have a pronounced flow of blood during the period of proestrus which usually lasts about ten days. As a rule, the bitch will not take the dog until bleeding has ceased and the best time for successful coition is soon after the cessation of this flow. Marshall (5) and Schmaltz (7) agree with this common view.

According to Marshall (5) occasionally blood has been observed in the mare's proestrus discharge but is not generally present. He also states that the ewe menstruates very little and usually shows no external signs. Very

Received for publication May 3, 1941.

[1] Submitted with the approval of Director of the Nebraska Agricultural Experiment Station—Journal Series No. 289.

rarely, a small amount of bloody mucous is observed during proestrus. The sow likewise usually does not show any external signs but occasionally a bloody mucous flow has been observed during proestrus.

The cow (2, 3, 9) is reported to menstruate about two days after heat. Hammond (3) presents evidence to show that in the cow the menstrual fluid comes from both the vagina and uterus. He expresses the opinion that the blood flow in the vagina comes from the region situated just above the urethra and that in the uterus there is special engorgement of the placental areas; but bleeding can come from the surface of any part of these two organs.

A few authors express the opinion that if a heifer or cow menstruates a few days after service it is an indication that conception did not take place, but in most cases they present no definite data to support their belief. W. W. Williams (9) states "The non-pregnant cow ordinarily menstruates about the 48th hour after heat subsides. A little blood-tinted mucus stringing from the vulva at this time, or upon the cow's tail, indicates that the service has been ineffective. The complete absence of any bloody discoloration of the vaginal mucus suggests that the cow has conceived especially if it has previously been noted that the cow menstruated normally at other periods."

Another author, W. L. Williams (8), writes, "Within 24 to 48 hours after a cow has been bred she may menstruate. The sanious discharge emanating from the vulva may adhere to that organ, the tail and adjacent parts. If the cow has been bred and conceived, it is doubtful if there will be menstruation following. If she fails to conceive, menstruation is quite certain to occur. In many cases of serious sterility, the volume of menstrual blood is very great. Fertilization appears to inhibit menstruation, but menstruation may occur in spite of conception. The absence or presence of menstruation must not be accepted as final proof of conception or non-conception. It is, however, a valuable sign, and should always place the breeder and veterinarian on guard, with a rather definite expectation that the animal which has menstruated after breeding will again be in estrum in due course of time."

Hammond (3) carefully observed four heifers after service to a fertile bull and states that all four menstruated at the normal time a few days later. Three of these had become pregnant and subsequent bleeding did not occur in these three. He refers to the fact that it is a common belief among herdsmen that bleeding does not occur two days after heat if fertilization takes place.

EXPERIMENTAL PROCEDURE

Because of the widespread belief among livestock men that menstruation in cattle occurring after service is an indication that conception did not take place, and because of the conflicting opinions expressed in the litera-

ture, it seemed that the problem was worthy of consideration. As a result, data have been collected in the University of Nebraska dairy herd as to the occurrence of menstruation following estrus in heifers and cows. The study covered the years 1937 to 1940 and included representatives of the Jersey, Guernsey, Holstein, and Ayrshire breeds. As used in this study, menstruation refers to the external discharge of a bloody fluid, usually mucus mixed with blood, from the genital tract following estrus.

A group of 100 heifers and a group of 100 cows were studied to determine the frequency of the occurrence of menstruation following estrus when they were not served. For comparison, two similar groups consisting of 100 cows and 100 heifers were inseminated during estrus and the frequency of subsequent menstruation and conception recorded. The amount of menstrual fluid discharged was also noted and given a rating of slight, moderate, and pronounced. Observations were made at six regular intervals each day for five days following estrus and any external signs of a blood-tinted discharge were noted.

PRESENTATION OF RESULTS

Table 1 presents data on the occurrence of menstruation following estrus in open and bred heifers and cows and its relation to conception.

TABLE 1

Occurrence of menstruation following estrus in open and bred heifers and cows and its relation to conception

Group	Females	After estrus						
		Females menstruating within 5 days	Females conceiving	Females conceiving and menstruating		Females not conceiving	Females not conceiving but menstruating	
	no.	*no.*	*no.*	*no.*	*%*	*no.*	*no.*	*%*
Heifers (open)	100	100	.....	.....	.....	.....	.....	.....
Cows (open)	100	61	.....	.....	.....	.....	.....	.....
Heifers (bred)	100	81	61	52	85.25	39	29	74.36
Cows (bred)	100	61	72	50	69.44	28	11	39.29

Menstruation was observed in everyone of the 100 heifers not bred during estrus. In the group of 100 cows not bred during estrus, a total of 61 had a menstrual discharge. Of the lot of 100 heifers bred at estrus, a total of 81 menstruated. Sixty-one heifers conceived and of these, 52 or 85.25 per cent menstruated within five days while 9 or 14.75 per cent showed no evidence of menstruation. From the 39 heifers which did not conceive after breeding, 29 or 74.36 per cent menstruated while 10 or 25.64 per cent showed no signs of menstruation. In the group of 100 cows bred at estrus, 61 menstruated within five days. Seventy-two cows conceived and of these 50 or 69.44 per cent menstruated while 22 or 30.56 per cent did not men-

struate. Of the 28 cows which did not conceive after breeding, 11 or 39.29 per cent menstruated and 17 or 60.71 per cent did not menstruate.

The estimated amount of menstrual fluid and the time after estrus when this was discharged was recorded and these data are presented in table 2.

TABLE 2

Time of menstruation and amount of menstrual fluid

Group	Females grouped according to estimated quantity of menstrual fluid			Females grouped according to time of menstruation			
	Slight	Moderate	Profuse	Days after estrum			
				1st	2nd	3rd	4th
	no.	*no.*	*no.*	*no.*	*no.*	*no.*	*no.*
Heifers (open)	32	59	9	4	82	12	2
Heifers (bred—no conception)	11	15	3	1	16	8	4
Heifers (bred—conceived)	17	29	6	6	39	7	...
Cows (open)	22	31	8	8	49	4	...
Cows (bred—no conception)	4	7	...	...	5	6	...
Cows (bred—conceived)	22	28	...	8	34	8	...
Total	108	169	26	27	225	45	6

In the above table, the data indicate that for the 303 individuals that menstruated, 108 or 35.64 per cent had a slight amount, 169 or 55.78 per cent a moderate, and 26 or 8.58 per cent a profuse amount of menstrual fluid. The second part of table 2 in which the females were grouped according to time of menstruation in days after estrus shows that 27 or 8.91 per cent menstruated on the first day, 225 or 74.26 per cent on the second day, 45 or 14.85 per cent on the third, and 6 or 1.98 per cent on the fourth day following estrus.

DISCUSSION

This study offers evidence that the common belief among livestock men and veterinarians that a heifer or cow which menstruates a few days after service did not conceive is erroneous. These data show to what a surprising degree this supposition is in error. The data presented reveal that of the 100 heifers which were bred, 61 conceived and that 85.25 per cent of those conceiving also menstruated. A group of 100 cows bred resulted in 72 conceptions and 69.44 per cent of those conceiving also menstruated. It was found that the frequency of menstruation in heifers is greater than in older cows. This may be due to the fact that heifers as a rule are more excited at heat than are older cows which may result in the genital organs becoming more engorged with blood. The genital organs of the cow also are longer and extend further forward and occupy more of an abdominal position as compared to the pelvic position in heifers and this may have a tendency to prevent the flow of the menstrual fluid from the vulva of some

of the older animals. Another point that might be mentioned is that the amount of menstrual fluid is possibly dependent on the thickness and toughness of the endometrium. This will vary with age and number of calvings and there will be some variation between individuals. The data presented indicate that of the 303 females that menstruated, 225 or 74.26 per cent passed off the menstrual fluid on the second day following estrus.

SUMMARY

Observations as to the external evidence of the occurrence of menstruation were made at six different times daily on each of five days following estrus, for four lots of dairy females each consisting of 100 animals. One hundred heifers and an equal number of cows were observed after estrus, when breeding did not occur, and 100 heifers and 61 cows showed evidence of menstruation. Two similar groups of 100 heifers and 100 cows were bred during estrus. Of the 100 heifers bred at estrus, 81 menstruated. Sixty-one of the heifers conceived and 52 or 85.25 per cent of those conceiving also menstruated while of the 39 that did not conceive, 29 or 74.36 per cent menstruated. Of the 100 cows bred at estrus, 61 menstruated. Seventy-two of these cows conceived, and 50 or 69.44 per cent of those conceiving also menstruated, while of the 28 that did not conceive, 11 or 39.29 per cent menstruated. The data do not indicate any definite relationship between breeding and conception as affecting menstruation. When external evidences of menstruation were observed a total of 303 of the 400 individuals menstruated and 225 or 74.26 per cent showed this menstrual discharge on the second day following estrus.

REFERENCES

(1) ALLEN, E., PRATT, J. R., NEWELL, Q. U., AND BLAND, L. J. Recovery of Human Ova from the Uterine Tubes. Time of Ovulation in the Menstrual Cycle. Jour. Amer. Med. Assoc. **91**: 1018–1020. 1928.

(2) CHAPMAN, A. B., AND CASIDA, L. E. Analysis of Variation in the Sexual Cycle and Some of Its Component Phases, with Special Reference to Cattle. Jour. Agr. Res. (U. S.) **54**: 417–435. 1937.

(3) HAMMOND, JOHN. The Physiology of Reproduction in the Cow. University Press, Cambridge, England. pp. 25–167. 1927.

(4) HOWELL, WILLIAM H. Text Book of Physiology, 10th edition. W. B. Saunders Company, Philadelphia, Pa. pp. 1004–1009. 1928.

(5) MARSHALL, FRANCIS H. A. The Physiology of Reproduction, 2nd edition, Longmans Green, and Company. New York, N. Y. pp. 32–158. 1922.

(6) REYNOLDS, SAMUEL R. M. Physiology of the Uterus. Medical Book Department of Harper Bros., New York, N. Y. pp. 141–168. 1939.

(7) SCHMALTZ, R. Das Geschlechtsleben der Haussäugetiere. 3rd edition. Verlags buchhandliung von Richard Schoetz, Wilhelmstrasse 10, Berlin, Germany. pp. 140–174. 1921.

(8) WILLIAMS, WALTER LONG. Veterinary Obstetrics, 2nd edition. Published by author, Ithaca, New York. pp. 123–. 1931.

(9) WILLIAMS, WALTER WILKINSON. Sex Hygiene and Reproduction of Cattle. Springfield Printing and Binding Company, Springfield, Massachusetts. p. 29. 1930.

FINAL REPORT OF COMMITTEE ON METHODS OF DETERMINING THE CURD TENSION OF MILK

The curd tension of milk, while probably not wholly satisfactory as a measure of digestibility and suitability of milk for infant use, nevertheless has been tacitly accepted as an indication of these characteristics. The recent action of the Council on Foods of the A.M.A. in "accepting" homogenized milks with soft curd claims and establishing a limit of 20 grams tension for such milks has further added to the repute of the curd tension value. Some municipalities have set, or are contemplating establishing, curd tension standards for homogenized milk, the production of which is increasing rapidly. It seems particularly desirable, therefore, to publish the procedure for making curd tension determinations which was approved at the Thirty-sixth Annual Meeting of the American Dairy Science Association, June 1941.

DETERMINATION OF THE CURD TENSION OF MILK

Reagent

The coagulant consists of .08 N hydrochloric acid to which U.S.P. (1:3000) dry pepsin has been added at the rate of 450 mgms. per 100 ml. This solution may be kept under refrigeration and away from light for a period of not more than 10 days without losing its effectiveness but, in case of doubt, results obtained with it must be checked against results obtained using a freshly prepared coagulant.

Apparatus

The instrument used in measuring the curd tension shall indicate the grams of force* necessary to cut the coagulum, obtained as described below, using the standard type of knife. The motion of the knife or the vessel containing the coagulum shall be automatic and at the rate of one inch in 7 to 8 seconds, obtained by lowering the knife or by raising the vessel containing the coagulum. The sensitivity of the instrument shall be such that readings can be made to an accuracy of $\pm$ 1.0 gram.

Standard Knife

The knife used as a part of the instrument for measuring the curd tension shall consist of eight radial blades each having $\frac{9}{16}$ inches of lineal cutting edge and being .020 inches thick, spaced equally and enclosed by a circular or ring blade, $1\frac{3}{4}$ inches outside diameter, $\frac{3}{16}$ inches high and .031 inches thick. The radial blades shall be attached to the inside of the circular or ring blade and extend upward from it a distance of $2\frac{1}{16}$ inches,

* Submarine Signal Company Curd Tension Meters made prior to July 1941 do not read in grams. Readings may be converted to grams, however, by adding 10 per cent (multiplying by 1.10).

being reduced to a width of 5/32 inches above the circular or ring blade. Their upper ends shall be curved inward and attached to a central spindle $\frac{5}{16}$ inches in diameter. The lower or cutting edge of the circular or ring blade shall be tapered from the outside at an angle of 30 degrees to the knife axis, to a dull knife edge. The lower or cutting edges of the radial blades shall be tapered, on each side, at an angle of 15 degrees to the knife axis, to a dull knife edge. The cutting edges of the ring blade and the radial blades shall lie approximately in the same plane, deviating not more than 1/32 inches. The total linear cutting edge of the knife shall be 9.8 inches $\pm$ 0.10 inches. All joints shall be mortised and soldered smoothly and the knife constructed of a non-corrosive metal.

Coagulation Vessel

The receptacle used for coagulating the milk shall be a heavy walled jar 3 to 4 inches high (inside) and having an inside diameter of $2\frac{3}{8}$ inches $\pm \frac{1}{8}$ inch. The jars listed below have been found to meet these specifications satisfactorily and undoubtedly others will also be found which conform.

W. M. Welch Scientific Company, Chicago—Museum jar No. 4612A (8 oz.)

Central Scientific Co., Chicago—Museum jar No. 10396 ($7\frac{1}{2}$ oz.)

Owens Illinois Glass Co., Toledo—Mayonnaise jar (8 oz.)

Sample Pipette

The pipette used for measuring and adding the milk sample to the jar containing the coagulant shall be one made to deliver 100 ml. which has had the tip removed and which empties water by gravity in approximately 4.5 seconds.

Water Bath

A suitable water bath shall be used to temper the jars containing the coagulant before the sample of milk is added and to hold the milk and coagulant at the proper temperature during the coagulating period. The water level shall come up on the outside of the jar to a point no lower than the milk and coagulant level on the inside of the jar. The volume of water shall be such that the temperature does not change more than 1.0° F. during the 10-minute period of coagulation and should preferably be agitated.

Procedure

Introduce 10 ml. of the coagulant into the coagulating vessel and set the vessel in the water bath, having previously adjusted the temperature of the water to 95° F. The vessel containing the coagulant should be tempered for no less than 3 minutes before introducing the milk sample.

The undiluted milk to be tested is tempered to 95° F. or 96° F. as experience dictates being careful not to exceed 100° F. in the process. The tempering should be accomplished in a five-minute period immediately preced-

ing the pipetting of the sample. Introduce 100 ml. of the sample into the coagulating vessel using the tipless 100 ml. pipette. This is to be accomplished by holding the pipette vertically over the center of the vessel and blowing the sample from the pipette as rapidly as possible. No further mixing of the vessel contents is to be employed and the vessel should not be disturbed in the water bath. Place a watch glass or other suitable covering over the vessel immediately.

The contents of the coagulating vessel are held at 95° F. ± 1.0° for 10 minutes, the time in the water bath being adjusted so that the cutting of the curd by the curd tension instrument occurs at the expiration of 10 minutes ± 30 seconds from the time the sample was placed in the coagulation vessel.

The curd tension reading is the maximum reading which is obtained at the moment the knife penetrates the surface of the coagulum. The test shall be made in duplicate or replicate and results to be acceptable must not deviate more than 5 per cent from the average. The average of the results so checking constitutes the curd tension of the sample.

Remarks

The curd tension value of milk should not be considered an absolute index of its digestibility nor of its suitability for infant feeding purposes. The values do, however, correlate in a general way with these properties and the determination appears to be the best available, simple method for the purpose.

The method is conventional and the procedure must be followed closely otherwise considerable variation in readings may result. One very important factor is that of securing *uniform* mixing of milk and coagulant with *promptness* so that the mixture will be quiescent before coagulation commences.

Another factor which has been shown to somewhat influence results is the speed of warming the milk samples to the coagulating temperature. Where the milk is warmed very rapidly the results are slightly lower than where slow warming is practiced.

Adjusting the pH of milk for the purpose of making curd tension determinations is not a part of this method. Results obtained after such adjustments cannot be considered normal.

The determination of the curd tension of milk as here described is recommended for use with undiluted milk only. Some types of soft curd milk on dilution give results which cannot be considered meaningful.

C. J. BABCOCK
L. A. CHAMBERS
C. C. FLORA
M. E. HULL
W. S. MUELLER
H. H. SOMMER
A. B. STORRS
F. J. DOAN, Chairman

VOLUME XXIV SEPTEMBER, 1941 NUMBER 9

JOURNAL OF DAIRY SCIENCE

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

ABSTRACTS OF LITERATURE

T. S. SUTTON, Editor
Columbus, Ohio

MILK AND MILK PRODUCTS

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

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

CONTENTS

THE SCIENCE PRESS PRINTING COMPANY LANCASTER, PA.

PUBLICATIONS AND ABSTRACTORS

EDITORS

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

ABSTRACTORS

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

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

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

Doan, F. J.

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

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

Frazier, W. C.

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

Hansen, Arne
Huffman, C. F.

Irvine, O. R.

Josephson, D. V.

Knight, D.

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

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

Price, W. V.

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

Stark, C. N.
Stebnitz, V. C.

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

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

Yale, M. W.

JOURNALS

American Butter Review
American Milk Review
American Journal of Diseases of Children
American Journal of Physiology
American Journal of Public Health
Archives of Pediatrics

Biochemical Journal
Biochemische Zeitschrift

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

Dairy Industries
Dairy World
Deutsche Molkerei Zeitung

Endocrinology

Food Industries
Food Manufacture
Food Research

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

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

Kaseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry
Milk Plant Monthly
Molkerei Zeitung
National Butter and Cheese Journal

Oil and Soap

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

Refrigerating Engineering

Scientific Agriculture

Tierernährung
Tierzüchter

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

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

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

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

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

562. Some Ocular Changes and Deficiency Manifestations in Mature Cows Fed a Ration Deficient in Vitamin A. L. A. MOORE, Michigan State College, East Lansing.

Mature cows fed a vitamin A deficient ration failed to develop blindness due to constriction of the optic nerve such as has been reported in calves. A definite papilledema failed to develop in two out of six animals fed the deficient ration. However, once the papilledema develops it takes considerable time for it to recede. They did develop nyctalopia, incoordination and an edema of the legs. The tapetum nigrum and lucidum developed a mottled appearance. When the plasma carotene values receded to a 0.2 to 0.5 microgram level per ml., deficiency symptoms usually followed in a short period of time. The fat of a Guernsey cow which died with symptoms of vitamin A deficiency showed the presence of a pigment which was most likely carotene since it was epiphasic between petroleum ether and 92 per cent methyl alcohol.

563. Preservation of Bovine Spermatozoa in Yolk-Citrate Diluent and Field Results from Its Use. G. W. SALISBURY, H. K. FULLER, AND E. L. WILLETT, Dept. Animal Husbandry, Cornell University, Ithaca, N. Y.

Investigation had earlier shown that the buffer capacity of bull semen was primarily due to citrates, phosphates, and carbonates. In an endeavor to develop a buffer solution to be used with egg yolk for semen studies having characteristics similar to the buffers of bull semen plasma, it was noted that a solution containing a high proportion of sodium citrate was effective in clearing the egg yolk. When using the microscope to examine a sample of semen diluted with this mixture one could readily discern the individual sperm; on the other hand, when using the yolk-phosphate diluent it was necessary to further dilute the mixture with a clear diluter before the individual sperm could be distinguished. This property was lost when the proportion of citrate was reduced.

A mixture of approximately one-half fresh egg yolk and one-half of an M/15 solution of sodium citrate produced a diluent which gave as good results as any other studied. When compared with the yolk-phosphate diluent the yolk-citrate mixture preserved the motility of spermatozoa at as satisfactory a level for two and four days of storage. For periods of storage of 6, 8, and 10 days it was superior to the yolk-phosphate diluent.

In a controlled field experiment to determine the effectiveness of the yolk-

citrate diluent in preserving the fertility of spermatozoa over periods of storage up to 5 days it was found that 178 services were required for 118 conceptions for semen stored in the yolk-citrate diluent. When the yolk-phosphate diluent was used, 193 services were required for 126 conceptions over the same period of storage for semen from the same bulls. No significant differences were noted in the rate of conception over the total storage period nor for any portion of the total storage period between the two diluters used.

564. Oxidized Flavor in Milk. X. The Effect of Feeding Potassium Iodide Supplements to Dairy Cows on the Carotene Content of the Butter Fat and on the Ascorbic Acid Content of the Milk and the Relationship to Metal-Induced Oxidized Flavor. W. CARSON BROWN, A. H. VANLANDINGHAM, AND CHAS. E. WEAKLEY, JR., West Virginia Agr. Expt. Sta., Morgantown.

A study of oxidized flavor in milk produced during two periods in which potassium iodide was supplemented to the normal ration revealed no relationship to the development of oxidized flavor. Potassium iodide was supplemented at the rate of 5 grams daily for a period of 14 days to five animals. In the second trial the supplement was repeated after a seven-day readjustment period. Two animals were used in the second trial.

As a result of these trials the following conclusions were drawn:

1. The feeding of 5 grams daily of potassium iodide for 14 days lowered to a marked degree the percentage of ascorbic acid secreted in the milk, but had no noticeable effect on the level of the carotene content of the milk.

2. The decrease in the ascorbic acid content of the milk did not produce a corresponding increase in the intensity of the metal-induced oxidized flavor.

3. From these results it appears that the level of the ascorbic acid in the milk may not be as great a factor in the production of milk with low susceptibility to oxidized flavor as was formerly believed.

565. An Analysis of the Relationship between the Curd Tension and the Curd Surface Area of Milk. ARNOLD B. STORRS, American Seal-Kap Corp., Long Island City, N. Y.

A statistical analysis of the relationship between the curd tension and the curd surface area of milk was made. No significant relationship was found within individual types of commercially modified milks. Within mixed groups of various types of modified milk the relationship between curd tension and curd surface area was found to be of variable significance and seemed to depend upon the types of milk included in the particular group.

The conclusion is offered that curd tension and curd surface area are

independent characteristics of milk and that each may be influenced or determined by factors not closely related.

566. The Effect of Hydrogenation on the Nutritive Value of the Fatty Acid Fractions of Butter Fat and of Certain Vegetable Oils. R. K. BOUTWELL, R. P. GEYER, C. A. ELVEHJEM, AND E. B. HART, Dept. Biochem., Univ. of Wisconsin, Madison.

The superior growth-promoting property of butter fat as compared to certain vegetable oils is probably due to a saturated compound; apparently a long chain saturated fatty acid (or acids) present in small amounts in butter fat is responsible for these properties of butter fat.

The unsaturated fraction of butter fat is relatively rich in an unsaturated form of this compound which by hydrogenation may readily be converted to the active compound.

Certain vegetable oils as corn oil, coconut oil, cottonseed oil and soybean oil apparently do not contain the unsaturated form of this compound. Hydrogenation of these vegetable oils did not improve their nutritive value when incorporated into skimmed milk.

567. The Effect of Vitamin A and Certain Members of the B-Complex upon Calf Scours. PAUL H. PHILLIPS, NORMAN S. LUNDQUIST, AND PAUL D. BOYER, Depts. of Biochem. and Dairy Husbandry, Univ. of Wisconsin, Madison.

The effect of vitamin A and certain members of the B complex on calf scours has been studied with these results. These studies indicate that the calf diarrhea encountered was largely nutritional in origin. The administration of high vitamin A potency shark liver oil and certain members of the vitamin B complex eliminated the diarrhea and the resulting mortality from pneumonia. Preliminary evidence would suggest that nicotinic and pantothenic acids may be the factors of the B complex which were lacking.

New-born calves were found to be amply fortified with ascorbic acid but they were uniformly deficient in vitamin A. The ingestion of colostrum milk rich in vitamin A quickly brought about normal blood plasma levels. The ration of the dam influenced to some extent the amount of vitamin A found in the blood plasma of the new-born calf. Winter rations tend to reduce it while rations with ample carotene or fortified with vitamin A tend to raise it. Low ascorbic acid values in the blood plasma were increased by feeding shark liver oil rich in vitamin A.

568. Factors Affecting the Gas Content of Milk. C. I. NOLL AND G. C. SUPPLEE, Borden Biol. and Chem. Res. Labs., Bainbridge, N. Y.

A quantitative study has been made of the dissolved gases in milk as affected by light, heat, vacuum, displacement by other gases and processing,

in order to observe the general principles governing the gas content of milk. Particular attention has been given to the oxygen content of milk and the study of methods for its removal.

Data are submitted showing that, within the limitations of the experimental procedures used, the oxygen content of milk is primarily a function of the partial pressure of the oxygen over the solution and the temperature of the solution. This is in agreement with the accepted laws of solutions of gases in liquids.

Quantitative experimental data are given showing the gas content of milk at various stages in several pasteurization processes, the loss of gases during the heating and their subsequent reabsorption on exposure to air during cooling.

The degree to which the oxygen content of milk can be lowered by heat (below boiling temperature), vacuum, displacement with other gases, light and light in the presence of added ascorbic acid is presented. The application of these data to the development of methods for the deoxygenation of milk is discussed with appropriate experimental evidence.

The correlated data show that if the dissolved oxygen in milk is completely removed, the vitamin C of fluid or processed milk is stable, notwithstanding subsequent heat treatment or exposure to light. Such factors as heat, exposure to light, the presence of copper, etc., appear to be secondary catalytic influences affecting the rate of destruction of vitamin C only if dissolved oxygen is present.

569. The Lethal Effectiveness of Ultraviolet Rays Applied to Milk.
G. C. SUPPLEE, G. E. FLANIGAN, AND O. G. JENSEN, Borden Biol. and Chem. Res. Labs., Bainbridge, N. Y.

The lethal effectiveness of ultraviolet radiation is well known, but available evidence concerning the degree of destruction of bacteria in milk under conditions which are adaptable for practical use, is very meager. The results from studies with commercial milk extending over a period of some years, have revealed the merits and limitations of this bactericidal principle as applied to milk wherein certain improvements in the experimental technique were employed.

By irradiating smooth flowing milk films of known characteristics and using appropriate spectral quality and intensity of the incident radiation, a reduction in bacteria count of average raw milk of 95 to 98% was obtained, with substantial regularity. This reduction may be accomplished without development of adverse flavor and odor within an exposure period of about seven to eight seconds or less. The spectral characteristics and the intensity of the radiations and method of application were found to be more significant in obtaining a consistent high percentage reduction, than variations in the resistance of the organisms comprising the usual milk flora.

Sub-lethal applications of ultraviolet energy of which a predominant proportion consisted of short radiation (2200–2300 Å but with none of the 2537 Å line) gave irregular results with evidence that such radiation may actually increase the bacteria count of milk under given conditions. Whether the increase in plate counts was due to a dispersal of clumps or to a stimulating effect on individual organisms is a matter of conjecture.

Irradiation at elevated temperatures, or simultaneous irradiation during elevation of the temperature by electrical heating of the flowing film, did not significantly enhance the lethal effectiveness of the ultraviolet energy; such method of treatment tends to develop a characteristic irradiation flavor.

Percentage reduction curves obtained with an experimental flowing film electric pasteurizer wherein the temperature may be raised to any desired degree within a period of about 0.8 second are compared with percentage reduction curves obtained by ultraviolet radiation under varying conditions of treatment. The data illustrate comparatively, the bactericidal effectiveness of both forms of energy applied to milk under conditions potentially adaptable for other than laboratory demonstration, and wherein the time element is reduced substantially to an irreducible minimum.

570. The Reliability of the Room Temperature Holding Test as an Index to the Keeping Quality of Butter. D. H. JACOBSEN, C. C. TOTMAN, AND T. A. EVANS, South Dakota State College, Brookings.

About 78 samples of butter were used in a study of the holding test. Scoring contest butter from entries of 3 different years and from 28 South Dakota creameries was used. Fresh scores ranged from 89 to 94 with the largest percentage ranging from 90 to 93. The salt content varied from 0.5 to 3.0 per cent and the average was 1.8.

The holding test conditions were 7 days at 70° F. The butter was scored when fresh and again at 7 days at 70° F. and after 30 days at 40° F. Samples losing most in score in the holding test, lost less in 30 days at 40° F. Samples losing least in score in the holding test, lost more in 1 month at 40° F. but only slightly more. Reference is made here to averages; several exceptions were noted. In most cases, scores under the 2 holding conditions show considerable correlation.

Flavor criticisms of the butter after holding indicate that greater bacteriological changes took place at 70° F. and that chemical changes were greater at 40° F. Yeast and mold counts on fresh butter showed no relation to keeping quality.

BOOK REVIEWS

571. Principles of Dairying. HENRY F. JUDKINS AND MERRILL J. MACK. 315 pp. Published by Wiley. 1941.

The third edition of this book in elementary dairying has been revised

by Professor Merrill J. Mack of Massachusetts State College. The book treats the subject largely from the standpoint of handling of milk and milk products.

The table of contents remains practically the same as the second edition (Judkins and Smith) with the exception of a new chapter added entitled "Quality Tests for Milk," to replace the chapter on "Acidity and Its Relation to Dairy Products." This new chapter contains considerable material not included in previous editions.

Much new material has been added to bring the book up-to-date. New illustrations, tables, problems and references have been added. Questions, problems and suggested practicums are given after each chapter. The chapters on "Properties of Milk," "Testing of Milk and Milk Products" and "Food Value" have been enlarged considerably and include much new information. The nineteen chapters cover the following subjects:

The General Scope of the Dairy Industry
The Secretion of Milk
The Composition and Properties of Milk
Factors Affecting the Composition of Milk, Particularly the Butterfat Content
The Sampling of Milk and Cream
The Babcock Test for Whole Milk
The Babcock Test for Milk Products
Testing Milk for Total Solids
The Bacteriology of Milk
Quality Tests for Milk
Keeping Milk and Butterfat Records
Essentials in the Production and Handling of Market Milk on the Farm
Market Milk from Farm to Consumer
The Separation of Cream
Butter Making
Ice Cream Making
Cheese Making
Miscellaneous Dairy Products
The Food Value of Milk and Its Products.

C.D.D.

572. Brucellosis (Undulant Fever) Clinical and Subclinical. HAROLD J. HARRIS. Paul B. Hoeber, Inc., New York. 1941. 286 pp., illustrated. Price, $5.50.

This excellent monograph on brucellosis was written primarily for the medical profession. However, it also provides information of definite interest to all who at some time or other might be affected by brucellosis or be responsible in any way for conditions or situations influencing its spread or transmittance.

The author has included a historical review as well as chapters on the etiology, epidemiology, pathology, symptomatology, diagnosis, prognosis,

treatment and prophylaxis of the disease. The numerous case histories with photographs and detailed descriptions of symptoms, diagnosis and reaction to treatment should prove highly useful to practicing physicians whose experience with this disease has thus far been limited. The author repeatedly emphasizes, as have recent investigators in this field, that while acute brucellosis frequently is recognized, the more common chronic form is in many cases never reported to a physician and altogether too often diagnosed incorrectly. According to the author, "There is no infection, except syphilis, that masquerades under so many guises as does brucellosis." He agrees with Levine and associates in their statement that "When brucellosis becomes chronic the one constant symptom is weakness; fever may not be present at all. The symptoms are confused with neurasthenia because there is exhaustion, insomnia, irritability and complaint of aches and pains for which no objective signs can be found."

Incidence figures of Gould and Huddleson reported in 1938 are interpreted as follows: "While an actual census made throughout the United States on a given date would probably reveal 120,000 persons clinically ill with the disease, any of the 12,000,000 infected persons may be added to that census as their infections wax and wane."

All public health officials and particularly dairy and meat sanitarians would profit by reading the chapters entitled respectively Epidemiology and Prophylaxis-pasteurization as well as the medico-legal aspect treated in the Addenda. In the chapter on prophylaxis, the author presents what he considers a desirable two point program to combat this disease: "(1) Pasteurization of all milk (the absolute prohibition of the sale of raw milk from any herd, no matter what its history and its record of laboratory tests). (2) A nation-wide campaign to destroy all infected cattle, sheep, goats, pigs, horses and all farm or domestic animals known to harbor the disease."

This two-point program is proposed to protect those individuals who habitually or occasionally drink infected raw milk and those whose occupations expose them to virulent organisms. The latter group includes stockyard and slaughter-house employees, butchers, meat dealers, chefs, farmers, dairymen, veterinary surgeons, and laboratory workers. Obstacles involved in and benefits to be attained from such a program are discussed. P.R.E.

573. Annual Review of Biochemistry. Vol. *10,* 1941. Published by Annual Reviews, Inc., Stanford University P. O., Calif. 692 pp. $5.00.

The **Annual Review of Biochemistry** is a volume consisting of chapters on biochemical subjects written by various individuals at the request and invitation of an editorial board. At times, certain subjects of broad aspect are discussed in consecutive years by various writers, thus permitting pre-

sentation of more than one viewpoint or approach in discussion. The volume is definitely by and for those engaged in educational, research and supervisory activities, although much of the material is of value to individuals having a "lay" knowledge and seeking review material. It is the intent of the Annual Reviews to consolidate the newer knowledge of a subject made available over a relatively recent period, say one, or two or three years. In this respect the volume is an authoritative review and will be of immediate value to the worker desiring to keep informed of the progress in the biochemical sciences. Volume *10* contains 24 chapters, plus a complete author and subject index. The following chapters will be of service to those whose activities include the production, processing and appraisal of the nutritional value of milk: Proteolytic Enzymes; Nonproteolytic Enzmyes; Fat Metabolism; The Metabolism of Proteins and Amino Acids; The Water Soluble Vitamins; Fat-Soluble Vitamins; Nutrition; Relation of Soil and Plant Deficiencies and of Toxic Constituents in Soils to Animal Nutrition, and Bacterial Metabolism. Other subjects which may be of interest to dairy industry workers are: biological oxidations and reductions, chemistry of the carbohydrates, glycosides, compounds of sulfur, carbohydrate metabolism, biochemistry of nucleic acids, purines, pyrimidines, creatine, creatinine, and hormones. K.G.W.

574. Indian Indigenous Milk Products. W. L. DAVIES. Published by Thacker, Spink and Co., Ltd., Calcutta, India. 1940. 96 pp., heavy paper cover, Rs. 1/8 (about 40–45 cents.)

This small but interesting text of the dairy products of India was written by W. L. Davies, Director of Dairy Research, Government of India, Calcutta, and author of the book "The Chemistry of Milk." This text is divided into seven chapters on: Composition and Behavior of Milk; Indian Milk and Whole Milk Products—Khoa and Rabbrï; Fermented Milk Products, Dahi and Lassi; Desi Butter, Ghee; Miscellaneous Products, Creams, Cheese, Channa; Utilization of Indian Milk for Manufacture of Western (World) Products.

One of the appreciated advantages of the volume is the comparison made between the various Indian milk products and comparable products of greater familiarity to us. In addition, the manufacture of the representative Indian products is given in sufficient detail, and technical control terms that the processes can be readily visualized and probably duplicated. For example, times and temperatures, titratable acidity, pH, color, physical appearance, keeping quality, native utensils and so forth are included to describe the making of the various products. Malai and sar are classified as clotted cream, khoa and rabbrï as dried, evaporated and sweetened condensed (khoa and rabbrï 6–1, Kheer 3.5–1). Channa is comparable to soft cheese, dahi and lassi resemble the fermented buttermilk, desi butter (soured

cream "country butter"), and ghee, heated melted butter. An interesting discussion is included on the probabilities and problems of making "western products" from the native milks. The discussion on ghee, an important dairy food item, is quite complete. The text will be of value to those seeking to develop new products and new uses of products. K.G.W.

BACTERIOLOGY

575. Single Colony Isolation of Anaerobes. L. GREENBURG, Dept. of Pensions and National Health, Ottawa, Canada. Canad. Pub. Health Jour., *32:* 84–85. 1941.

A method of isolating anaerobes which requires no special apparatus is described. A very light inoculum is transferred to 5 ml. of sterile broth and mixed. A loopful of this broth is then transferred to the special semi-solid media which has been heated in boiling water to displace oxygen and then cooled at 45° C. For most *Clostridium* species studied, incubation was at 22° C. overnight followed by holding at 37° C. Cultures are removed from the incubator when colonies are of a suitable size. The medium used is: Proteose peptone, 10 grams; Tryptone, 10 grams; Sodium Thioglycollate, 1 gram; Agar, 3 grams; Distilled water, 1,000 ml.

This medium is adjusted to pH 7.4, dispensed into tubes and autoclaved at 15 pounds pressure for 20 minutes. O.R.I.

576. Laboratory Procedures in Staphylococcal Food Poisoning. R. J. WILSON, Univ. of Toronto. Canad. Pub. Health Jour., *31:* 607–612. 1940.

A method is outlined whereby individual strains of staphylococci may be identified by their toxigenic properties. The regular methods of classifying these organisms by means of carbohydrate utilization, chromogenicity, etc., are unsatisfactory to incriminate enterotoxin producing strains. Identification is made by tests for hemolysis, color and the kitten test, in addition to other procedures. O.R.I.

577. A Study of Methods for the Detection of the Presence of Coliform Organisms, in Water. N. J. HOWARD, A. G. LOCKHEAD AND M. H. MCCRADY. Canad. Pub. Health Jour., *32:* 29–36. 1941.

Results are presented from five laboratories where the brilliant green bile test was compared with the A.P.H.A. "completed test" as confirmatory procedures for the detection of coliform organisms in water supplies after lactose broth had shown positive results in the presumptive test. The results indicate that the brilliant green bile method is quite as satisfactory as the "completed test." O.R.I.

BREEDING

578. Estimates of Producing Ability in Dairy Cattle. G. E. DICKERSON. Jour. Agr. Res. *61,* No. 8: 561. October 15, 1940.

Lifetime butterfat production records of 274 Holsteins from 41 herds were studied to determine what adjustments for environmental influences are advisable and the relative usefulness of five kinds of adjusted records (240-day, 305-day, 365-day, total lactation, and testing year) in selecting cows for producing ability. The average within-herd correlation between records of the same cow (repeatability) was the criterion used in evaluating adjustments and comparing kinds of records.

Age-correction significantly increased the repeatability of all five kinds of records. Correction for calving interval to a 365-day basis increased the repeatability. Season of calving was a relatively unimportant source of variation in production and no correction factors were given. It was concluded that the age-corrected 305-day record was probably the most satisfactory for selection purposes because of its early availability, ease of computing and high degree of correlation with the average lifetime record.

W.J.C.

579. Judging Dairy Cattle on the Basis of Type and Records of Production. W. W. SWETT AND R. R. GRAVES, Bureau of Dairying, Washington, D. C. U.S.D.A. Miscellaneous Publication 409. 29 pp. Jan., 1941.

In order to place cows on a combined type and production basis a system for numerical evaluation is presented. Ten per cent of the yearly butterfat production records corrected to maturity are used as a base. If equal emphasis is placed on type and production the extreme scores for type are the same as the extreme values of the 10 per cent of the butterfat production. As an example, if 10 per cent of the highest and lowest producing cows is 98.8 and 40.2 respectively, then the best type cow is scored 98.8 and the poorest 40.2 regardless of the range of differences in type. Intermediate types may be credited with scores of adjusted intervals, depending upon variations of the type in the group. The final placing is based upon a summation of the type "score" and the production "score."

A more complicated system of scoring proven bulls involves: (a) rating on average type of daughters, (b) average production of daughters, (c) average increase of butterfat production by daughters, and (d) per cent of daughters that increased production. The scores for type and average increase in butterfat production for the highest and lowest sires have the same numerical values, respectively, as the highest and lowest average butterfat production of the daughters. The values of all four considerations are summated for final placing.

W.E.P.

580. Early Recognition of the Freemartin Condition in Heifers Twinborn with Bulls. W. W. SWETT, C. A. MATTHEWS AND R. R. GRAVES. Jour. Agr. Res., *61,* No. 8: 587. Oct. 15, 1940.

It is estimated that about 11 out of 12 heifers twinborn with male calves will be freemartins. In a study of 17 heifers twinborn with male calves all those that were kept to breeding age proved to be sexually abnormal and incapable of reproduction. Two of the 17 heifers were found on post mortem to have normal genital development.

Characteristics found to be associated with freemartins were: 1. highly retarded udder development or atypical mammary gland development; 2. enlarged clitoris; 3. the presence of a fold of skin often containing a cord which extended along the median plane of the body, part or all the way from a point above the rear attachment of the udder to the navel. One to all three of the characteristics were found in the 15 freemartins studied. W.J.C.

BUTTER

581. Leaky-bodied Butter. S. T. COULTER, Univ. of Minnesota, St. Paul. Natl. Butter and Cheese Jour., *32,* No. 6: 14. 1941.

Leakiness in butter is measured by determining its loss of weight when 1 pound prints are subjected to high vacuum for 10 minutes followed by removal of free moisture in an air blast. Leakiness is decreased by the use of fat found in Summer butter; by thorough cooling of cream; by low temperatures of working; probably by adding water for standardizing at the start of working; by salting while the butter is in the granular form; by thorough working; and by avoiding the addition of too much water in standardizing. W.V.P.

CHEESE

582. Au Suject de L'adaptation des Butyromètres a Lait pour le Dosage de la Matière Grasse dans les Fromages. (On the Subject of the Adaption of Milk Butyrometers to the Determination of Fat in Cheese.) MADAME JEAN BOURGEOIS. Le Lait, *20:* 403–407. 1940.

Confusion exists as to the correct factor to use in calculating the fat content of cheese when 2.5 g. of sample are used in the milk butyrometer. One factor was suggested on the basis that the milk butyrometer was calibrated on the basis of volume while the second factor is based on weight. Literature is reviewed and it is suggested that the factor, 4.4 based on weight calibration, is more reliable. O.R.I.

583. Preliminary Observations on the Survival of *S. typhi* in Canadian Cheddar-type Cheese. L. E. RANTA AND C. E. DOLMAN, Univ. of Toronto. Canad. Pub. Health Jour. *32:* 73–74. 1941.

Five ml. amounts of a standardized *S. typhi* broth culture were intimately mixed with 30 cc. of minced British Columbia Cheddar cheese and stored in sealed Petri dishes at 68° F. At intervals, samples were withdrawn, macerated in sterile saline and single drops spread on plates of selective media. In three trials, survival occurred until twenty-sixth, twenty-eighth and twenty-sixth day respectively. In the refrigerator, samples were positive for 17 weeks after inoculation.

In the second series of trials a standardized suspension of *S. typhi* was made in Seitz-filtered whey. This was poured over unmacerated cheese in a Petri dish. Survival time was approximately the same as in the above trials. In a third trial, it was shown that *S. typhi* possessed the ability to penetrate cheese for 4–5 cm.

The authors suggest that these observations point out the need for significant changes in control measures in the manufacture and marketing of Canadian Cheddar cheese. O.R.I.

584. Factors Affecting the Survival of *Streptococcus Pyogenes* in Cheese. M. W. YALE AND J. C. MARQUARDT. Jour. Milk Tech., *3:* 326–333. 1940. (Also published in the 14th Annual Report of the N. Y. State Assoc. of Dairy and Milk Insp., 1940.)

In cheese made from milk inoculated with *S. pyogenes,* the variety of the cheese, its moisture content, and curing temperature were some of the important factors affecting the length of survival of these organisms in the cheese.

In cottage cheese where the minimum pH values were about 4.5 the organism was not recovered at the end of 24 hours.

When pasteurized milk inoculated with *S. pyogenes* was added to 28 hour old curd, no *S. pyogenes* were recovered 20 hours later.

S. pyogenes survived for 28 to 51 days in limburger cheese containing 42.8 per cent moisture and for only 9 to 14 days in another lot containing 49.3 per cent moisture. In the case of cheddar cheese the organisms survived much longer, curing temperature being a factor. In cheese cured at 45° F. the organisms survived for over 18 weeks, while in duplicate cheese cured at 62° F., they survived for only between 9 and 11 weeks. At 50° F. they survived for less than 18 weeks. L.H.B.

585. Pasteurization for Cheesemaking. E. C. DAMROW, Fond du Lac, Wis. Natl. Butter and Cheese Jour., *32:* No. 6: 10. 1941.

The regenerative system of pasteurization is most practical because it uses steam and water efficiently. Such a system with a capacity of 6500 pounds of milk per hour, uses seven and one-half horse power per hour, while water requirements range from nothing up to 2500 pounds depending on the temperature of incoming milk. W.V.P.

CHEMISTRY

586. La Fabrication D'acide Lactique Pur. (The Manufacture of Pure Lactic Acid.) G. GENIN. Le Lait, *20*: 412–417. 1940.

The manufacture of crude and purified lactic acid is reviewed and industrial standards of purity are outlined. Six different methods of purifying are described including (1) purification by crystallization as calcium lactate; (2) or as zinc lactate; (3) extraction from aqueous solution using such solvents as isopropyl ether; (4) oxidation of the organic impurities by chromates, permanganates, ozone, etc.; (5) fractional distillation, and (6) separation and hydrolysis of lactic esters. The latter is the method of Smith and Claborn (Indust. Engin. Chem. News Ed., *7:* 641. 1939). O.R.I.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

587. Analyse des Laits Altérés ou Coagulés. (The Analysis of Altered or Coagulated Milk.) E. G. VOIRET, Municipal Lab., Lyon. Le Lait, *20:* 407–410. 1940.

A laboratory-sized, motor-driven mill is described and illustrated which has proven satisfactory for the reconstituting of milk samples which have developed abnormal consistencies. The motor is mounted vertically and operates several stirrers in the base of the hopper. In addition, a disc, also integral with the motor shaft and stirrers, helps emulsify the samples.
O.R.I.

588. Deux Nouveaux Défauts du Lait Concentré Sucré. (Two New Defects of Sweetened Condensed Milk.) C. A. CECILIA, Vet. School, Madrid. Le Lait, *20:* 385–390. 1940.

Two flavor defects of bacterial origin in sweetened condensed milk are described. One possesses the odor of fish while the second has the odor and taste of glue. In the case of the fishy flavor samples, the cans were greatly swelled, the contents coagulated and stuck to the sides and yellow-brown in color. The titratable acidity was 0.5–0.7 per cent and the Breed count 20,000–50,000 per gram on the samples which had been previously unopened. *B. mycoides* and *B. mesentericus* were isolated either singly or in combination in these samples. In no case was *Proteus ichthyosimus* Hammer found. While it was found impossible to reproduce this defect by inoculating sweetened condensed milk with these organisms and with *B. pseudo anthracis*, alone or in combination, nevertheless, it is still felt by the author that their presence contributes to this off flavor.

Cans containing milk possessing the glue flavor were normal in external appearance although some swelled after being incubated for 48 hours. The

color, viscosity, and solubility were normal. Acidities ranged from 0.3 per cent to 0.8 per cent. Plate counts ranged from 1,000 to 15,000 colonies per gram. Some of the small colonies isolated from the plates produced a glue flavor grown on lactose agar. The following characteristics were found for the organism: A *Strepto bacillus* producing longer chains in milk than in other media; well capsulated especially if allowed to stand in the incubator for a few days; cells display metachromatic granulations; dimensions are less than those of *B. anthracis;* non-motile and does not form spores.

It may be considered as a facultative aerobe growing up to 55° C. Milk is coagulated in 72 hours. The name *Thermobacterium mathiacolle* has been proposed for this organism. O.R.I.

DISEASE

589. Simplified Cultural Methods for the Diagnosis of Streptococcic Mastitis. RALPH B. LITTLE, Rockefeller Inst., Princeton, N. J. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *21:* 565–570. Apr. 1941.

The Hotis test as originally reported by Hotis and Miller was modified by the addition of sodium azide to brom cresol purple which prevented the development of coliform organisms without hindering the growth to *Str. agalactiae.* For a more critical test Edwards selective liquid medium was used. Serological identification of streptococci can be made from Edwards selective medium growth. The above tests result in a saving of time and simplification of equipment. E.F.G.

590. A New Group of Sterilizing Agents for the Food Industries and a Treatment for Chronic Mastitis. F. M. SCALES AND MURIEL KEMP, Sheffield Farms Co., New York City. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *19:* 491–519. Apr. 1941.

The literature with reference to wetting agents as germicides is reviewed and the results of new work reported.

The wetting agents have the advantage over chlorine solutions in their wetting properties causing uniform films on surfaces, and also in stability and no corrosive action. Death of the bacterial cell is brought about by the wetting quality permitting penetration of the mildly toxic agent to the protoplasm of the bacterial cell. The wetting agents used included Aerosol OT, Nacconol, Modinal E S, Intramine Y, Triton 720, Aerosol D G A, Turkey Red Oil, Mellol No. 100.

The wetting properties of many of these preparations as sold is reduced and their germicidal properties are reduced by admixtures of neutral salts as sodium sulphate or sodium chloride. Aerosol O T in pure solution gave killing effect in 3 minutes at room temperature on high concentrations of *Staph. aureus* in solution of pH 4.0 acidified with phosphoric acid. Ther-

moduric organisms may be killed in plant work by wetting agents in a 0.03 per cent concentration at pH 4.0 at a solution temperature of 22° C. and up. For farm utensils the following procedure is suggested. Wash the utensil in an alkaline solution plus the wetting agent which will considerably reduce the number of organisms. Rinse with warm water and finally give a second treatment with a solution of cleaning powder and wetting agent which will sterilize in ten minutes at 43.5° C. and up. The cleaning powder used should contain sodium tetra phosphate to remove any lime deposits from the utensils. Spores of *B. subtilis* are not acted upon readily even by the best of the wetting agents Aerosol O T. Zephiran is a good agent to use for cows udders since it is effective in neutral solutions. For udders a 1 to 5000 dilution is recommended. This compound has the ability to reduce the surface tension of water to approximately half, resulting in suds upon shaking. It is suggested that injection of wetting agents directly into the milk cistern may hold possibilities for treatment of chronic mastitis. Corrosion by the wetting agent acidified with phosphoric acid (pH 4.0) was approximately one sixteenth as extensive on tinned copper as hypochlorite solutions of 100 p.p.m. available chlorine. Sterilizing solutions of wetting agents will cost from $\frac{1}{3}$ as much to the same as chlorine. E.F.G.

591. Contagious Abortion of Cattle and Undulant Fever in Man. J. S. FULTON, Univ. of Saskatchewan. Canad. Pub. Health Jour., *32:* 194–198. 1941.

While contagious abortion has been known to be common in Saskatchewan for many years, it is only recently that a blood testing service has revealed the extent of human Brucillosis. Since 1933, the percentage of reacting bovine blood samples has been halved as have also the percentage of positive human blood samples.

Results are given of a study of the milk of 60 reacting cows in which 70 per cent were found to yield *Br. abortus* in their milk. The organism survived at least 18 months in sterile milk at icebox temperatures.

Details are given of the Saskatchewan plan of control whereby municipalities are encouraged to foster eradication programs. O.R.I.

592. The Present Status of Milk-Borne Disease Hazards. C. E. DOLMAN, Univ. of British Columbia. Canad. Pub. Health Jour., *32:* 183–193. 1941.

National public health statistics usually indicate a far lower incidence of disease than actually occurs. It is suggested that milk-borne diseases may result in 1500 cases and 130 deaths in Canada per year as a result of typhoid, paratyphoid and scarlet fevers, and septic sore throat. Cases of tuberculosis and Brucillosis of bovine origin are difficult to blame on milk since they do not occur in epidemic form.

The rate of incidence of such diseases as tuberculosis, Bang's disease and streptococcal and staphylococcal mastitis is estimated and the relation of these bovine diseases to human diseases pointed out by means of references to recent literature.

The need for control of typhoid and other types of carriers is discussed, the former particularly in the case of cheese producers. The use of pasteurization in the preparation of all dairy products is particularly stressed as a preventive measure. O.R.I.

593. Transmission of Animal Disease to Man through Milk. MAZYCK P. RAVENEL, Univ. of Missouri. Canad. Pub. Health Jour., *32:* 174–182. 1941.

Although this treatise is not extensive nor complete, it is a very clear discussion of three animal diseases transmissible to man through milk. The diseases dealt with are: Brucellosis, the pathogenic cocci, and tuberculosis. Enough of the pioneer work is reviewed to make the account very interesting. O.R.I.

594. The Significance of the "Ceased" Reactor to Bang's Disease. B. A. BEACH, M. R. IRWIN, AND L. C. FERGUSON. Jour. Agr. Res., *61,* No. 1: 75. July 1, 1941.

Twenty-one "ceased" reactors (those animals that have lost their agglutinin titer to *Brucella abortus* following infection) were allowed to comingle with 54 animals from Bang-negative herds through either 1 or 2 gestation periods for each of the normal cows. Except for a transitory udder infection in one "ceased" reactor and a low titer in the blood serum of one normal cow (no evidence of the organism) no evidence of infection was obtained by culture or guinea pig injection at the time of calving. The results of the experiment indicated that it is relatively safe to allow "ceased" reactors to contact normal or non-infected cows. W.J.C.

595. Ineffectiveness of Proprietary Remedies and Other Drugs in the Control of Bang's Disease with Special Reference to "3-V Tonic" and "Bowman's." A. B. CRAWFORD AND B. A. BEACH. Jour. Agr. Res., *60,* No. 8: 565. Apr. 1, 1941.

The history of drugs or other therapeutic chemicals in the treatment of Bang's disease has been negative so far as finding any substance which has a specific action on *Brucella* organisms in the tissues of animals. In spite of this fact so-called remedies for Bang's disease still appear on the market. Two of these alleged remedies "3–V Tonic" and "Bowman's" were tested for their effectiveness.

In testing "3–V Tonic" a group of 19 pregnant heifers negative to the agglutination test was fed this product prior to exposure to virulent strains

of *Brucella abortus;* a second group of 20 heifers was fed the preparation prior to and subsequent to exposure; and a third group of 19 heifers, as controls, received only exposure. *Brucella abortus* organisms were found in the colostrum or uterine material of all cows following parturition. All cows either aborted or gave birth to weak calves.

In the testing of Bowman's product a group of 19 pregnant heifers was fed the preparation prior and subsequent to exposure to *Brucella abortus* and a second group of 20 heifers as control were only exposed. All heifers in both groups except one in each group either aborted or gave birth to weak calves and *Brucellus* organisms were recovered in uterine material or colostrum of all 30 animals. Feeding the material for 8 months after infecting did not decrease the blood titer.

It was concluded that the "3–V Tonic" and Bowman's were ineffective in preventing or curing Bang's disease. W.J.C.

596. Treatment of Nephrosis with Vitamin A and Unsaturated Fatty Acid Therapy. GEORGE W. CALDWELL. Arch. Ped., *57*, No. 4: 247. 1941.

A case is reported where a seven-year-old girl suffering from nephrosis was treated by feeding 40,000 to 100,000 units of vitamin A per day and 2 to 6 teaspoonfuls of corn oil (unsaturated oil) daily. The case responded quite favorably to this treatment which suggests that nephrosis is a deficiency disease in addition to any infectious factor. W.J.C.

597. Suprarenal Gland and Lactose in the Treatment of Major Disorders in Childhood. STEPHEN D. LOCKEY. Arch. Ped., *57*, No. 11: 725. 1940.

Whole suprarenal gland concentrate plus lactose (1 to 111 drams daily depending on age) were fed by mouth to 163 cases of major allergic disorders of children (eczema, asthma, hay fever) with a clinical improvement in approximately 82 per cent of the cases. In bronchial asthma the suprarenal gland concentrate and lactose reduced the frequency of attack and the attacks were milder when they did occur as compared to the control groups. Suprarenal gland concentrate and lactose improved the general health condition of the children as compared to the controls. The administration of the suprarenal gland concentrate and lactose to children afflicted with eczema showed very marked improvement in 3 to 5 days. W.J.C.

598. The Leucocyte Count and the Chloride Content of Milk from Bovine Udders with Mild Streptococci Infections. J. FRANK CONE. J. Milk Tech., *3:* 341–345. 1940. (Also published in the 14th Annual Report of the N. Y. State Assoc. of Dairy and Milk Insp., 1940.)

The chloride content and leucocyte count of milk failed to reliably distinguish between mildly infected quarters and non-infected quarters. In conjunction with bacteriological tests the chloride content and leucocyte count of samples from the various quarters of the same udder gave valuable information in support of the cultural method.

An abrupt rise in the chloride content and leucocyte count of the milk from cows tested periodically strongly indicates the beginning of infection, even though these values may not exceed the values arbitrarily set as indicating mastitis.

The leucocyte count is a more reliable index for detecting mastitis than is the chloride content. L.H.B.

FEEDS AND FEEDING

599. Untersuchungen über die Veränderung der Nährstoffe durch künstliche Trocknung. (Studies Relating to Feed Drying Techniques and Nutritive Value Changes). W. LENKEIT AND M. BECKER. Ztschr. f. Tierernährung und Futtermittelkunde, *4*: 20–37. 1940.

This article deals with procedures to preserve carotene in beet leaves and red clover. Sixty to 90 per cent is retained by shredding and pressing. In the normal hay drying procedures only 30 per cent of the carotene content is retained. J.C.M.

600. The Feeding Value and Nutritive Properties of Citrus By-products. II. Dried Grapefruit Pulp for Milk Production. P. T. DIX ARNOLD, R. B. BECKER, AND W. M. NEAL. Florida Agr. Exp. Sta. Bul. 354. 14 pp. 1941.

In feeding trials where it composed 40 per cent of the T.D.N. of the ration, dried grapefruit pulp was found to have about the same value in the dairy ration as dried beet pulp. It is palatable to dairy cows and produced no detectable flavors in the milk. Twenty-day digestion trials on 4 steers showed 24.8 per cent of the crude protein, 71.5 per cent of the crude fiber, 92 per cent of the nitrogen-free extract and 79.4 per cent of the crude fat to be digested. The dried product was calculated to contain 1.2 per cent digestible crude protein and 76.0 per cent T.D.N. W.E.P.

601. Estimating the Quantity of Settled Corn Silage in a Silo. J. B. SHEPHERD AND T. E. WOODWARD. U.S.D.A. Cir. 603. 11 pp. April, 1941.

Data and table are presented giving average weight and dry matter per cubic foot for silage at varying depths for corn averaging 27.63 per cent dry matter. Except for the first three feet (which were not as heavy) the table shows higher weights per cubic foot than the table of Eckles, Reed

and Fitch. The weights per cubic foot increased rapidly for the first five feet and more slowly up to depths of 30 feet, below which the weights were practically constant. Settling continues for 30 days.

Stage of maturity affected silage weight. If the corn is well eared but immature, add 5 per cent to weights; if only a fair number of ears, deduct 5 per cent and if it has few or no ears deduct 10 per cent. If the corn contains 31 to 33 per cent dry matter and ears are fully dented, deduct 5 to 10 per cent. If corn contains 34 to 36 per cent dry matter and ears are fully dented, deduct 15 to 20 per cent.

Finely cut silage weighs more. When cut in $\frac{5}{8}$ to $\frac{3}{4}$ inch lengths, deduct 5 per cent as compared to $\frac{1}{4}$ inch lengths. W.E.P.

FOOD VALUE OF DAIRY PRODUCTS

602. The Pigments, Vitamins and Enzymes of Milk in Relation to Changes in Flavor and Nutritive Value. DAVID B. HAND AND PAUL F. SHARP, Cornell University, Ithaca, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *17:* 460–463. March 1941.

It is pointed out that the oxidation changes which take place in pasteurized milk and other dairy products resulting in flavor changes and loss of nutritive value are only partially understood.

Vitamin C behaves as an antioxidant and the addition of relatively large amounts of it to milk will retard the development of oxidized flavor. Experiments have shown that riboflavin, the fluorescent green coloring matter in whey, is responsible for the oxidation of vitamin C in light. Riboflavin when combined with a specific protein becomes a catalyst or enzyme. About 5 per cent of the total riboflavin of cows' milk is so combined. The flavoprotein or Shardinger enzyme is concentrated on the surface of the fat globule. If cream rich in riboflavin is wanted it should be separated raw since pasteurization breaks down the flavoprotein and there is then no concentrating effect from separation. Carotene is considered to be an antioxidant. Tallowiness may develop as the carotene in cream is bleached. Oxidized fats exert a destructive effect upon both vitamin A and E. The interaction of vitamin C and hydrogen peroxide offers a clue to the way vitamin C retards the oxidation of fats. The initial stage in the oxidation of fat is thought to be the formation of an organic peroxide. It is possible that vitamin C reduces this peroxide as fast as it forms. E.F.G.

603. Some Observations on Canadian Nutrition. E. W. MCHENRY, Univ. of Toronto. Canad. Pub. Health Jour., *31:* 584–588. 1940.

Some fairly accurate information has recently been accumulated regarding deficiencies in Canadian dietary habits among two income groups. The

average values for 100 families having incomes below $1,000 per year showed that the supply of calories was 76.5 per cent of the recommended standard; protein supply, 77 per cent; calcium, 69 per cent; and iron, 62 per cent. In the the income group between $1,500 and $2,400 these values were: total calories, 93 per cent of standard; protein, 95 per cent; calcium, 116 per cent; and iron, 99 per cent.

While this evidence suggests that undernutrition is due to financial inability to buy proper food, other factors were found to contribute to this picture particularly lack of nutritional knowledge. For low income groups, the use of more milk, skimmilk, and cheese is advocated as well as the use of breads containing whole wheat flour or wheat germ to increase the intake of the B group of vitamins. O.R.I.

604. An Educational Program to Raise Nutrition Levels through Increased Milk Consumption. M. FRANCES HUCKS, Milk Foundation of Toronto. Canad. Pub. Health Jour., *32:* 158–162. 1941.

A co-operative, producer-distributor, non-commercial enterprise which is now in its fourth year is known as the Milk Foundation of Toronto. This foundation has had the support of other health groups and its program has been readily accepted, particularly by school authorities. Its principal aim is to foster interest in, and promote greater consumption of milk. In addition to its school program, newspaper advertisements, lectures, food demonstrations and a technicolor sound film have been widely used. O.R.I.

605. Vitamin C—Practical Considerations. I. A. GOULD. Michigan State College, East Lansing, Mich. Milk Dealer, *30,* No. 6: 108–109. March 1941.

A brief discussion is given of vitamin C, with a review of the factors influencing ascorbic acid in milk. C.J.B.

606. Effects of Milk Diets on Guinea Pigs. ROSALIND WULZEN AND ALICE BAHRS, Oregon State College, Corvallis, and St. Helen's Junior College, Portland, Ore. Am. Physiol. Soc. Proc., p. 312. Apr., 1941.

Groups of young guinea pigs were fed rations of whole raw milk, pasteurized whole milk, raw skim milk and pasteurized skim milk. Animals fed raw whole milk grew excellently and at autopsy showed no abnormality of any kind. Those on the pasteurized milk rations did not grow as well and developed a definite syndrome, the first sign of which was wrist stiffness. On pasteurized skim milk ration the syndrome increased in severity until the animals finally died in periods ranging from a month to a year or more. They showed great emaciation and weakness before death but remained in normal posture and had no tendency to paralysis of the limbs. Upon

autopsy the muscles were found to be extremely atrophied and in most cases were streaked with closely packed, fine white lines of calcification running parallel to the muscle fibers. There were often lumps of tricalcium phosphate deposited under the skin, in the joint regions, between the ribs and indiscriminately in many body organs including heart and aorta.

It was found that raw cream given by mouth had power to cure the original wrist stiffness. An extract was made from raw cream which was able in a few days to restore the stiff wrists of affected animals to their normal limber condition. This active substance was found by Romeo Gouley to be methylvinylketone and was successfully synthesized by him. The synthetic product had active curative power.

When cod liver oil, one-half per cent, was substituted for carotene in the skim milk ration, in addition to stiffness the animals quickly developed paralysis. Their hind legs dragged and locomotion soon became impossible. It was found that synthetic methylvinylketone was able to restore locomotion to those animals provided they were not moribund. D.L.E.

HERD MANAGEMENT

607. Bull Quarters, Breeding Chute, Yard-house. J. G. HAYS, A. J. BELL AND C. H. JEFFERSON. Mich. State College Ext. Bul. 32. 12 pp. March 1941.

Details with illustrations are given for building the bull house, yard and breeding chute. W.E.P.

ICE CREAM

608. Pastuerizing Ice Cream Mix. J. M. BRANNON, Univ. of Illinois. Ice Cream Field, *37*, No. 5: 26. 1941.

The evidence available leaves little doubt that pasteurization at 150° F. to 160° F. will destroy all disease germs in ice cream mixes. It is the author's opinion that high bacterial content in ice cream may be due either to (1) lack of vigilance in selecting ingredients or (2) lack of thorough cleaning of equipment.

Mention is made of an earlier survey which showed that only 17 per cent of the ice cream sold in Illinois had bacteria contents of 100,000 per gram or less. It is also pointed out that increase in the "plate count" of ice cream during freezing is probably due largely to the breaking up of bacterial clumps.

The author expresses the view that ice cream mix is generally sufficiently pasteurized and the largest number of bacteria in commercial ice cream are picked up from the equipment used after pasteurization. W.C.C.

609. Refrigeration Troubles. P. B. REED, Servel Inc., Evansville, Ind. Ice Cream Field *37*, No. 4, 21. 1941.

From the point of view of preventing difficulties in new installations three principle sources of trouble are discussed.

(1) *Leaks.* The author subscribes to the view that "all refrigeration systems leak, but some leak faster than others." The possibility of leakage in the highsides or lowsides obtained from reputable manufacturers is rather remote at present. Furthermore the use of soldered connections to replace flare nuts and flanges is a step in the right direction. Some leaks are too small to be easily detected, hence it is recommended that an excess of 10 to 25 per cent be carried in a highside receiver as a practical reserve.

(2) *Lubrication.* The early failure of mechanical parts of a refrigeration compressor is almost always due to imperfect lubrication. It is stated further that dilution of oil or washing by liquid refrigerant can be minimized by careful adjustment of expansion valves, proper location of thermostatic expansion valve bulbs and the selection of expansion valves.

(3) *Foreign matter in the systems.* Air and other "non condensable" gases are common offenders. They raise the head pressure which reduces the capacity and increases the power consumption and at the same time increase the hazard of chemical action in combination with the refrigerant. It is recommended that a high grade vacuum pump be used in addition to the old practice of "purging."

Moisture in the system also may be a source of considerable trouble. Several precautions are indicated as to possible sources of moisture. Dehydrators are sometimes used to advantage but it is claimed that "anti-freezes" are not substitutes for the elimination of moisture in refrigeration systems.

W.C.C.

610. The Profitable Production of Novelties. H. J. Brown, Central Ice Cream Co., Chicago. Ice Cream Field, *37*, No. 5: 14. 1941.

Emphasis is made of the necessity of selecting the novelties that will be acceptable to the consuming public, also the fact that relatively large scale production is required because of the special equipment necessary to manufacture such novelties. It is stated that "stick novelties" such as chocolate coated bars and frozen water ices usually account for the largest volume, and that these novelties require the greatest investment in equipment and manufacturing space.

It is stated that proper plant layout, low brine temperature, elimination of waste at filling molds, careful defrosting of filled molds, and use of suitable automatic machinery all contribute towards plant efficiency. Several operations can now be made automatic, but it is claimed that each type of operation has its own particular problems which must be considered as a basis of eliminating waste.

The selection of raw material is of most importance in profitable novelty operation but the author states that in order to gain sales volume novelties must be of high quality. W.C.C.

611. Soda Fountain Trends. R. H. CRANE, Liquid Carbonic Corp. Ice Cream Field, *37*, No. 5: 10. 1941.

The author states that the soda fountain of today is the result of a slow evolution over the past thirty-five years; further, that future improvements in the fountain itself can be expected to be slow. It is claimed, however, that the carbonated beverage business is undergoing the greatest growth of almost any industry and along with the increased consumption of these products people are buying ice cream, malted milks and other fountain products.

There is a trend towards the installation of larger soda fountain units with more attention being given to sanitation and pleasant environment associated with "modernization." Cleanliness and food health are of major importance to the consuming public and certain progressive fountain operators are capitalizing on this fact, the author states.

The reverse wall fountain accounts for 65 per cent of fountain layouts longer than 18 feet and the view is expressed that this type installation will become standard. It is also reported that a fountain may become identified in the minds of the public as a restaurant if it encroaches too far into the food business, and because of this there is a tendency towards limiting the menu in the fountain where its service operations are open to the view of the public. Other trends mentioned are: wider top slabs at the fountain, more knee room for the customers, added color and utility through use of plastics. W.C.C.

612. New Uses for Dry Ice. ANONYMOUS. Ice Cream Field, *37*, No. 4: 10. 1941.

It is stated that the annual production curve for dry ice shows a high peak from May 15 to September 15 and that any development tending to equalize the production would at the same time tend to lower production and distribution costs. Added usage in the industrial field should likewise lower costs.

Regarding more efficient use of dry ice it is claimed that (1) For delivery truck refrigeration proper insulation and the use of icefin plates offer the maximum efficiency. The conduction plate which controls temperature is the secret of this system. (2) The Siphotherm dry ice cabinet, because it requires less frequent icings and because it uses less dry ice seems best adapted to permanent operation. (3) The adoption of paper cans for ice cream makes the use of corrugated cartons and dry ice obligatory, but there is an efficient compromise between cost of carton and the amount of dry ice necessary for refrigeration purposes. Paper cartons made of "triple corrugated" paper box board add to convenience in assembling boxes of a given efficiency.

Descriptions are given of several types of paper cartons which are now being used by the ice cream industry. W.C.C.

613. Variegated Ice Cream. J. J. SHEURING, Univ. of Illinois. Ice Cream Field *37*, No. 4: 18. 1941.

Variegated ice cream is prepared by injecting flavored syrups or gels into ice cream as it comes from the freezer, in such a way as to give a wavy ribbon-like appearance throughout the finished product. It is stated that the flavoring should be injected into the ice cream as near the outlet of the package-filling attachment as possible in order to prevent the flavoring from being "smeared" with ice cream. Improvised methods are mentioned for continuous as well as batch freezers.

Settling of the flavoring material is obviously objectionable. The following methods of preventing settling are given: (1) The ice cream should be sufficiently firm or stiff when it leaves the freezer. (2) The flavoring material should be cold (at least 40° F. and preferably 32° F.) and be high in viscosity although fluid enough to be pumped satisfactorily. (3) The ice cream should be hardened as rapidly as possible and distributing cabinets should be maintained at a relatively low temperature. It is also pointed out that iciness may be caused if the flavoring material added is above 40° F., if the sugar content of the flavoring is too low, if heat shocking occurs or if the flavoring is not properly stabilized.

Many flavoring materials are now available for this type of ice cream. Chocolate, raspberry and strawberry are the most common. It is stated that fruits used for this purpose may be either fresh, frozen packed or canned, but in any case they should be in the form of puree or very finely ground. Marshmallow syrup, butter scotch fudge and caramel fudge are mentioned as other popular flavors. W.C.C.

614. Variegated Ice Cream. C. D. DAHLE, Pennsylvania State College, State College, Pa. Ice Cream Field, *37*, No. 4: 14. 1941.

Variegated ice cream, which started with chocolate ribboned through vanilla ice cream, has been sold under a variety of names. It now includes many fruit flavors, although it is stated that chocolate, raspberry and strawberry are the most important flavors.

Many types of pumps and fillers are available for satisfactory use with the continuous freezers, and some of the equipment now in use with the batch freezers, although not sanitary, result in fairly satisfactory appearing finished products according to the author. Certain very small manufacturers have been able to make this type of ice cream by pouring the flavor syrup into the ice cream as it is drawn from the freezer.

The following essentials are given by the author for desirable fruit flavors for variegated ice cream: (1) proper color, (2) correct amount of

stabilizer (usually pectin) to give desirable body, (3) proper sugar content, and (4) satisfactory acidity.

The main steps in the preparation of such fruit flavors are outlined as follows: grind or pulp the fruit, calculate the sugar content of the fruit and increase it to about 40 per cent, adjust the final acidity and the pectin content to 1 per cent or more. W.C.C.

615. Dramatizing the Soda Fountain. W. C. SHOEMAKER, Read Drug and Chemical Co., Baltimore, Md. Ice Cream Field, *37*, No. 4: 36. 1941.

Emphasis is placed on the necessity of using suitable displays to dramatize the soda fountain. Products sold at the soda fountain get proportionately less newspaper, magazine and radio advertising than drugs and patent medicines, toilet articles or tobacco and cigarettes, hence point of purchase merchandizing must be made effective if the soda fountain does the business expected of it.

Several examples are cited to show the effectiveness of "fruit window displays." Strawberries, cantaloupes and other fruits in season serve as effective display material, and it is claimed sales are materially increased accompanying their proper use.

Dramatization of fountain personnel, it is stated, is also an effective means of increasing sales. Life-sized pictures of fountain managers, or enlarged pictures of busy soda fountains can be used as centers of window displays to advantage according to the author.

Back bar displays of fruit in season serve as effective advertising it is stated. An outline is also given of the procedure used in planning and carrying through one of their "merchandizing drives." W.C.C.

616. Ice Cream is as Good as its Flavor. E. G. WEED, Foote and Jenke, Inc. Ice Cream Field, *37*, No. 5: 43. 1941.

The importance of properly selecting the mix ingredients is emphasized. No one flavor will blend with every type of mix according to the author and it is further stated that a mix with an "off" taste may need a small amount of "fortifier" in case of vanilla flavor, whereas a properly balanced mix with a good taste can be easily flavored with a minimum amount of pure, unfortified vanilla.

Since about 50 per cent of ice cream is flavored with vanilla, the selection of vanilla flavor is important. "Pure" vanilla can be obtained from many different sources and its quality also varies considerably. The increased use of vanilla concentrates is mentioned but it is stated that flavor losses vary from 10 to 30 per cent in the production of concentrated vanillas by heat processes. Mention is also made of vanilla powders prepared using (1)

finely ground beans mixed with sugar and (2) a mixture with or without beans but containing artificial vanillin.

New types of imitation vanilla flavors are being placed on the market, the author states, and he stresses the importance of buying from reputable manufacturers and having them use suitable specifications on labels.

Brief mention is made of fruit flavors including those from citrus products.

The proper care of flavors after purchase is essential if best results are to be expected, furthermore they should be used in the correct proportion it is pointed out. W.C.C.

MILK

617. Sur La Congélation du Lait. (On the Freezing of Milk.) A. FOURNIER, the Sorbonne, Paris. Le Lait, *20:* 390–402. 1940.

It is known that fresh meat withstands ordinary temperatures better than does meat which has been previously frozen. This difference is attributed to the fact that freezing destroys the cellular structure of the product.

Whether or not freezing alters the 'acidogenic' properties of milk and lactic ferments has been the subject of this study. Five ml. samples of varying proportions of milk and water, milk and lactic ferment, and lactic ferment and water have been prepared and the ability to produce acid after freezing, compared to unfrozen controls.

The ability to support acid production after freezing was not changed to what it was before being frozen. Dilution with water did not significantly affect the ability to support acid production. Although data are not given, it is stated that other properties such as flavor and reductase activity were not altered either. Apparently unsterile milk was used in this study since acidity developed spontaneously in all samples. O.R.I.

618. Conservation des Échantillons de Lait. (Preservation of Milk Samples.) E. G. VOIRET AND BONAIMÉ, Municipal Lam., Lyon. Le Lait, *20:* 411–412. 1940.

The preservation of milk samples, especially in summer or in warm countries, presents many difficulties and many of the common preservatives are not entirely efficient. The use of amyl alcohol in conjunction with potassium dichromate appears to have great advantages as a preservative. The alcohol is a good antiseptic, and remains to a considerable extent in the cream layer. It is an emulsifying agent and aids in maintaining the original properties of the milk.

Its use is suggested at the rate of about one per cent alcohol to be added at the same time as the dichromate is added. O.R.I.

619. A New Method of Retarding Oxidized Flavor and Preserving Vitamin C—Deaeration. PAUL F. SHARP, E. S. GUTHRIE, AND D.

B. HAND. Cornell University, Ithaca, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *20:* 523–545. Apr. 1941.

Destruction of vitamin C and the development of oxidized flavor in pasteurized milk may be prevented by removal of the oxygen from the milk at the time of pasteurization. Milk at the time it is produced contains an average of 22.2 mgs. of vitamin C per liter but this has been reduced to 2.9 mgs. by the time the pasteurized milk is consumed. Mixed nights' and mornings' milk as delivered to the country milk plant was found to be 18.9 mg. per liter. Passage through the country milk plant did not decrease the vitamin C content much but increased the susceptibility to oxidation due to increases in copper and air content. Tank car transportation to New York City resulted in a further 3 to 5 mg. loss. At the city the cold milk was practically saturated with oxygen, the average being 10.3 mgs. per liter. During pasteurization by the holding method, 2 to 5 mgs. of vitamin C may disappear. When milk is heated over external surfaces, it loses some oxygen but takes more on when cooled over similar surfaces.

A commercial 3000 lb. per hour deaerator manufactured by the Thermal Engineering Corporation of Richmond, Virginia, is described. This is essentially a chamber in which the pressure is reduced to about .15 inches by means of 2 steam jets connected in series with an inner condenser. As the milk is introduced into the high vacuum chamber at 105° F. to 115° F. a drop in temperature of 7–15° F. occurs and the oxygen along with 0.5 per cent water vapor passes off as the milk boils. The total cost is 3 to 4 cents per 1000 lbs. of milk. True vacuum bottle fillers or bottom up type fillers are needed to prevent re-entry of oxygen. Milk with 19.4 mgs. of vitamin C per liter when aerated raw and pasteurized at 160° F. for 15 seconds showed 19.1 mgs. ascorbic acid after 3 days and no oxidized flavor. E.F.G.

620. **Remarks on Homogenized Milk.** IRVING J. WOLMAN, Children's Hospital of Philadelphia, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *20:* 546–550. Apr. 1941.

A group of 800 babies was divided into 4 groups of 200 fed on formulas made from: (1) Sonic vibration treated milk; (2) Milk homogenized at 2500 lbs.; (3) Milk homogenized at 750 lbs.; (4) Milk boiled for 5 minutes in the home.

All groups showed a similar growth curve and all milks seemed acceptable. Using homogenized milks simplifies the preparation of formulas but its selection over other available forms is a matter for the individual physician to decide. The dairy industry should establish standards for such milk which assure highest quality. E.F.G.

621. The Value of Laboratory Control. D. E. NOFSINGER, Richmond Dairy Co., Richmond, Va. Milk Dealer, *30*, No. 7: 129–133. Apr. 1941.

A brief discussion of some of the laboratory tests used to control composition and quality is given. C.J.B.

622. The Elwell Plan of Sliding Scale of Prices to Consumers. EDWIN S. ELWELL, Northland Milk and Ice Cream Co., Minneapolis, Minn. Internal. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *16:* 411–417. March 1941.

The Elwell plan includes any systems in which additional quarts on the same delivery are sold for a lesser price than the first quart or the average price per quart of more than one quart is less than a single unit. Essentially the plan is a platform price to which is added a delivery charge, which is large on the first quart, but small or nothing on additional units. The purpose is to give the larger quantity buyer the benefit of savings in delivery. Since the retail price of milk is well below the delivered price of single units, the single quart customer can buy cheaper at the store but the multiple quart customer is more likely to give all business to the route man. Driver opposition to the plan has not been great because drivers realize that more drivers can be employed under this plan than if the customers are allowed to drift to milk depots and stores. Instead of presenting the plan to the customer as base price plus a delivery charge, it seems best to quote a price for the first unit, which includes delivery and additional units at a lower price. C.J.B.

623. Chocolate Milks. R. J. ALBERTS, Ohio State University. Milk Dealer, *30*, No. 7: 126–127. Apr. 1941.

Following a brief discussion of the sales possibilities of chocolate milk, the author sets forth the following reasons for settling when non-settling chocolate is used:

1. Addition of the chocolate at too low or too high a temperature—manufacturers of chocolate specify a proper temperature and in the case of powders this is most generally 120–125° F. Some, however, prefer adding to the hot milk—150° F.—this is always so stated and must be followed for best results.

2. Old returns and high acid milk will cause settling besides giving a poor flavored chocolate milk—use only fresh dairy products.

3. Do not use cream and skim milk—use whole milk and standardize with fresh skim milk.

4. Too cold—less than 38° F. over surface cooler will cause too great a shock and will result in settling.

5. Too vigorous agitation—where high and low speed agitation is available on vat agitator, use only low speed.

6. Foaming—when using positive pump, always have line in back of pump full to prevent foaming.

7. Foaming—when using centrifugal pump, always keep flow to the pump full and regulate the speed of flow above pump.

8. Pre-cooling in vat is always dangerous although some chocolate manufacturers advise such to prevent too great a cooling shock at surface cooler. If pre-cooling takes too long (over five minutes) before chocolate milk is finally cooled, then it is too dangerous to attempt.

Other defects mentioned are: 1. Added viscosity because of too high a pasteurizing temperature. 2. Flocculating chocolate when chocolate milk is cooled too low—below 38° F. C.J.B.

624. Refrigeration Equipment for the Milk Dealer. I. A. MAHON, The Creamery Package Mfg. Co., Chicago. Milk Dealer, *30*, No. 7: 41, 86–88. Apr. 1941.

The author points out that in dairy plants, volume is the measure of success and the bane of refrigeration designing. The very essence of volume makes for improbability, if not impossibility, of accurate refrigeration designing. Some suggestions are offered for installing refrigeration equipment which will more nearly meet the demand when the plant exceeds its planned capacity. C.J.B.

625. Refrigeration Equipment in Milk Production. H. O. ROBERTS, JR., Central Power and Light Co., Corpus Christi, Texas. Milk Dealer, *30*, No. 7: 40, 83–86. Apr. 1941.

A brief review of the necessity for cooling milk followed by a discussion of how Texas dairymen are cooling their milk. It is pointed out that where electric service is available, most milk producers today are using some form of mechanical refrigeration. The rapid growth in the use of mechanical refrigeration by Texas dairymen is attributed largely to (1) capacity to cool milk rapidly, (2) saving in labor, (3) low cooling cost—lower electric rates, and (4) improved and lower-cost equipment. Current consumption for cooling milk on six representative farms in the Houston area, where milk was being cooled in tank type coolers and the evening milk was cooled and stored and the morning milk only cooled, showed that 0.98 kilowatt-hours was used per 100 pounds of milk cooled. C.J.B.

626. What Can Be Done to Improve the Quality of Milk. H. A. BENDIXEN, State College of Washington, Pullman, Wash. Milk Dealer, *30*, No. 7: 38–39, 94–95. Apr. 1941.

The author states that in his mind the four cardinal requirements of a

high-quality market milk are that the milk be (1) nutritious, (2) palatable and of good keeping quality, (3) safe, and (4) clean and attractively packaged. The subject is then discussed under the following: 1. Can we improve the nutritive value of cow's milk? 2. Palatability and keeping quality. 3. Cleanliness and attractiveness in merchandising. C.J.B.

627. **That Cleaning Chore.** R. M. HOYT, Normal Sanitary Dairy, Normal, Ill. Milk Dealer, *30,* No. 7: 30–31, 75–78. Apr. 1941.

The necessity of using the proper washing powders, temperatures, etc., in the cleaning operations of a milk plant are discussed. Special emphasis is placed on the necessity of properly training new employees. C.J.B.

628. **Engineering Features of Pasteurizing Plants and Equipment.** G. A. A. BURN, Ontario Dept. of Health, Toronto. Canad. Pub. Health Jour., *32:* 199–207. 1941.

Ontario's regulations for milk pasteurization plants are interpreted by a sanitary engineer, special attention being given to plant construction, milk processing equipment and the correction of defects in pasteurization systems. The use of high-short pasteurization is not, as yet, a legal method for fluid milk in Ontario. O.R.I.

629. **A Laboratory Procedure for Detecting and Eliminating Thermoduric Bacteria from Pasteurized Milk.** V. E. GRAHAM AND W. H. ORME, Univ. of Saskatchewan. Canad. Pub. Health Jour., *32:* 70–71. 1941.

This procedure consists of two steps, the first to check the efficiency of pasteurization in the plant being inspected and the second to detect the offending shipper.

In the investigation of an outbreak, samples should be taken from all vats in the plant at the conclusion of the holding process and before cooling. This sample is cooled in the sample bottle and taken to the laboratory. Here, the sample is divided and a portion repasteurized. Both the repasteurized and original samples are then replated. Several dilutions should be used and incubation should be at 37° C.

If thermoduric organisms are present there will be little or no reduction in the count on the plates from the repasteurized sample. In such cases individual samples are taken from each producer's milk and part of each of these subjected to laboratory pasteurization. Plates are then prepared using a dilution of 1:1000 for the raw milk and 1:100 for the pasteurized. The presence of thermoduric organisms will be indicated by a high count on the plates from the pasteurized samples. In such cases, further work will have to be done on the farm and improperly cared for milking machines are often the cause of the trouble. O.R.I.

630. Milk Consumption in the Vancouver Metropolitan Area. J. S. KITCHING, Vancouver, B. C. Canad. Pub. Health Jour., *32:* 154–157. 1941.

By means of a questionnaire circulated to 16,000 homes in the Vancouver district, a picture was obtained of the milk consuming habits of a large section of the community. The average per capita consumption was calculated to be 0.83 pints per day. Many of the factors affecting consumption are similar to those reported in other surveys of this kind. O.R.I.

631. Consumption of Milk in Canada. W. C. HOPPER, Dominion Dept. Agr., Ottawa. Canad. Pub. Health Jour., *32:* 147–153. 1941.

Statistics are given for per capita consumption of fluid milk in different sections of Canada for different racial, income, occupational and age groups. The figures are for fresh fluid milk and do not include that purchased in other products. For most cities the average was approximately 0.70 Imperial pints per day. French-Canadians had a lower per capita consumption than those of other groups as did Jews, Italians and Orientals. Consumption by farm families was over one pint while in all groups consumption increased as did family income. Only 23 per cent of the adults (over 16 years) drink any milk. The proportion of adults drinking milk increased as family income increased.

Children of relief and low income families in cities more frequently were milk drinkers than were children in families of higher income groups. O.R.I.

632. The Application of the Evelyn Photo-Electric Colorimeter to a Modification of Kay and Graham's Phosphatase Test. J. WYLLIE, Queen's Univ., Kingston, Ontario. Canad. Pub. Health Jour., *32:* 122–128. 1941.

A modification of the original Kay and Graham test is proposed in which the color produced is more accurately measured in a colorimeter. Standard colorimeter values for this instrument are suggested for both A and B tests. It would seem, however, that the standards adopted are such as to allow under-pasteurized milk to be passed. The method affects a saving through the use of smaller amounts of reagents. O.R.I.

633. Practical Experience with the New Medium in Quality Control. A. J. POWERS, Borden's Farm Products, Brooklyn, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *17:* 443–459. March 1941.

Results with the new tryptone-glucose-extract-milk agar over a period of eighteen months have revealed the following. Comparing the counts obtained with the new medium in the first year of its use with the counts

obtained on the old nutrient agar in the preceding year, Grade A milk showed in monthly average counts 1.03 to 4.26 times higher with the new medium, grade B milk 2.00 to 5.13 times higher and pasteurized cream 0.76 to 7.80 times higher. Weekly averages of parallel counts on grade A pasteurized milk were 1.08 to 8.0 times higher for the new medium and grade B pasteurized 1.08 to 5.24 times higher. Interest in "pasteurizability" and study of the problem of individual farm samples have indicated clearly that proper sanitary practice at the individual dairies or the receiving plants generally removes the tendency toward high counts after pasteurization.

Replies to a questionnaire to 34 industry laboratories with regard to their experience with the new medium are summarized. The use of the new medium has encouraged the pasteurization of individual dairy samples to locate the source of milk difficult to pasteurize satisfactorily. It is thought that the new medium has made the plate count a more useful tool in milk control work. E.F.G.

634. Introducing a Selection System for Milk Route Salesmen, Clerks, and Other Personnel. VERNE STEWARD, Los Angeles, Calif. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *18:* 467–471. Apr. 1941.

A description and explanation are given of the I.A.M.D. manual entitled "How to Appraise Prospective Milk Route Salesmen" also the "Composite Inventory and Examination for Milk Industry Employees" and the "Medical Examination Form."

Careful use of the above helps is recommended in order that the waste from employing men not suited to this sort of work may be avoided. Attention is called to the fact that persons ill-suited to the work of route salesmen are eliminated with greater difficulty and expense that formerly. E.F.G.

635. Cost Reports for the Plant Manager. BRUCE BALDWIN, Baldwin Dairies, Inc., Philadelphia, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *16:* 435–439. March 1941.

Some of the more valuable reports are: product cost reports, milk fat losses, fluid milk losses, fluid cream losses, manufacuring losses, bottle losses, power fuel and light costs, washing powder cost and labor costs. The point is made that the selection of the basis and the form of these reports should tend toward simplicity and ease of understanding if the hoped for benefits are to be realized. E.F.G.

636. Cost Reports for Sales Managers. F. W. ROOT, Glendale Farms, Inc., Wilkes Barre, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *16:* 431–434. March 1941.

The uses to which the sales manager can put certain reports as overhead statements on selling and delivery costs, individual route costs, and individual truck costs are described. Individual route cost reports are considered to be the most valuable. E.F.G.

637. The Single Service Container and Its Effect upon Milk Distribution Costs. E. L. VEHLOW, Calif. State Dept. Agr., Sacramento, Calif. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *16:* 418–430. March 1941.

Prior to 1939 only fibre containers sterilized on the premises were permitted. Since that time factory formed containers have been permitted so that by August 1940 nearly 50 per cent of all milk sold to consumers through retail stores in the major California milk markets where fibre has been introduced is in fibre containers.

Added processing cost over glass ranged from .86 cent to 1.15 cent for various types of fibre containers. If the cost of the fibre container is to approach the cost of glass operation it must come from greater efficiency in delivery. The most efficient fibre operator delivered milk for .5042 of a cent less than the most efficient exclusive glass container operator. The net added cost of fibre over glass was .3544 of a cent per quart. The elimination of the bottle deposit results in glass container costs comparable with fibre. Grocer preference has boosted the sale of milk in fibre containers. Many distributors have reduced the fat content of milk in fibre containers close to the legal limit to compensate for the added cost of the fibre container. An added one-half cent wholesale for milk in fiber containers in Los Angeles has not been passed on to the consumer but absorbed by the retailer. E.F.G.

638. Fluid Milk Production Costs. PAUL YOUNG, Telling Belle Vernon Co., Cleveland, Ohio. Milk Dealer, *30,* No. 6: 116–120. March 1941.

A discussion is presented of the extra costs of requirements for the production of fluid market milk over milk for manufacturing purposes. The author suggests that the problem of increasing consumption and of determining a fair remuneration to producers for the extra costs of supplying milk for fluid markets, could be solved most satisfactorily by giving careful study to the individual problems peculiar to every market and then basing fluid milk producer prices on the evaporated code price plus the extra costs of meeting fluid milk quality, quantity, and transportation requirements above evaporated requirements. C.J.B.

639. Comparison of Chemical, Steam and Hot Air Sterilization of Dairy Equipment. HARRY H. WEISER, Ohio State University. Milk Dealer, *30,* No. 6: 112–114. March 1941.

A discussion of the sterilization of dairy equipment, in which data are presented to show the effect of varying the pH, temperature, and time on the germicidal effect of a chlorine solution. Data are also presented to show the germicidal effect of alkyl-aryl-sulfonate when added to the chlorine solution. The following general observations are made by the author:

1. Various types of washing solutions are effective detergents in cleaning milk utensils and dairy equipment but are not efficient sterilizing agents.

2. Chlorine compounds are efficient and practical sterilizing agents when properly handled.

3. A chlorine solution adjusted to pH 6.0 increases the germicidal power of the compound. However, an acid solution of the compound is less stable and has a greater corrosive action on the equipment than an alkaline chlorine solution.

4. Chlorine compounds are less effective as a sterilizing agent in the presence of organic matter.

5. Relatively low concentrations of chlorine are effective in destroying bacteria in the absence of organic matter.

6. A temperature range from 50° F. to 90° F. showed very little difference in the germicidal efficiency in the pH value of the chlorine solutions.

7. The addition of alkyl-aryl-sulfonate to the chlorine solution enhanced the germicidal efficiency of the chlorine compounds.

8. The use of washing solutions combined with the use of steam as a sterilizing agent is effective in sterilizing milk cans, etc., followed by currents of hot air to dry the can.

9. The use of dry heat for sterilizing laboratory glassware is satisfactory.

C.J.B.

640. Suggestions on How to Make Good Buttermilk. A. D. BURKE, Alabama Polytechnic Institute. Milk Dealer, *30,* No. 6: 41, 82–83. March 1941.

The essentials of making good buttermilk are discussed from the following standpoints: 1. Quality of milk used. 2. Selection of cultures. 3. Preparation of mother culture milk. 4. Sterilization. 5. Temperature control. 6. The bulk product. 7. Culturing the bulk product. 8. Breaking the curd. C.J.B.

641. Tips on Cleaning Test Bottles. LEONARD BEACH, Beach Milk Co., Denver, Col. Milk Dealer, *30,* No. 6: 35, 46. March 1941.

The method of washing test bottles used at the Beach Milk Co. is as follows: 1. Select a good washing powder. This plant uses tri-sodium phosphate, because of its rinsing properties. 2. Place just enough dry powder in each test bottle to cover the bottom. 3. Add enough cold water to form a thick paste. 4. Shake bottles; a few quick shakes should be enough. 5.

Rinse with cold water. The cold water is important if tri-sodium phosphate is used for a washing powder. A diagram of a special apparatus for rinsing the bottles is given. It consists of a small copper tube connected to the cold water supply, sealed at the end and with holes in the side.

C.J.B.

642. **Milkstone Formation.** LEWIS SHERE, Diversey Corp., Chicago. Milk Dealer, *30,* No. 6: 33, 56–64. March 1941.

A discussion is given of the factors causing and methods of preventing milkstone formation. Methods of removing milkstone which has formed on equipment are also discussed. C.J.B.

643. **Six Day Delivery in Canton and Akron, Ohio.** ANONYMOUS. Milk Dealer, *30,* No. 6: 31, 77–78. March 1941.

A general discussion is given of dealer, employee, and public reaction to six-day delivery of milk in Canton and Akron, Ohio. C.J.B.

644. **Six Day Milk Delivery—Six Day Delivery from the Plant Angle.** H. D. DRAIN, Peoples Dairy Co., Akron, Ohio. Milk Dealer, *30,* No. 6: 31, 78–79. March 1941.

The author discusses the following problems which confronted the plant in the change to a six day delivery: 1. Provision for a supply of fluid milk available for needs of the sales department. 2. Selection of a day the plant should operate on a reduced schedule. 3. Supply and storage for cases and containers. 4. Storage room for finished products. 5. Ways of handling returns. 6. Product difficulties.

It is concluded that all of the problems involving the plant can be handled in a reasonably satisfactory manner. Some savings in labor, power, light, and water are possible. C.J.B.

645. **Six Day Milk Delivery—Columbus Humanizes the Marketing of Milk.** J. C. NISBET, Ohio Dairy Products Assoc. Milk Dealer, *30,* No. 6: 30, 75–76. March 1941.

The reaction of the public to daylight, no-Sunday delivery of milk and its effect on sales and labor are discussed. Summarizing the proposition of how to sell no-Sunday, daylight delivery, the author states the Columbus experiment would emphasize the following:

"First, to point out that the great improvements made in the production, processing and distribution of milk have eliminated the necessity for daily delivery by eliminating the problem of keeping milk an extra day—or several days for that matter.

"Secondly, eliminate entire 'time of delivery' as a competitive argument. Convince your customer that whenever you deliver the milk, whether

it be 8 A.M. or 12 noon, that she will receive a 24-hour supply. All she need do is purchase the extra amount needed for the first day and an extra day's supply each Saturday.

"Remember, whenever anything new is introduced that changes habits of long standing, there may be some confusion during the period of adjustment. Expect this. Anticipate it and be prepared, but recognize that such a period will soon be over and the benefits will start to accrue."

C.J.B.

646. For Precise Reading of Babcock Test. E. O. HERREID, Vermont Agr. Expt. Sta., Burlington. Natl. Butter and Cheese Jour., *32*, No. 6: 30. 1941.

A piece of equipment invented by Julias Hortvet for measuring the length of the fat column has been improved. Estimations can easily be made to 0.025 per cent. This equipment is not being manufactured at the present time. W.V.P.

647. Practical Pointers on Quality Production. DAVE NUSBAUM, Univ. of Wisconsin, Madison. Natl. Butter and Cheese Jour., *32*, No. 6: 18. 1941.

Quality of dairy products is lowered by off-flavors and odors caused by bacterial growth. Such growth in milk depends on contamination, food, water, time, temperature and other essential factors such as oxygen tension and pH which cannot be readily discussed with milk producers. Control of contamination can be accomplished by careful farm practices such as clean barns, plenty of bedding, clipping of udders, cleaning of cows before milking, proper maintenance, cleaning and sterilizing of utensils. Prompt cooling of milk is essential. Keep milk Clean, Cool and Covered. W.V.P.

648. Survey of Milk Control, Including the Extent of Pasteurization in Municipalities of Two Thousand Population in Canada. Survey of Milk-Borne Diseases in Canada. Milk Committee of the Canad. Pub. Health Assoc. Canad. Pub. Health Jour., *32*, 216–226. 1941.

Statistics are presented relating to licensing, inspection, tuberculosis and contagious abortion testing and extent of pasteurization for most towns and cities in Canada.

A survey of all the milk-borne types of diseases recorded in Canadian municipalities between 1912–1940 is also presented. O.R.I.

649. Progress in Pasteurization in Ontario. A. E. BERRY, Ontario Dept. of Health, Toronto. Canad. Pub. Health Jour., *32:* 208–212. 1941.

Since 1938 Ontario has made compulsory the pasteurization of milk in all cities and towns and has gradually extended these regulations to cover villages and some unincorporated areas and summer resorts. It is now estimated that 98 per cent of the fluid milk sold is pasteurized.

Public health statistics for 1939 show a 45 per cent reduction in undulant fever cases and the typhoid fever death rate was lowered about 50 per cent. Paratyphoid and infant mortality were substantially reduced. It is reasonable to contend that pasteurization was partly responsible. O.R.I.

PHYSIOLOGY

650. Growth of the Mammary Gland Following Local Application of Estrogenic Hormone. WARREN O. NELSON, Dept. of Anatomy, Wayne Univ., Detroit, Mich. Amer. Physiol. Soc. Proc., p. 209. Apr. 1941.

The theory that the ovarian hormones stimulate growth of the mammary glands only through their action on the anterior hypophysis and the production therein of one or more mammogenic hormones is controverted by experiments in which application of estrin to the area of one gland has induced growth of that gland only (women, monkeys, rabbits). The present work deals with similar studies in the guinea pig.

Seven gonadectomized male and female guinea pigs received applications of estrin to one mammary gland area. In three animals the second nipple was massaged daily with sesame oil alone.

Growth of the nipple on the side receiving applications of estrin was evident by the 8th day and continued throughout the period of treatment in each animal.

In only one instance was any growth observed in the nipple on the side receiving sesame oil only. The mammary glands recovered from the side treated with estrone showed development of ducts and buds at 15 days, and progressive growth of both ducts and alveoli at 25 and 35 days. A slight growth of ducts was produced in one gland which received applications of oil only.

These results present further evidence that local application of small amounts of estrin to the area of a mammary gland will stimulate growth of the gland only. D.L.E.

651. The Lack of Inactivation of Stilbestrol by the Liver. M. J. ALLEN, Northwestern Univ. Med. School, Chicago. Am. Physiol. Soc. Proc., p. 6. April 1941.

Stilbestrol differs from the natural estrogens in that it is very potent by mouth. There is good evidence that natural estrogens are inactivated by

the liver. Other workers have reported that when ovaries are transplanted intramesenterically in such a position that their venous drainage is into the portal system, they have no estrogenic effect. This liver inactivation is considered to be the reason why natural estrogens are relatively ineffective by mouth. It was considered possible that the high oral potency of stilbestrol might be due to the inability of the liver to inactivate it.

This hypothesis was tested. Stilbestrol pellets (approximately 3.0 mgm. each) were implanted intramesenterically into 10 castrate female rats and subcutaneously into 10 control castrate rats. After 48 hours the animals of both groups went into prolonged estrus. It is concluded that stilbestrol differs from natural estrogens in that stilbestrol is not inactivated by the liver. It seems probable that this fact explains the oral potency of stilbestrol. D.L.E.

652. The Blood Precursors of the Short Chain Fatty Acids of Milk. J. C. SHAW AND C. B. KNODT, Dept. Dairy Industry, Storrs Agr. Exp. Sta., Storrs, Conn. Am. Physiol. Soc. Proc., p. 255. Apr. 1941.

Arteriovenous differences demonstrated that acetone bodies were used by the lactating gland of the cow. Fractionations disclosed that the utilization of acetone bodies was limited to β-hydroxybutyric acid. According to arteriovenous differences the quantity of β-hydroxybutyric acid utilized is just sufficient to provide for the fatty acids C_{14} and lower. Such synthesis would explain the high R.Q. of the lactating gland. Approximately 40 per cent of the total oxygen consumption of the gland would be required for the complete oxidation of β-hydroxybutyric acid for energy purposes. Considering the high R.Q. of the normal lactating gland such a postulation does not appear to be warranted.

The R.Q. of the lactating gland in periods of inanition and cod liver oil feeding was less than unity. Likewise marked decreases in Reichert-Meissl values of the milk fat occurred in both cases. Simultaneously the β-hydroxybutyric acid arteriovenous differences decreased significantly. When dextrose was fed in large quantities or pumped into the rumen there was a fall in blood acetone bodies of over 50 per cent which resulted in a decrease in the arteriovenous difference of β-hydroxybutyric acid. Coincident with the decline in blood β-hydroxybutyric acid there was a marked decrease in the saponification number, Reichert-Meissl value and Polenske value of the milk fat.

In severe ketosis in dairy cows in which both blood glucose and blood lactic acid were less than 50 per cent of normal, the R.Q. of the active gland was in excess of unity and indicated that carbohydrate material is probably not used for fat synthesis in the gland.

It is concluded that β-hydroxybutyric acid is probably used in the synthesis of the short chain fatty acids of milk. D.L.E.

653. Desoxycorticosterone and Lactation. ROBERT GAUNT. Dept. of Biology, New York University. Am. Physiol. Soc. Proc., p. 101. Apr. 1941.

This report concerns the effect of desoxycorticosterone acetate (DCA) on the lactation of rats adrenalectomized within 24 hours after delivery.

When the mothers received 0.3–0.5 mgm. DCA per day all the young died between the 11th and 19th days, despite large weight gains and excellent health of the mothers (8 litters). One-tenth milligram DCA gave similar results in 3 cases, but one anomalous animal lactated normally.

This would seem to indicate that DCA not only failed to support lactation but probably actually inhibited it, perhaps because it is a mammary-growth stimulating substance.

DCA did not, however, inhibit lactation of intact rats in doses of 0.5 mgm. per day (3 litters), showing that if there is an inhibitory effect it can be prevented (at this dose level) by the normal cortical secretions.

This was further illustrated by giving 0.3 mgm. DCA per day plus 2 cc. Eschatin to the adrenalectomized mothers of 4 litters. All the young were raised to weaning although growth was not normal.

Although these results might be interpreted as indicating that DCA, due to its lack of ability to maintain a normal carbohydrate metabolism or for some analogous reason, is qualitatively incapable of sustaining lactation, such an interpretation is not necessary until the possibility that it acts as a direct lactation inhibitor is more completely ruled out. D.L.E.

MISCELLANEOUS

654. Water Supply and Sewage Disposal for Dairies. J. R. FLEMING, Univ. of Tennessee. Milk Dealer, *30,* No. 7: 52–54. Apr. 1941.

Water supplies are discussed as to (1) availability, (2) adequacy, and (3) quality. Sewage disposal is discussed mainly from the angle that it shall not contaminate the water supply. C.J.B.

655. Recommended Methods for Cleaning and Sterilizing Stainless Steel Equipment. ANONYMOUS. Milk Dealer, *30,* No. 7: 72. Apr. 1941.

The methods for cleaning and sterilizing stainless steel equipment, issued by the Alloy Tank Manufacturers Council and the Batch Pasteurizer Manufacturers Council, and approved by the Technical Committee of the Dairy Industries Supply Association, Incorporated, are given. C.J.B.

656. What Should Go in the Advertising Appropriation. P. H. KEMPER, Bowman Dairy Co., Chicago, Ill. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., *18:* 472–478. Apr. 1941.

The method recommended is not based on a percentage of sales, a unit of sale method or proportion of profits but is based upon an elastic budget, used where it will do the most good and from which unwarranted charges are excluded. There is much disagreement among companies as to which items are properly charged to advertising and which should be charged to some other account. Reports from 62 companies showed 1.29 per cent of the sales' dollar going into advertising. E.F.G.

657. The Frozen Food Industry. HARRY CARLTON, Univ. Tenn. Knoxville, Tenn. Agr. Expt. Sta. Bul. 173.

This is a very comprehensive bulletin of 175 pages dealing with the fast growing frozen food industry. The bulletin, practically a text book on the subject, is divided into four parts as follows: Part I. Distribution; Part II. Production for freezing; Part III. Processing operations; Part IV. Miscellaneous.

Part I covers early history, early distribution difficulties, growth of quick-frozen food distributions, channels of distribution, increased acceptance, frozen-food production, markets, sales policies, retail cabinets, selling prices and losses.

Part II discusses freezing operations, variety of fruits and vegetables, packing areas, seasons for packing, leading fruits used, yields, prices paid grower and harvesting costs.

Part III deals with quality control, vitamin content of quick-frozen food, blanching for quick frozen foods, fine modern methods used in freezing, packaging frozen foods, cost of packaging, costs comparison between quick-freezing and canning costs.

Part IV covers such subjects as cold storage rates in leading fruit and vegetable packing areas, transportation rates for frozen fruits and vegetables, quick-frozen poultry, freezer locker plants and their operation.

The bulletin treats the subject very completely and is a decided contribution to the frozen food industry and in addition to the above subjects contains many statistics of this important industry. C.D.D.

AMERICAN DAIRY SCIENCE ASSOCIATION

INCORPORATED IN THE DISTRICT OF COLUMBIA

Officers

President ..... HARRY W. CAVE, Stillwater, Oklahoma
Vice-President ..... HENRY F. JUDKINS, New York, New York
Secretary-Treasurer ..... R. B. STOLTZ, Columbus, Ohio
Editor ..... T. S. SUTTON, Columbus, Ohio
Director ..... HOWARD B. ELLENBERGER, Burlington, Vermont
Director ..... ARTHUR C. DAHLBERG, Geneva, New York
Director ..... C. N. SHEPARDSON, College Station, Texas
Director ..... FORDYCE ELY, Lexington, Kentucky
Director ..... J. W. LINN, Manhattan, Kansas
Director ..... M. E. PARKER, Chicago, Illinois
Director ..... E. S. GUTHRIE, Ithaca, New York

Officers of Sections

SECTION NO. 1—Dairy Production

Chairman ..... W. E. PETERSON, St. Paul, Minnesota
Vice-Chairman ..... H. A. HERMAN, Columbia, Missouri
Secretary ..... K. S. MORROW, Durham, New Hampshire

SECTION NO. 2—Dairy Manufactures

Chairman ..... C. D. DAHLE, State College, Pennsylvania
Vice-Chairman ..... L. H. BURGWALD, Columbus, Ohio
Secretary ..... E. O. ANDERSON, Storrs, Connecticut

SECTION NO. 3—Extension

Chairman ..... O. J. HILL, Pullman, Washington
Vice-Chairman ..... GLEN W. VERGERONT, Madison, Wisconsin
Secretary ..... J. F. KENDRICK, Washington, D. C.

OFFICERS OF DIVISIONS

Southern

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

Eastern

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

Western

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

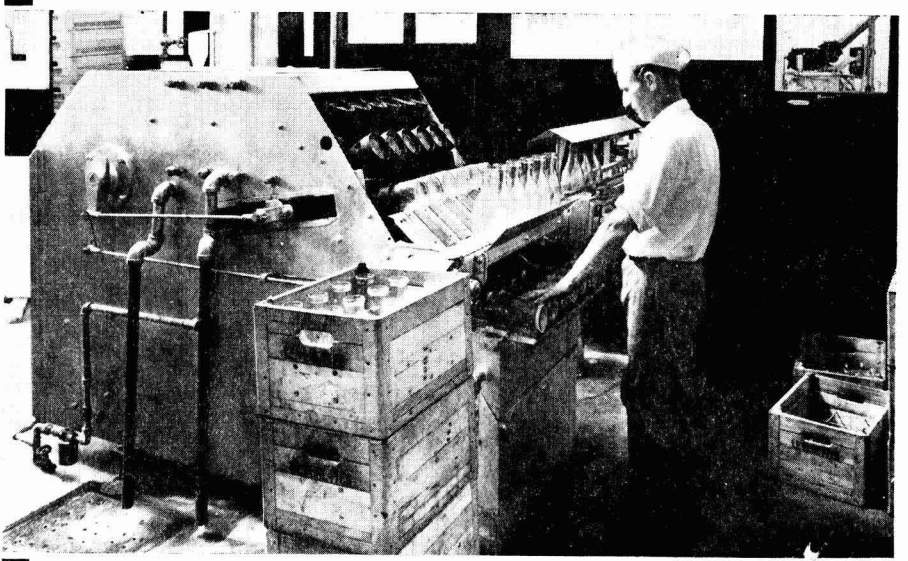
The American Dairy Science Association was organized to advance the general welfare of the dairy industry, especially by the improvement of dairy instruction by the stimulation of scientific research in all phases of the subject and by improvement in methods of conducting extension work.

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

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

THERE'S A CP SOAKER WASHER

That Fits Every Job!



CP Bantam equipped with automatic discharge.

FROM 16 TO 96 BOTTLES PER MINUTE!

CP makes seven great soaker washers—the famous Style C, in 8–, 10 and 12 row units—the 4– 6 and 8 row Junior—and the compact 6 row Bantam, which operates efficiently in spots too small to permit the installation of any other soaker washer.

Whichever size a dairy installs, the CP Soaker Washer can be depended upon to provide top value in performance, long wear and economical maintenance . . . to give day-in and day-out delivery of clean, sparkling bottles that meet the most stringent sanitation requirements.

THE CREAMERY PACKAGE MFG. COMPANY
1243 West Washington Boulevard, Chicago, Illinois

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

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

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