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Contents

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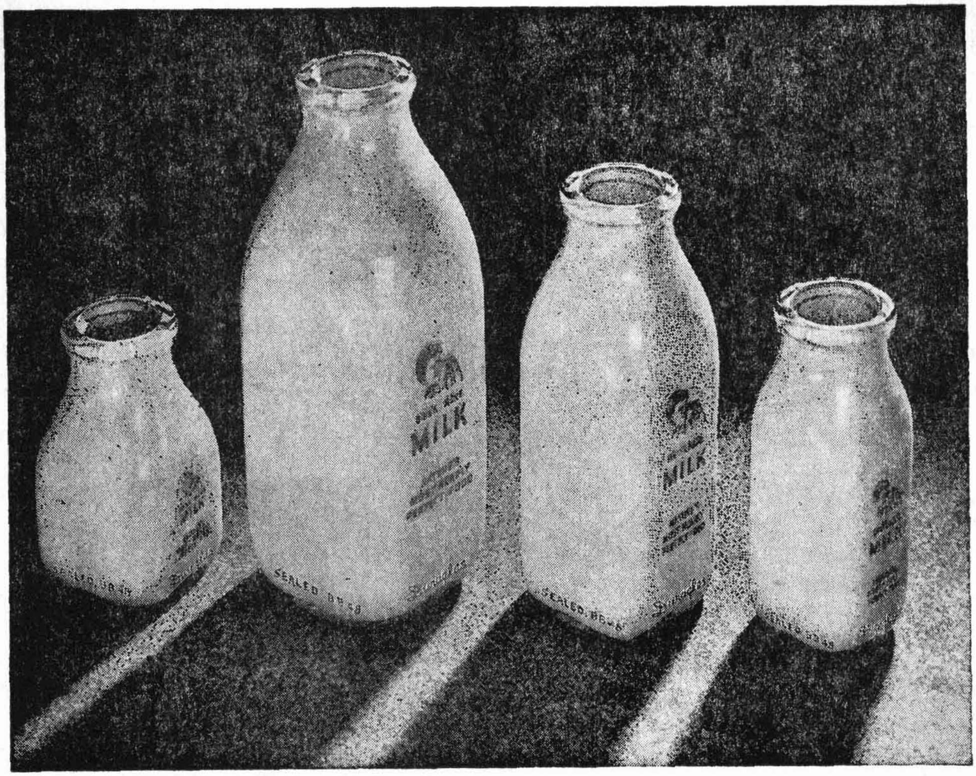

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Surge

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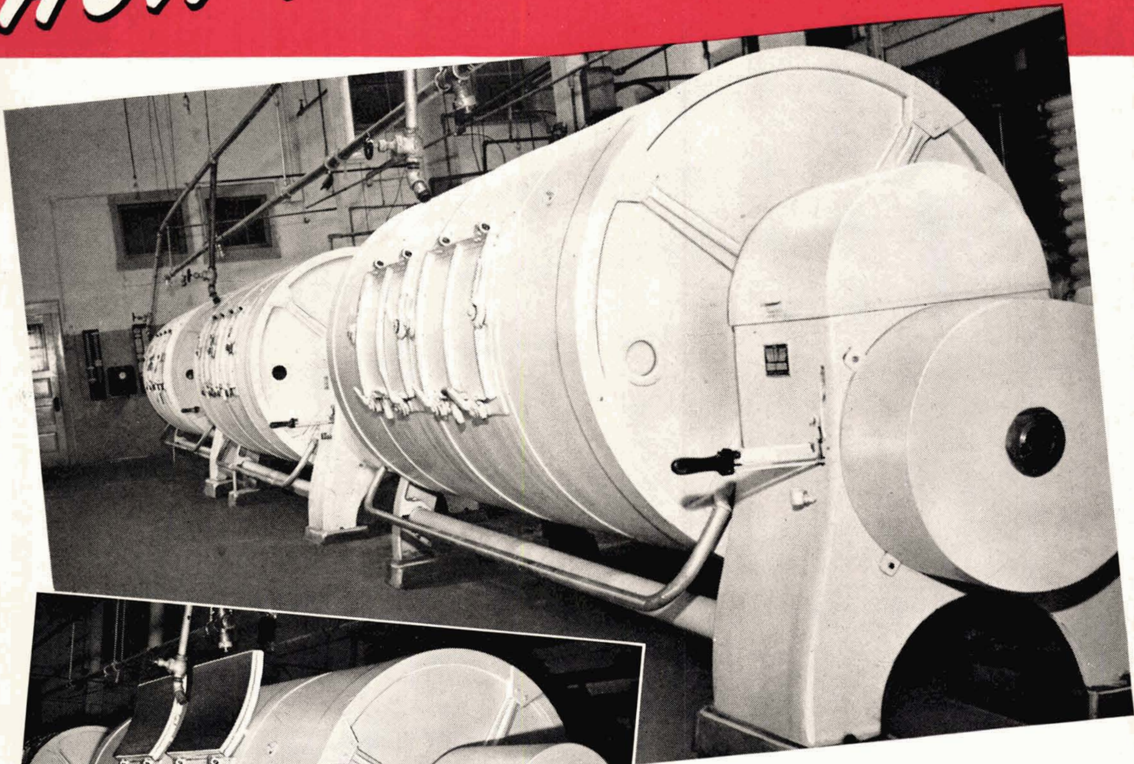

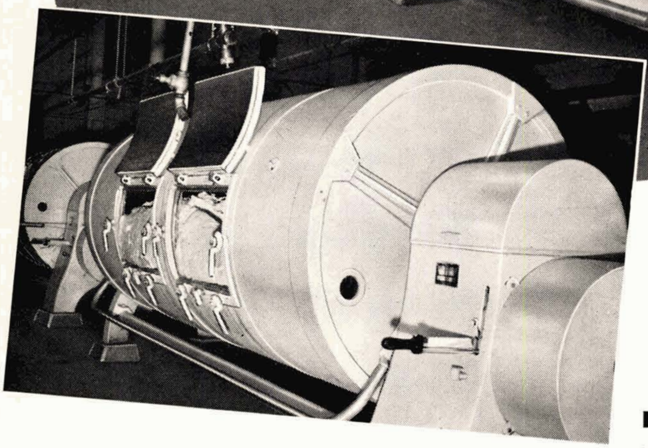

Hats Off to the Lakeville Creamery

Working closer to the 80% line and being sure of it every time pays off these days—any day—at Lakeville. Above are shown three of four VANE CHURNS doing a big job ever since 1940. Smaller photo shows how "criss-cross" working action piles butter right in front of the churn door, permitting easier, quicker unloading. This same "criss-cross" action assures Lakeville Creamery of more uniform distribution of moisture and salt . . . better composition.

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GENERAL DAIRY EQUIPMENT COMPANY

Minneapolis 14, Minnesota

TODAY'S BUTTER SHORTAGE

Lakeville Creamery's records prove efficiency of the VANE CHURN

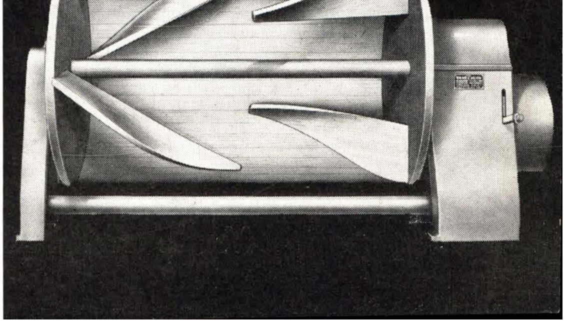
LAKEVILLE CREAMERY
Lakeville, Minn.

	Composite of Churning				Printed				Diff.
Churn	% Moist	% Salt	Est. Curd	% Bft.	% Moist	% Salt	Est. Curd	% Bft.	Diff.
				May					
350	17.10	1.80	.90	80.20	17.05	1.80	.90	80.25	-.05
395	17.00	1.75	.90	80.35	17.00	1.75	.90	80.35	.
396	17.00	1.80	.90	80.30	16.95	1.80	.90	80.35	-.05
403	17.00	1.80	.90	80.25	16.90	1.85	.90	80.35	-.10
404	17.10	1.80	.90	80.20	16.85	1.85	.90	80.40	-.20
459	17.15	1.85	.90	80.10	17.00	1.90	.90	80.20	-.10
460	17.00	1.90	.90	80.20	16.95	1.90	.90	80.25	-.05
				June					
36	17.00	1.90	.90	80.20	16.90	1.85	.90	80.35	-.15
162	17.10	1.80	.90	80.20	17.10	1.75	.90	80.25	-.05
163	17.10	1.80	.90	80.20	17.15	1.80	.90	80.15	+.05
164	17.00	1.80	.90	80.30	16.90	1.75	.90	80.45	-.15
213	17.05	1.80	.90	80.25	17.10	1.80	.90	80.20	+.05
231	17.00	1.75	.90	80.35	17.10	1.75	.90	80.25	+.10
268	17.05	1.75	.90	80.30	17.00	1.75	.90	80.35	-.05
269	17.10	1.75	.90	80.25	17.10	1.70	.90	80.30	-.05
				July					
7	17.05	1.75	.90	80.30	17.00	1.75	.90	80.35	-.05
24	17.05	1.75	.90	80.30	17.05	1.75	.90	80.30	.
25	17.05	1.75	.90	80.30	17.05	1.75	.90	80.30	.
26	17.05	1.75	.90	80.30	17.00	1.75	.90	80.35	-.05
44	17.00	1.75	.90	80.35	17.10	1.75	.90	80.25	+.10
54	17.05	1.75	.90	80.30	17.05	1.75	.90	80.30	.
57	16.90	1.80	.90	80.40	16.95	1.80	.90	80.35	+.05
				August					
4	17.20	1.75	.90	80.15	17.20	1.75	.90	80.15	.
6	16.90	1.75	.90	80.45	16.85	1.75	.90	80.50	-.05
11	17.00	1.75	.90	80.35	17.10	1.75	.90	80.25	+.10
33	17.10	1.75	.90	80.25	17.05	1.75	.90	80.30	-.05
50	17.25	1.75	.90	80.10	17.25	1.75	.90	80.10	.
120	17.10	1.80	.90	80.20	17.10	1.80	.90	80.20	.
141	16.90	1.75	.90	80.45	16.95	1.75	.90	80.40	+.05
146	17.10	1.75	.90	80.25	17.00	1.75	.90	80.35	-.10
150	16.90	1.75	.90	80.45	16.90	1.75	.90	80.45	.
151	17.25	1.80	.90	80.05	17.2-	1.80	.90	80.10	-.05
				September					
4	17.10	1.70	.90	80.30	17.10	1.75	.90	80.25	+.05
7	17.15	1.70	.90	80.25	17.15	1.70	.90	80.25	.
8	16.75	2.10	.90	80.25	16.70	2.10	.90	80.30	-.05
12	16.70	2.00	.90	80.40	16.70	2.00	.90	80.40	.
19	17.00	2.00	.90	80.10	17.00	2.00	.90	80.10	.
20	16.80	2.05	.90	80.25	16.75	2.05	.90	80.30	-.05
33	16.80	2.00	.90	80.30	16.90	2.00	.90	80.20	+.10
38	16.70	2.00	.90	80.40	16.80	2.00	.90	80.30	+.10
51	16.70	2.00	.90	80.40	16.75	2.00	.90	80.35	+.05
96	16.75	2.05	.90	80.30	16.90	2.05	.90	80.15	+.15
113	17.00	2.00	.90	80.10	17.00	2.00	.90	80.10	.
				October					
28	16.90	1.75	.90	80.45	16.95	1.75	.90	80.40	+.05
29	17.10	1.75	.90	80.25	17.00	1.75	.90	80.35	-.10
41	16.90	1.75	.90	80.45	16.90	1.70	.90	80.50	-.05
80	17.15	1.70	.90	80.25	17.15	1.70	.90	80.25	.
81	16.75	2.10	.90	80.25	16.70	2.10	.90	80.30	-.05
82	16.70	2.00	.90	80.40	16.70	2.00	.90	80.40	.
83	17.00	2.00	.90	80.10	17.00	2.00	.90	80.10	.
97	16.80	2.05	.90	80.25	16.75	2.05	.90	80.30	-.05
105	16.80	2.00	.90	80.30	16.90	2.00	.90	80.20	+.10
106	16.70	2.00	.90	80.40	16.80	2.00	.90	80.30	+.10
107	16.70	2.00	.90	80.40	16.75	2.00	.90	80.35	+.05
134	16.90	2.05	.90	80.15	16.90	2.05	.90	80.15	.
135	17.00	2.00	.90	80.10	17.00	2.00	.90	80.10	.
172	17.00	2.00	.90	80.10	17.00	2.00	.90	80.10	.
173	16.80	1.90	.90	80.40	16.80	1.90	.90	80.40	.
174	17.10	2.00	.90	80.00	17.10	2.00	.90	80.00	.
221	16.70	2.05	.90	80.35	16.75	2.05	.90	80.30	+.05
222	16.75	2.00	.90	80.35	16.70	2.00	.90	80.40	-.05
223	16.80	2.05	.90	80.25	16.80	2.00	.90	80.30	-.05
232	16.95	2.05	.90	80.10	17.00	2.05	.90	80.05	+.05
236	16.90	2.00	.90	80.20	16.90	2.00	.90	80.20	.
237	16.80	2.00	.90	80.30	16.80	2.00	.90	80.30	.
				November					
1	17.05	2.00	.90	80.05	16.95	2.00	.90	80.15	-.10
2	16.70	2.00	.90	80.40	16.75	2.00	.90	80.35	+.05
10	16.90	2.00	.90	80.20	16.90	2.00	.90	80.20	.
11	16.95	2.00	.90	80.15	16.90	2.00	.90	80.20	-.05
12	16.90	2.00	.90	80.20	16.85	2.00	.90	80.25	-.05

THERE'S no question about the seriousness of today's butter shortage . . . the question is how to help relieve it. Part of the answer lies in how to work closer to the 80% legal line, eliminating wasteful, profit-losing over-allowances of butterfat. Records show that far too much butter containing 81% fat is still being made.

Here is where the efficiency of the VANE CHURN is helpful. "Proof of the pudding" comes from composition control records kept by the Lakeville Creamery (Lakeville, Minnesota) Lenihan Brothers, owners and operators. These tests were originally made to check moisture loss in the printing process, but they also prove uniform composition control. Study these records . . . *note that Lakeville's average butterfat content is 80.26% . . . not one churning out of the seventy shown is below the 80% legal requirement.*

Proof like this shows why hundreds of profit-making buttermakers use the VANE CHURN. Proof like this shows you how to eliminate costly over-allowances of precious butterfat. Yes, you can help relieve today's butter shortage . . . and answer tomorrow's buttermaking questions . . . with VANE CHURNS.



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LACTIC ACID, PYRUVIC ACID, AMINO ACIDS, ACETONE BODIES, OXYGEN, CARBON DIOXIDE, AND HEMOGLOBIN IN ARTERIAL AND MAMMARY VENOUS BLOODS OF COWS UNDER VARIOUS PHYSIOLOGICAL CONDITIONS

J. C. SHAW

Department of Dairy Industry, Storrs Agricultural Experiment Station, Storrs, Connecticut

The study of the blood precursors of milk, which received its early impetus by the technique of Kaufmann and Magne (14), and in which interest has been heightened in more recent years by Graham's (11, 13) techniques of obtaining arterial blood, has contributed greatly to our knowledge of the metabolism of the mammary gland. It is only natural that such techniques should continue to be refined and that with such improvements the work should be expanded and some of the earlier interpretations altered in the light of more recent studies. One such refinement was the detection by Shaw and Petersen (28) of the relationship between excitation and changes in the concentration of hemoglobin in the blood traversing the mammary gland, which led to the finding by Powell and Shaw (19) that the reported uptake of blood lactic acid by the active gland was only an apparent utilization caused by agitation of the animal, with a resultant rapid increase in the lactic acid in the arterial blood and a temporary disproportion between the arterial and venous concentration of lactic acid. One of the purposes of this work was to obtain more conclusive data as to whether blood lactic acid is taken up by the active gland. A companion substance, pyruvic acid, was also included in this study.

In view of the conflicting reports on arteriovenous hemoglobin changes and the respiratory quotient of the mammary gland, these studies were also extended. In addition a series of arteriovenous experiments were conducted on cows in which the per cent of milk fat and the lower fatty acids of milk had been decreased by feeding fish oils.

EXPERIMENTAL PROCEDURE

As both lactic acid and pyruvic acid increases rapidly with excitation, numerous arteriovenous studies were made of these two substances on anes-

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thetized lactating and nonlactating cows, fasted cows, and cows fed cod-liver oil. The respiratory quotients of mammary glands of normal-lactating, fasted, and nonlactating-nonpregnant cows were also determined on cows under nembutal anesthesia. The respiratory quotients were also obtained on the mammary glands of both nonanesthetized and anesthetized cows in which the per cent of fat in milk had been depressed by feeding fish oil.

Amino acid determinations were made on arterial and mammary venous bloods of anesthetized cows before and after depressing the per cent of milk fat by the feeding of red-fish oil. In the studies on the effect of fish oils, blood samples were not taken in any case until a large decrease in the per cent of milk fat had been observed. Acetone bodies were determined on arterial and mammary venous bloods of nonanesthetized cows before and after feeding cod-liver oil. Hemoglobin determinations were made on all blood samples.

Arterial bloods were obtained from either the internal iliac or prepubic arteries by rectal puncture. Mammary venous bloods were obtained from the subcutaneous abdominal veins. Ethyl chloride was used to anesthetize the skin in the region of the venipuncture on nonanesthetized cows. After repeated venipunctures cows are subject to more agitation. Local ethyl chloride anesthesia prolonged the period that the animals remained unagitated. Once the animals reached the stage where they anticipated the venipuncture, local anesthesia only served to agitate the animals further. Blood samples drawn from highly agitated cows were usually discarded. Determinations were made on a few, however, to demonstrate the effect of excitation upon arteriovenous hemoglobin differences.

In anesthetizing the animals the nembutal was injected intravenously while the animal was standing in order to avoid undue disturbance. From three to five grams were injected within a period of 30 seconds, the dosage varying with the size and condition of the cow. The animal was allowed to fall in a well-bedded stall and kept on its sternum by the use of bags filled with sawdust. The head was always kept in a low position to allow for the draining of saliva. During the first hour approximately one gram of nembutal was injected intravenously at 20-minute intervals to maintain anesthesia. The respiration rate was taken at frequent intervals to aid in maintaining a moderate anesthesia. After the first hour nembutal injections were made at less frequent intervals. The cows usually remained lying down for several hours after regaining consciousness. In a few cases blood samples were obtained after the cows had partially recovered from anesthesia but were still not reactive to the needle. After partial recovery from the effects of the anesthesia the cows were always rolled over on the opposite side to improve circulation, still maintaining the fore part of the animal in an upright position. When such procedure was followed, no serious after affects were observed. A light feeding of grain was always given a few hours before anesthetizing the animals in order to avoid any alterations in the metabolism of the mammary gland due to fasting.

Early in the course of the work it was observed that large fluctuations occurred in both the arteriovenous differences and in the absolute values when blood samples were taken too soon after anesthetization. This was particularly true of oxygen, carbon dioxide, hemoglobin, lactic acid and pyruvic acid. For this reason blood samples were usually not taken until 15 to 20 minutes after anesthetization and in most cases a longer period of time was allowed to elapse. In addition the samples were usually drawn after the animal had been very quiet and the rate of respiration had been steady and normal for from 10 to 15 minutes or more. As there is a tendency for the arteriovenous differences to be similar over relatively short periods, rather lengthy periods of time were allowed to elapse between samples in order to obtain a more representative picture of the metabolism of the gland.

Bloods for lactic acid were taken in oxalated flasks containing sodium fluoride and chilled in ice water. Bloods for amino acids and hemoglobin were taken in oxalated vessels. Bloods for oxygen and carbon dioxide were drawn under oil in vessels containing heparin. Bloods for pyruvic acid were drawn last in clean flasks and immediately pipetted into cold trichloracetic acid without the use of preservative or anticoagulant. When consecutive arteriovenous samples were being drawn, the bloods for pyruvic acid were always pipetted into trichloracetic acid before the next series of blood samples were taken. Arterial and mammary venous bloods for each substance to be determined were always drawn simultaneously.

The chemical methods used were as follows: acetone bodies, Barnes and Wick (3); glucose, Somogyi's (32) modification of the Shaffer and Somogyi method; lactic acid, Miller and Muntz (18) as modified by Koenemann (17) and Barker and Summerson (2); pyruvic acid, Friedemann and Haugen (7); hemoglobin, Evelyn and Malloy (5); amino acids, Frame *et al.* (6) and Russell (22); oxygen and carbon dioxide, Van Slyke and Neill (33) and the Reichert-Meissl value of fat, Official and Tentative Methods of Analysis (1).

RESULTS

The Respiratory Quotient of the Mammary Glands of Normal Lactating, Lactating Fasted, and Nonlactating, Nonpregnant Cows Under Nembutal Anesthesia

A total of 22 respiratory quotients were obtained from eight normal lactating cows under anesthesia. The mean respiratory quotient was 1.27 which confirms the reports of Graham *et al.* (9) and Reineke *et al.* (20) on goats and is in accord with the findings of Shaw and Petersen (29) on cows in which there were no arteriovenous hemoglobin differences. The low respiratory quotient on both fasting and nonlactating cows is also in accord with previous reports (20, 31) although more data are needed to establish these relationships with certainty.

The Respiratory Quotient of Lactating Mammary Glands of Cows Fed Fish Oil

In view of the reports that the respiratory quotient of the mammary gland of the fasted cow is less than unity and the suggestion by Reineke

TABLE 1

Arterial and mammary venous blood oxygen and carbon dioxide on cows under nembutal anesthesia

Experiment No.	Minutes under anesthesia	Respiration rate	Per cent hemoglobin difference	O_2 difference, vol.%	CO_2 difference, vol.%	R.Q.
			Normal lactating cows			
D.E. 242	20	Normal	− 0.31	+ 3.58	− 5.37	1.50
	90	Normal	− 0.50	+ 3.62	− 4.54	1.25
	110	Normal	+ 0.49	+ 2.77	− 2.90	1.05
D.E. 244	30	Normal	0.00	+ 2.12	− 2.52	1.19
	95	Normal	0.00	+ 3.20	− 3.49	1.09
D.E. 245	10	Normal	0.00	+ 3.08	− 2.84	0.92
	85	Normal	0.00	+ 2.84	− 3.38	1.19
	120	Normal	0.00	+ 3.21	− 4.17	1.30
	122	Normal	0.00	+ 3.11	− 2.87	0.92
D.E. 246	107	Normal	+ 0.64	+ 3.86	− 4.39	1.14
D.E. 248	43	Normal	− 1.71	+ 2.90	− 2.25	0.78
	110	Normal	0.00	+ 2.73	− 3.89	1.43
	320*	Normal	0.00	+ 3.88	− 3.85	0.99
D.E. 249	28	Normal	0.00	+ 2.36	− 4.72	2.00
	31	Normal	− 0.98	+ 2.79	− 3.76	1.35
	43	Normal	0.00	+ 1.76	− 3.72	2.11
D.E. 250	30	Normal	− 0.95	+ 3.30	− 3.80	1.15
	57	Normal	− 0.73	+ 2.64	− 3.52	1.33
	60	Normal	0.00	+ 3.40	− 5.26	1.55
D.E. 251	91	Rapid	− 1.31	+ 3.83	− 5.55	1.45
	102	Rapid	− 0.76	+ 4.00	− 4.91	1.23
	182*	Normal	− 0.81	+ 5.85	− 5.85	1.00
Average	....	....	0.48	+ 3.22	− 3.98	1.27
			Lactating cow fasted 40 hours			
D.E. 273	40	Normal	+ 0.84	+ 2.23	− 1.34	0.60
	55	Normal	0.00	+ 2.19	− 2.70	1.23
	58	Normal	0.00	+ 3.28	− 2.62	0.80
Average	......	....	0.28	+ 2.57	− 2.22	0.88
			Nonlactating-nonpregnant cow			
D.E. 272	50	Normal	− 1.65	+ 2.28	− 0.94	0.41
	53	Normal	0.00	+ 4.37	− 3.07	0.70
	58	Normal	0.00	+ 3.82	− 2.76	0.72
Average	......	....	0.55	+ 3.49	− 2.26	0.61

* Conscious but not reactive to needle.

et al. (20) that the low quotient is due to a decrease in the synthesis of the lower fatty acids of milk from carbohydrate, a study was made to determine whether the relationship between the low quotient and the decrease in the lower fatty acids on fasting was real or fortuitous. As the feeding of cod-liver oil also decreases the short-chain fatty acids of milk fat markedly, a low respiratory quotient should result if the low quotient on lactating glands of fasted cows is to be accepted as evidence that such acids are synthesized from carbohydrate.

TABLE 2

Arterial and mammary venous blood oxygen and carbon dioxide on cows fed fish oil

Experiment No.	Days fed fish oil	Milk fat, per cent	Minutes under anesthesia	Condition of cow	Per cent hemoglobin difference	O_2 difference, vol.%	CO_2 difference, vol.%	R.Q.
Cows fed cod-liver oil								
D.E. 50	0	3.0	......	......	......	......	......	......
	43	1.8	......	Quiet	−0.76	+4.63	−4.42	0.95
	Two minutes between samples			Quiet	−0.76	+3.97	−3.69	0.93
D.E. 51	0	2.8	......	......	......	......	......	......
	18	2.1	......	Quiet	0.00	+3.70	−2.62	0.71
D.E. 53	0	3.5	......	......	......	......	......	......
	37	1.5	......	Quiet	0.00	+3.95	−2.76	0.70
	Two minutes between samples			Quiet	0.00	+4.16	−2.56	0.62
D.E. 54	0	4.4	......	......	......	......	......	......
	24	3.2	......	Quiet	0.00	+4.25	−5.76	1.36
	Two minutes between samples			Quiet	−0.94	+4.38	−6.95	1.59
D.E. 55	0	6.1	......	......	......	......	......	......
	15	4.5	......	Agitated	+2.18	+3.80	−8.36	2.20
D.E. 56	0	3.2	......	......	......	......	......	......
	17	1.9	......	Quiet	0.00	+6.25	−7.13	1.14
	Two minutes between samples			Quiet	−0.68	+6.03	−8.64	1.43
	Two minutes between samples			Quiet	0.00	+5.10	−6.77	1.33
	23	1.9	......	Agitated	+5.75	+4.42	−6.23	1.41
	24	2.0	......	Agitated	+1.44	+4.62	−5.67	1.23
D.E. 57	0	4.2	......	......	0.96	+4.56	−5.50	1.20
	17	3.1	......	Agitated	+1.44	+3.58	−2.27	0.63
Average of nonanesthetized cows					1.00	+4.48	−5.26	1.16
Cows fed red-fish oil—respiration normal in all cases								
D.E. 251	0	6.2	......	......	......	......	......	......
	23	3.2	71	......	0.00	+1.18	−1.28	1.08
	......	......	228*	......	0.00	+2.74	−3.38	1.23
D.E. 251	32	3.0	75	......	0.00	+3.42	−5.28	1.54
	......	......	127	......	0.44	+1.98	−3.52	1.78
D.E. 250	0	5.5	......	......	......	......	......	......
D.E. 250	21	3.0	76	......	0.00	+3.08	−3.18	1.03
D.E. 250	26	3.2	57	......	+1.53	+3.05	−3.87	1.27
	......	......	77	......	+0.76	+3.10	−3.79	1.22
Average of anesthetized cows					0.38	+2.65	−3.47	1.31

* Conscious but not reactive to needle.

Eight cows were fed either cod-liver oil or red-fish oil until the per cent of milk fat had been decreased markedly. Red-fish oil was used because it has been found to be at least as potent as cod-liver oil in decreasing the per cent of milk fat and the lower fatty acids. From 300 to 450 ml. of fish oil per day were fed over extended periods of time to obtain the maximum effect.

In the initial trials on nonanesthetized cows, a low quotient was obtained and it was believed that the similarity to fasted cows prevailed. More detailed analyses, however, failed to confirm these results. As noted in table 2, the average respiratory quotient of fifteen experiments on six nonanesthetized cows was 1.16. In addition, seven such calculations were made from experiments on two cows under nembutal anesthesia in which the per cent of milk fat had been depressed by the feeding of red-fish oil. The mean respiratory quotient was 1.31. In a total of 22 such experiments, the respiratory quotients on the active glands of cows fed fish oil exceeded unity in 15 cases with a mean value of 1.21. As a check on the relationship of the decrease in the per cent of milk fat and the lower acids, Reichert-Meissl values were determined on the milk fat of two cows before and after the depression of the per cent of fat by feeding fish oil. D.E. 53 exhibited a decrease from 38.56 to 25.09 and D.E. 56 a decrease from 36.50 to 22.84.

Arteriovenous Studies on Lactic Acid and Pyruvic Acid

Since excitation has such a marked influence on the apparent uptake of lactic acid by the active mammary gland it seemed advisable to study this matter further by the use of anesthetized animals. Pyruvic acid determinations were also included in these studies. Cows in various physiological conditions were studied, since it was entirely possible that under certain conditions the metabolism of the gland might be altered in such a way as to effect changes in the metabolism of either pyruvic acid or lactic acid or both. As noted in table 3, 22 analyses on six normal lactating cows under anesthesia showed an arteriovenous difference in lactic acid of only +0.18 mg. per cent. A total of 26 analyses on eight normal lactating cows under anesthesia showed an arteriovenous difference of only +0.047 mg. per cent pyruvic acid. It is apparent from these data that neither blood lactic acid nor pyruvic acid play a significant rôle in the elaboration of milk. Likewise, the arteriovenous differences in these two substances on fasted, nonlactating, and fish-oil-fed cows were insignificant and did not suggest any alteration in the metabolism of either lactic acid or pyruvic acid. The only cases in which a significant amount of either substance was taken up by the gland was shortly after anesthetization, when the arterial blood was still apparently slightly above normal due to the excitation of the animal during the initial injection of nembutal, although even in these cases the largest positive difference was only 1.10 mg. per cent lactic acid and 0.424 mg. per cent pyruvic acid.

TABLE 3

Arterial and mammary venous blood hemoglobin, lactic acid, and pyruvic acid on cows under anesthesia

Cow No.	Minutes under anesthesia	Hemoglobin			Lactic acid			Pyruvic acid		
		Arterial	Venous	Per cent difference	Arterial	Venous	Difference	Arterial	Venous	Difference
				Normal lactating cows						
		%	%			mg.%	mg.%	mg.%	mg.%	mg.%
D.E. 242	20	13.00	13.04	−0.31	......	......	......	0.708	0.542	+0.166
	90	12.83	12.89	−0.50	......	......	......	0.528	0.454	+0.074
	110	14.25	14.18	+0.49	......	......	......	0.463	0.426	+0.037
D.E. 243	5	11.83	12.10	−2.28	......	......	......	1.104	0.680	+0.424
	85	13.75	13.75	0.00	......	......	......	0.442	0.442	0.000
	105	14.04	13.97	+0.50	......	......	......	0.358	0.434	−0.076
D.E. 244	12	10.74	10.74	0.00	6.08	5.87	+0.21	......	......	......
	30	10.81	10.81	0.00	3.29	3.03	+0.26	0.448	0.310	+0.138
	95	10.57	10.57	0.00	2.02	2.21	−0.19	0.296	0.318	−0.022
D.E. 245	10	10.41	10.41	0.00	4.45	3.66	+0.79	0.596	0.410	+0.186
	85	11.07	11.07	0.00	1.70	1.51	+0.19	0.318	0.230	+0.088
	120	12.00	12.00	0.00	2.27	2.03	+0.24	0.318	0.282	+0.036
D.E. 247	38	12.17	12.17	0.00	6.25	6.07	+0.18	0.466	0.410	+0.056
	99	12.09	12.09	0.00	8.27	9.24	−0.97	0.445	0.562	−0.117
	147	12.83	12.83	0.00	7.87	8.78	−0.91	0.484	0.664	−0.180
D.E. 248	43	10.48	10.66	−1.71	4.07	3.68	+0.39	0.390	0.310	+0.080
	110	10.74	10.74	0.00	2.52	2.34	+0.18	0.326	0.298	+0.028
	320*	11.66	11.66	0.00	4.20	3.24	+0.96	0.410	0.330	+0.080
	28	9.32	9.32	0.00	2.60	2.37	+0.23	0.290	0.264	+0.026
	31	9.23	9.32	−0.98	2.21	2.18	+0.03	0.306	0.264	+0.042
	43	9.23	9.23	0.00	2.15	2.23	−0.08	0.290	0.274	+0.016
D.E. 250	30	9.39	9.48	−0.95	4.66	3.56	+1.10	0.314	0.258	+0.056
	57	9.63	9.70	−0.73	3.78	3.14	+0.64	0.290	0.258	+0.032
	60	9.78	9.78	0.00	3.28	2.97	−0.31	0.322	0.294	+0.028
D.E. 251	21	9.85	10.09	−2.44	4.66	4.10	+0.56	0.458	0.378	+0.080
	91	10.68	10.82	−0.14	2.72	2.61	+0.11	0.306	0.322	+0.016
	102	10.57	10.65	−0.76	2.73	3.37	−0.64	0.322	0.370	−0.048
	182*	9.93	10.01	−0.81	3.10	2.83	+0.27	......	......	......
Average	......	......	......	0.45	3.86	3.68	+0.18	0.423	0.376	+0.047
				Lactating cows fed red-fish oil						
D.E. 251	51	9.40	9.43	−0.32	1.85	1.83	+0.02	0.501	0.501	0.000
	71	10.17	10.17	0.00	1.75	2.38	−0.63	0.593	0.536	+0.057
	228	10.01	10.01	0.00	1.97	3.93	−1.96	0.450	0.560	−0.110
D.E. 250	43	10.49	10.49	0.00	3.74	3.75	−0.01	0.676	0.596	+0.080
	76	10.49	10.49	0.00	2.07	2.31	−0.24	0.556	0.466	+0.090
	85	10.49	10.49	0.00	2.18	2.19	−0.01	0.516	0.460	+0.056
D.E. 250	57	10.49	10.33	+1.53	1.69	1.69	0.00	0.373	0.298	+0.075
	77	10.49	10.41	+0.76	1.56	1.54	+0.02	0.298	0.280	+0.018
Average	......	......	......	0.31	2.10	2.45	−0.35	0.495	0.462	+0.033
				Lactating cow fasted 40 hours						
D.E. 273	40	10.74	10.65	−0.84	3.77	3.67	+0.10	0.370	0.306	−0.064
	55	10.49	10.49	0.00	3.33	3.36	−0.03	0.374	0.317	−0.057
	58	10.49	10.49	0.00	3.49	3.26	+0.23	0.374	0.354	−0.020
Average	......	......	......	0.28	3.53	3.43	+0.10	0.372	0.326	−0.047
				Nonlactating-nonpregnant cow						
D.E. 272	50	12.71	12.92	−1.65	2.76	3.20	−0.44	0.342	0.426	−0.084
	53	12.71	12.71	0.00	2.33	2.75	−0.42	0.371	0.442	−0.071
	58	12.38	12.38	0.00	2.54	2.75	−0.21	......	......	......
Average	......	......	......	0.55	2.54	2.90	−0.36	0.357	0.434	−0.078

* Conscious but not reactive to needle.

Arteriovenous Studies on Acetone Bodies on Cows Before and After Feeding Fish Oil

Because the active mammary gland was found to utilize blood β-hydroxybutyric acid and not acetoacetic acid (25) the former substance appeared to be a possible precursor of the lower fatty acids of milk fat. Initial trials, which were made before the influence of the concentration of β-hydroxybutyric acid on its utilization was understood (23), appeared to confirm these suspicions. To avoid any possible misintrepretations due to the individuality of the animal, arteriovenous determinations were made on the total blood acetone bodies before and after the feeding of cod-liver oil. The cows were not anesthetized, as previous work had shown that excitation did not exert any significant influence on the arteriovenous difference (25). The data presented in table 4 do not indicate that the utilization of β-hydroxybutyric acid by the lactating mammary gland is altered by the feeding of cod-liver oil. Although the mean arteriovenous difference is greater in the cows fed cod-liver oil, this difference is undoubtedly due to a higher than normal concentration of acetone bodies in the arterial blood of three of the cows since the utilization is known to be greater at higher than normal concentrations (23, 30).

TABLE 4

Arterial and mammary venous blood acetone bodies on nonanesthetized cows before and after feeding cod-liver oil

Cow No.	Per cent hemoglobin difference	Acetone bodies (as acetone)		
		Arterial	Venous	Difference
		Normal cows		
		mg. %	*mg. %*	*mg. %*
D.E. 54	0.83	2.93	2.01	+0.92
D.E. 55	1.32	1.83	1.14	+0.79
D.E. 56	0.00	3.13	2.31	+0.82
D.E. 57	0.89	2.45	1.40	+1.05
Average	0.76	2.59	1.72	+0.90
		Cod-liver-oil-fed cows		
D.E. 54	0.00	2.88	1.64	+1.24
D.E. 55	0.00	6.29	4.04	+2.25
D.E. 56	0.00	7.60	5.35	+2.25
	−0.68	7.75	5.43	+2.32
D.E. 56	−5.75	2.27	1.33	−0.94
	−1.44	3.06	2.29	+0.77
D.E. 57	+1.44	2.29	1.22	+1.07
Average	1.33	4.59	3.04	+1.55

Arteriovenous Studies on Amino Acids on Anesthetized Cows Before and After Feeding Red-fish Oil

The utilization of amino acids by the gland of the normal cow (4, 12, 27), the formation of urea (10), together with the presence of arginase in the gland (26), and the lack of utilization of amino acids reported for the fasted cow (21, 31), suggested that the free blood amino acids should be given consideration as possible precursors of the lower fatty acids. Calculations on the basis of the calcium and amino acid uptake by the gland and the total calcium and lower fatty acids in milk had shown that the lower fatty acids could be accounted for by the amount of free amino acids taken up by the gland (31).

TABLE 5

Arterial and mammary venous blood amino acids on a nonlactating cow and on lactating cows before and after feeding red-fish oil

Cow No.	Per cent hemoglobin difference	Amino acids		
		Arterial	Venous	Difference
		Normal cows		
		mg. %	*mg. %*	*mg. %*
D.E. 250	− 0.95	5.86	5.19	+ 0.67
	− 0.73	5.38	5.05	+ 0.33
	0.00	5.22	4.66	+ 0.56
D.E. 251	− 2.44	6.17	5.71	+ 0.46
	− 1.31	5.65	5.32	+ 0.33
	− 0.76	5.77	5.40	+ 0.37
	− 0.81	5.50	4.95	+ 0.55
Average	− 1.00	5.65	5.18	+ 0.47
		Red-fish-oil-fed cows		
D.E. 250	0.00	5.64	5.19	+ 0.45
	0.00	5.64	5.31	+ 0.33
	0.00	5.58	5.12	+ 0.46
D.E. 251	− 0.32	5.59	5.29	+ 0.30
	0.00	5.58	5.09	+ 0.49
	0.00	5.54	5.33	+ 0.21
Average	− 0.05	5.60	5.22	+ 0.37
		Nonlactating-nonpregnant cow		
D.E. 272	− 1.65	5.67	5.72	− 0.05
	0.00	5.67	5.72	− 0.05
	0.00	5.56	5.56	0.00
Average	....	5.63	5.67	0.03

Accordingly a series of amino acid determinations were made on the arterial and mammary venous bloods of cows before and after the per cent of milk fat had been depressed by the feeding of red-fish oil.

These animals were anesthetized because studies on substances known to be affected by excitation were also being made. As noted in table 5, the feeding of red-fish oil did not materially alter the utilization of amino acids by the active mammary gland, the mean arteriovenous difference before and after feeding fish oil being 0.47 mg. per cent and 0.37 mg. per cent, respectively. The decrease in the lower fatty acids effected by feeding fish oil cannot, therefore, be considered as due to a failure of the gland to take up amino acids from the blood. Three arteriovenous values obtained on a dry cow provide a good check on the technique and demon trate that the inactive gland does not take up blood amino acids.

ARTERIOVENOUS HEMOGLOBIN DIFFERE CES

It was first shown by haw and Pet r ' 11 (2) that marked agitation resulted in large changes in the concentration of the blood traversing the mammary gland. uch differences did 110t occur in the nonexcited cow and therefore the arteriovenous hemoglobin difference. could be used a a criterion of the degree of excitation provoked in the animal. Bloods drawn from cows under anesthesia should provide an excellent opportunity to study this matter further. With moderate anesthesia the arteriovenous differences in hemoglobin might be expected to resemble those of the nonexcited, nonanesthetized animal. Arterial and mammary venou hemoglobin values are presented in table 3 in some detail. It will be observed that out of a total of 42 arteriovenous hemoglobin determination ' all but five exhibited less than 1.0 per cent hemoglobin difference and in 30 of the 42 experiments the difference was not over 0.5 percent. Further, in all five of the experiments exhibiting over 1.0 pcr cellt hemoglobin difference the bloods were the first of a series of samples in which)10ne of th later sample' exhibited this degree of change. In the e five cases the animals had either been under anesthesia but a short time 01' the l'espiration had been teady for but a short period. The average arteriovenou. hemoglobin difference for the 42 experiments was 0.40 per cent. Thi compares favorably with the average of 0.64 reported by Shaw and Petersen (2) on Ilonexcited cow and may be constrasted with the much larger hemoglobin per cent difference of 5.70 observed on excited cows (28).

DISCUSSION

The failure of the respiratory quotients of the mammary gland of·cows fed fish oils to parallel that reported for fasted cows lea\'es the interpretation of the low respiratory quoti lit of the latter in doubt. One fact which has troubled the writer for some time is that there is a considerable quantity of the lower fatty aeids being .ynthesized after several day of fa ling and yet the quotient is apparently below unity. If the respiratory quotient of the gLand can be u.ed afely as all indication of the type of metabolism taking place in the gland, it must meau that considerable oxidation of fat is taking place in the fasted cow. If β-hydroxybutyric acid is oxidized in the gland lor energy purposes, as appears to be the case, it would help to account for a quotient below unity in the fasted cow. However, the complete oxidation of this substance would re ult in a quotient of 0.89 and but very little synthesi of fat from carbohydrate would be needed to elevate the quotient to unity or above. The report that everal days of fasting are required to produce a quotient below. u.nity (20) is also not in accord ,vith the suggestion that the low quotient demonstrates that the lower fatty acids are synthesized from carbohydrate, as the major decrease in these acids occurs within 24 to 48 hours (15) of fasting. However, the data on the fasted cow are very limited and further speculation is probably unwarranted until more information is obtained on both fasted and fish-oil-fed animals.

The low respiratory quotient of the inactive mammary gland is also difficult to evaluate. If it were due to the oxidation of fat it would appear that the gland of the nonlactating cow should utilize the readily oxidizable β-hydroxybutric acid. Such does not appear to be the case, however (25). It is significant that the low quotients on the mammary gland have been reported only in those cases in which the gland has been relatively inactive, as in the case of the gland of the nonlactating cow and the cow fasted for several days. In the latter case milk production drops to a very low level within a matter of two to three days. A possible explanation is that the lymph of the inactive gland may be carrying away a larger proportionate amount of carbon dioxide resulting in an apparent rather than a real respiratory quotient below unity. This would also explain the failure to obtain consistently low values on the glands of cows in which the lower acids have been depressed by the feeding of fish oil, as milk production is not materially affected by the feeding of these oils.

The nonutilization of amino acids reported for the active gland of the fasted animal may also be due to the precipitous drop in milk secretion in which the usual functions of these acids may be amply provided for by amino acids taken up by the gland as protein. At least the apparent normal utilization of blood amino acids by the active gland of the fish-oil-fed cow does not suggest any relationship between the amino acid utilization and the lower fatty acids.

The failure of cod-liver oil to effect a decrease in the utilization of acetone bodies by the gland, together with the finding that the fasted-ketotic cow exhibits an increased utilization of β-hydroxybutyric acid with a decrease in the lower fatty acids of milk fat, appears to rule out the possibility of β-hydroxybutyric acid acting as a precursor of the lower acids and favors our alternative suggestion that this substance is used by the gland for energy purposes (25).

An increase of over 100 per cent occurs in the utilization of β-hydroxybutyric acid by the gland in ketonemia (23, 30) and since it appears to be utilized for energy purposes offers some excellent possibilities in studying the energy metabolism of the gland. The fact that practically all of the oxidation by the gland in ketonemia (23, 30) can be accounted for by the uptake of β-hydroxybutyric acid indicates that a shift must take place from the oxidation of both β-hydroxybutyric acid and other substances to the sole oxidation of β-hydroxybutyric acid. This assumes that β-hydroxybutyric acid is used for energy purposes, an assumption that appears valid on the basis of our present knowledge of the metabolism of this substance. Information as to the substances involved in such a shift would be invaluable to a more complete understanding of the metabolism of the gland. The possibility that one of the substances may be fatty acids other than β-hydroxybutyric acid should be explored further even though the short-chain fatty acids of nonfasted ketotic cows did not appear to be appreciably low (31).

The data on lactic acid values of cows under anesthesia amply confirm our previous observations that the arteriovenous change in the concentration of this substance is insignificant in nonexcited cows (19). The mean arteriovenous difference in these studies of + 0.18 mg. per cent is in sharp contrast with the earlier reports by Graham (8) and Shaw, Boyd and Petersen (24) of a mean utilization of 16.70 and 3.64 mg. per cent, respectively, on goats and cows, but is in substantial agreement with the arteriovenous value of + 0.52 mg. per cent reported by Powell and Shaw (19) for unagitated cows, a value shown to be statistically insignificant.

The relatively insignificant arteriovenous difference in pyruvic acid of + 0.047 mg. per cent obtained from 26 experiments on lactating cows under anesthesia was somewhat surprising in view of the utilization of this substance found by Knodt and Petersen (16) in incubated tissue. However, it does demonstrate that blood pyruvic acid does not play a significant rôle in the metabolism of the gland of the cow under normal conditions.

The lactic acid and pyruvic acid values obtained on fasted, nonlactating, and fish-oil-fed cows do not show any significant difference from the normal cows. The relatively low mean arterial value of 3.86 mg. per cent lactic acid on normal cows under anesthesia is considerably less than the value of 7.29 mg. per cent found on nonexcited, nonanesthetized cows (19) and suggests that even in those cases in which the cow does not exhibit excitation there is significant disturbance to effect an increase in blood lactic acid.

There is some reason to believe that a rather close relationship exists between rumen digestion and the synthesis of the lower fatty acids of milk fat. It is entirely possible that some of the effects of fasting and fish oils on the synthesis of milk fat are related to an alteration in rumen digestion. It appeared probable that some of the end products of bacterial fermentation would contribute to the concentration of certain blood substances, in which case any marked change in rumen digestion might be expected to result in a change in the level of such substances in the blood. Two such are lactic acid and pyruvic acid. Fasting did not appear to influence the blood concentration of either substance. Also, the feeding of red-fish oil did not appear to influence the blood pyruvic acid. However, the values for blood lactic acid are consistently lower for the cows on red-fish oil than for the normal cows, the arterial concentration being 2.10 mg. per cent as compared to 3.86 mg. per cent for cows fed a normal diet. However, more data are needed to establish the validity of this observation. Certainly the feeding of cod-liver oil did not decrease the blood acetone bodies; substances for which unpublished work in this laboratory has indicated rumen precursors.

The mean difference in blood hemoglobin concentration of 0.40 per cent on 42 anesthetized cows is in sharp contrast with the value of 5.70 per cent obtained by Shaw and Petersen (28) on 23 excited cows and in substantial agreement with the value of 0.64 on nonexcited cows. As would be expected, the arteriovenous changes on anesthetized animals show greater uniformity.

The question may be raised as to whether nembutal anesthesia interferes with milk secretion. Reineke *et al.* (20) concluded that milk secretion was not diminished by nembutal. The following data were obtained on three cows which had been under nembutal anesthesia for one to two hours and in which the animals recovered sufficiently to be milked at the usual time.

		D.E. 251, lbs. milk	*D.E. 250, lbs. milk*	*D.E. 249, lbs. milk*
Day before anesthesia	A.M.	10.3	13.4	6.2
	P.M.	9.2	9.7	4.4
Day of anesthesia	A.M.	11.6	13.7	6.4
	P.M.	8.5	8.9	4.4
Day after anesthesia	A.M.	10.0	13.0	6.1
	P.M.	9.9	8.5	4.3

There was very little diminution in the rate of milk secretion in these experiments. In each case the cow was put under anesthesia after the morning milking. As the cows were fed lightly on the morning of the experiment, some decrease might have been expected the following day. More conclusive information could have been obtained by the use of oxytocin injections at short intervals, but the data do indicate that no large decrease occurred in milk production.

SUMMARY AND CONCLUSIONS

1. The respiratory quotient of the active mammary glands of both normal and fish-oil-fed cows under nembutal anesthesia exceeded unity with mean values of 1.27 and 1.31 respectively. In experiments with nonanesthetized cows in which the per cent of fat and the low fatty acids of milk fat had been depressed by feeding fish oil, the respiratory quotient exceeded unity in 9 of the 15 experiments with a mean quotient of 1.16. On the basis of these data the suggestion that a metabolic relationship exists between the respiratory quotient of the gland and the synthesis of the lower fatty acids of milk is still in doubt.

2. Numerous experiments on cows under anesthesia confirm the earlier report (19) that the mammary gland does not utilize a significant amount of blood lactic acid. The mean arteriovenous value for 22 experiments was + 0.18 mg. per cent.

3. The mean arteriovenous difference for pyruvic acid in 26 experiments

was + 0.047. Consequently, blood pyruvic acid appears to be of little significance in the metabolism of the active mamary gland.

4. The arteriovenous differences of lactic acid and pyruvic acid were not altered significantly on fish-oil-fed, fasted, or nonlactating cows from that observed on normal lactating cows.

5. Neither the utilization of amino acids nor acetone bodies were altered significantly by depressing the per cent of milk fat and the lower fatty acids by feeding fish oils.

6. Arteriovenous hemoglobin studies on anesthetized cows confirm earlier observations that little or no arteriovenous change occurs in unagitated cows. The per cent hemoglobin difference for 42 experiments on anesthetized cows was 0.40 and exceeded one per cent in only 5 cases.

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EFFECT OF WARM WEATHER ON GRAZING PERFORMANCE OF MILKING COWS

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Grazing habits of dairy cattle are of direct concern to dairymen whenever they help explain increases or decreases in milk production. Published reports on activities of dairy cattle while on pasture are relatively few and none has been found that reported the effect that changes in atmospheric temperatures have on grazing habits. Hodgson (3) in 1933 reported that dairy cows at Puyallup, Washington, spent from 6½ to 7 daylight hours grazing under a rotational pasture system and from 7 to 7½ hours on a continuous grazing plan. No records were kept of their grazing habits at night.

A more detailed study by Atkeson, Shaw, and Cave (1) showed that Kansas milking cows during 11.7 daylight hours grazed 5.6 hours while on good pasture; 6.5 hours on fair pasture; and 7.3 hours on poor pasture. The cows lay down an average of four times on good pasture and only two times on fair or poor pasture. Records taken on 56 dry cows and heifers while on excellent Balbo rye pasture day and night during April showed an average of 7 hours grazing; 4 hours standing or walking; and 13 hours lying down. During the 14-hour daylight period the animals grazed 40 per cent of the time; while only 16 per cent of the 10-hour night period was spent grazing. They lay down 35 per cent of the daylight period and 80 per cent of the night. Grazing seemed to be spaced into four primary periods.

Records on beef cattle (4) taken in New York during July, August, and September averaged 7 hours and 32 minutes of grazing time during the 24 hours of the day. Of this, 4 hours and 23 minutes took place between 7 A.M. and 7 P.M., and 3 hours and 9 minutes between 7 P.M. and 7 A.M.

The present study, while similar in some respects to those reviewed, had two primary objectives: First, to determine changes in body temperature and pulse and respiration rates of cows on pasture during relatively warm days and second, how the warm weather affected the grazing habits of milking cows.

EXPERIMENTAL

During a period of three days, September 4, 7, and 8, 1945, observations were made on 6 milking cows, 3 Jerseys and 3 Holsteins, in an effort to determine changes in their body temperatures, pulse rates, and respiration rates during the daytime and while they were on pasture. Rectal temperatures, pulse counts from coccygeal arteries of the tail, and respiration counts from flank movements were made during five periods of the day, *i.e.*, just before cows entered pasture at 5:45 A.M.; when they entered shade (averaged 9:20

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A.M.); one hour after entering shade; at 2:00 P.M.; and at 3:00 P.M. The 5:45 A.M. observation was taken in the barn immediately after the morning milking; while the 3:00 P.M. reading was made after cows were put into the barn prior to feeding, washing, and the evening milking. All other observations took place in the pasture. This was made possible by using cows relatively tame and by tying them with halters during the time observations were made.

Observations relative to grazing performance during five 24-hour periods constituted the second phase of the experiment. The same six milking cows, with the exception of one substitute Holstein cow, were used. Observations were made on September 10 to 14, inclusive. The days selected proved to be fortunate choices, for average daily air temperatures in the shade (table 2) varied from 72° to 86° F. during the daytime and from 62° to 81° F. for the nights. These wide variations made it possible to observe changes in grazing habits caused by air-temperature changes.

By the use of a sling psychrometer wet- and dry-bulb, atmospheric temperature determinations were made throughout the period of the experiment. This was done in order to determine changes in atmospheric temperature and humidity from day to day and during the course of each day.

Cows on the experiment had access to relatively good permanent pasture, which consisted largely of grasses—Bermuda, Dallis and carpet. The pasture contained numerous large trees which furnished shade utilized by the cows during the hot, sunshiny portions of the days.

RESULTS

I. *Daytime Changes in Body Temperatures and Respiration*

Indications of how cows react to changes in atmospheric temperatures during the daytime were secured from recorded changes in their body temperature and respiration and pulse rates during three days on pasture. In general, these changes showed increases (table 1) averaging for the day 1.8° F. in body temperature, 16 in respirations per minute, and only 1 in pulse rate per minute. The latter change was not significant.

TABLE 1

Reaction of milking cows to daytime changes in atmospheric temperatures

Period	Time of day	Air temp.	Relative humidity	Body temp.	Resp. rate	Pulse rate
		°F.	*%*	*°F.*	*per min.*	*per min.*
In milking barn	5:45 A.M.	73.0	89.3	101.7	63	66
Cows enter shade	9:20 A.M.*	80.0	81.3	102.4	64	67
1 hour in shade	10:20 A.M.	83.1	74.3	102.6	71	66
In shade	2:00 P.M.	86.7	73.0	103.3	78	68
In milking barn	3:00 P.M.	86.0	65.3	103.5	79	67

* The time that cows entered shade varied from 8:35 to 10:15 A.M. with an average of 9:20 A.M.

During the day atmospheric temperatures increased from an average of 73° F. when cows left the barn at 5:45 A.M. to 86.7° F. at 2:00 P.M., with the reading slightly lower, 86° F., at 3:00 P.M. when cows were put into the barn prior to the evening milking. During this same period the relative humidity had shown a progressive drop from 89.3 per cent to 65.3 per cent.

Between 5:45 A.M. and the time that cows entered shade (average time 9:20 A.M.) air temperatures increased from 73° to 80° F., while relative humidity dropped from 89.3 to 81.3 per cent. Body temperatures of the cows had increased during that time from 101.7° to 102.4° F., but the increase in respiration rate was negligible, from 63 to 64 per minute.

After one hour in the shade with an increase from 80° to 83.1° F. in air temperatures and a decrease from 81.3 to 74.3 per cent in humidity, the cows were apparently unable to eliminate heat fast enough to prevent further changes in their temperature and respiration. As a result, body temperatures increased to 102.6° F. and respiration to 71 per minute. At 2:00 P.M. this upward trend continued, for air temperatures had then reached 86.7° F. and the cows averaged 103.3° F. in body temperature and 78.2 in respiration rate. After cows entered milking barn at 3:00 P.M. the only significant further change was in body temperatures, which then averaged 103.5° F., the highest recorded for the day.

II. *Grazing Performance During 24-Hour Periods*

During five 24-hour days, September 10 to 14, 1945, the six cows were constantly observed while on pasture. For the purpose of this experiment the cows' day (24-hour period) was considered as beginning when they entered pasture following the morning milking. During these days atmospheric temperatures were recorded at intervals, *i.e.*, 8:30 A.M., 11:30 A.M., 2:30 P.M., 6:30 P.M., 12:30 A.M., and 3:30 A.M. These readings (table 2) show some striking variations within each 24-hour period as well as between periods.

In general, the temperatures for the first two days averaged relatively high during the daytime, 86° F. and 85° F., while for the third day they averaged slightly lower, 82° F. The last two days were much cooler, the temperature averaging 72° F. for each. The averages for night temperatures are much in the same order, with the exception of that for day number 2 which was lower than day number 3, due to the cooling effects of a shower at around 5:00 P.M.

The first two days of observation on grazing (table 3) gave results which appear to be representative of how milking cows perform on pasture during relatively warm weather. The daytime period consisted of that portion of the day between the time cows entered pasture in the morning (7:15 A.M.) and the time they left in the afternoon (2:35 P.M.). During this daytime period the cows grazed only 1.9 hours the first day and even less, 1.8 hours,

TABLE 2

Daily changes in atmospheric temperatures

Time of day	24-hour periods (days)					
	1	2	3	4	5	Average
	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*
Day						
8:30 A.M.	80	79	75	70	65	74
11:30 A.M.	87	88	83	72	75	81
2:30 P.M.	90	88	87	75	77	83
Average	86	85	82	72	72	79
Night						
6:30 P.M.	87	72	73	71	73	75
12:30 A.M.	78	72	72	58	58	68
3:30 A.M.	78	70	73	56	55	66
Average	81	71	73	62	62	70

the second day. As contrasted to this, time spent not grazing (mostly in shade) was 5.7 hours for the first day and 5.5 hours the second day. The daytime atmospheric temperatures averaged 86° and 85° F., respectively, for the two days.

The night totals for grazing of 6.5 and 6.2 hours for these first two nights revealed one of the unexpected findings from this study. Grazing at night for these warm days thus equaled more than three times that for the daytime.

For the third day the grazing record showed an intermediate status. Daytime grazing increased approximately 1 hour, to a total of 2.8 hours, while grazing at night fell off 1.1 hours.

The fourth and fifth days gave some striking evidence of how cooler weather affects grazing habits. Daytime grazing increased to 4.5 hours for each of these two days, or 2.4 times the average for the first two (warm) days. Night grazing decreased to 4.7 and 5.0 hours, respectively, for the last two days. In spite of this decrease the total grazing during 24 hours

TABLE 3

Grazing and air-temperature relationships (average of 6 cows for daytime and night)

24-hour periods	Average air temperatures*		Hours in pasture	Hours spent grazing or not grazing					
				Daytime		Night		Daily totals	
	Day-time	Night		Grazing	Not grazing	Grazing	Not grazing	Grazing	Not grazing
days	°*F.*	°*F.*							
1	86	81	17.2	1.9	5.7	6.5	3.1	8.4	8.8
2	85	71	17.3	1.8	5.5	6.2	3.8	8.0	9.3
3	82	73	17.2	2.8	4.4	5.1	4.9	7.9	9.3
4	72	62	16.9	4.5	2.7	4.7	5.0	9.2	7.7
5	72	62	16.8	4.5	2.8	5.0	4.5	9.5	7.3

* Air temperature readings are averages of those taken at 8:30, 11:30, and 2:30 during the daytime and 6:30, 12:30, and 3:30 during the night.

for these cooler days showed 9.2 hours and 9.5 hours, or more than 1 hour longer than for the first three days.

The number of grazing periods each cow had for day and night is shown for each of the five days in table 4. While variations existed, in general, it can be seen that one grazing period during the day was most common, and the average was 1.4. At night three periods were most often spent grazing and the average was 2.7.

TABLE 4

Number grazing periods during day and night (summary of five 24-hour periods for 6 cows)

24-hour periods	Daytime							Night							Daily average
	Cow number						Average	Cow number						Average	
	1	2	3	4	5	6		1	2	3	4	5	6		
days															
1	2	2	1	3	2	2	2.0	3	2	3	2	3	3	2.7	4.7
2	1	1	1	1	1	1	1.0	3	3	2	3	3	3	2.8	3.8
3	1	2	1	1	1	1	1.2	3	4	2	2	3	3	2.8	4.0
4	2	1	2	1	2	2	1.7	3	3	3	3	2	2	2.7	4.4
5	2	1	1	1	2	1	1.3	2	2	2	3	2	1	2.3	3.6
Average	1.6	1.4	1.2	1.4	1.6	1.4	1.4	2.8	2.8	2.4	2.6	2.6	2.4	2.7	4.1

In each case the cows had their longest grazing periods immediately after being turned into pasture following milking. In the daytime the early morning grazing was the only period that cows grazed a sufficiently long time to make a major contribution. Whenever a cow grazed a second or third time during the daytime, it was for only a short time and usually during either a cloudy period or in some spot shaded by trees.

Night grazing started off in all cases by the long first period, averaging 3.1 hours. Following this the cows spent an average of 1.2 hours lying down, standing, chewing cud, etc., prior to the second grazing period. With the exception of one cow during one night, they then all grazed for a second period, averaging 1.4 hours. When the first two grazing periods were long, the cows sometimes omitted further grazing. However, the records showed that for an average of three of the five nights the six cows grazed during a third period averaging 1.5 hours. One cow during one night had a fourth grazing period of 3 minutes. While much variation occurred between cows and for different nights, the first grazing periods began at 5:45 P.M. on the average; the second around 10:30 P.M.; and the third, when it occurred, started at approximately midnight. Cows were taken to the milking barn at 3:30 A.M.; otherwise, there may have been more third and fourth grazing periods.

On an average, the cows spent 4.2 hours not grazing during the night. Variations among the six cows (table 5) ranged from 3.5 to 4.9 hours. Time

TABLE 5

Nongrazing record during night (average of 5 nights)

Cow No.	Lying-down	Standing	Total
	hours	*hours*	*hours*
1	2.8	1.5	4.3
2	3.0	0.8	3.8
3	4.4	0.3	4.7
4	3.1	0.4	3.5
5	4.1	0.8	4.9
Average	3.5	0.7	4.2

spent lying down ranged (between cows) from 2.8 to 4.4 hours and averaged 3.5 hours. Standing time not grazing ranged from 0.3 hours to 1.5 hours, with an average of 0.7 hours.

DISCUSSION

Results secured from this study should have general application to much of the United States, inasmuch as daytime atmospheric temperatures during the course of the experiments were not extremely high or extremely low, varying from 65° to 90° F. These findings, which show to what extent cows became uncomfortable while grazing in the sunshine and how that tended to shorten their grazing period, suggest a need for improvements in summer management of dairy cattle.

Cows observed in this study entered shade on relatively warm days when their body temperatures averaged 102.4° F. This was an increase of 0.7° F. over their near-normal temperature (2) of 101.7° F. when they were turned to pasture at 5:45 A.M. Respirations per minute during this same period had increased from 63 to 71. Pulse-rate observations showed practically no change during this period. It seems obvious that shade tended to make the cows more comfortable even though further increases in body temperature and respiration rates were observed as the day progressed up until 3:00 P.M. During this same period atmospheric temperatures also increased.

Daytime grazing during the two warm days under observation was surprisingly short (1.9 and 1.8 hours). Cows took shelter under trees at around 9:00 A.M. and refused in most cases to venture forth into the sunshine in order to graze, but instead waited until night when they grazed for periods exceeding the daytime periods by a ratio of more than 3 to 1. Two cool days, averaging 72° F., which was 14° and 13° F. lower, respectively, than the two warmer days, caused a significant change in the grazing schedule. Daytime grazing increased around 2.5 times and night grazing decreased some, yet the 24-hour totals showed increases in grazing time due to cool weather of more than 1 hour daily.

The increased activity of cows on nights following warm days indicates the importance of allowing cows access to good night pasture. The plan of leaving cows overnight in a dry lot or on poor pasture so that they will be convenient to the barn in the morning is most certainly a poor management practice. The daytime grazing data for warm days show that cows should be turned into the very best pasture during the forenoon if they are to become filled before the heat of the day forces them to seek shade. In fact, if it is a choice between a fair and an excellent pasture, it would seem best to use the excellent pasture during the day and use the fair pasture at night when cows will spend more time grazing to get their fill. The short daytime grazing period indicates a need for experimental work to test how best to furnish cows supplemental feed during their long period in the shade. Likewise, tests are needed on what practical methods can be used to maintain lower body temperatures and respiration rates during the times cows are in the shade.

SUMMARY

Observations on 3 Jersey and 3 Holstein milking cows during the summer of 1945 at Baton Rouge, Louisiana, gave the following results:

1. Cows showed a progressive rise in body temperature throughout the day. When they left the milking barn at 5:45 A.M. it averaged 101.7° F.; upon entering the shade of trees at 9:20 A.M. it was 102.4° F.; after a period of one hour in the shade, 102.6° F.; at 2:00 P.M., 103.3° F.; and upon entering milking barn at 3:00 P.M. it was highest, 103.5° F. During these same respective periods respiration rates were 63, 64, 71, 78, and 79 per minute. Atmospheric temperatures during these periods increased from 73.0° F. at 5:45 A.M. to a high of 86.7° F. at 2:00 P.M.

2. Observations of 24-hour grazing periods showed that during two relatively warm days cows grazed less than two hours, 1.9 and 1.8 hours during daytime (between A.M. and P.M. milking periods) but grazed three times as much, 5.7 and 5.5 hours, at night (between P.M. and A.M. milking). Data on two cool days showed daytime grazing 2.4 times as great as for warm days, and 24-hour grazing totals more than one hour longer than for warm days.

3. The number of grazing periods averaged 1.4 for daytime and 2.7 for night. Cows seldom had but one important grazing period during the daytime. Three grazing periods were the most common at night and the time spent grazing averaged 5.5 hours, while 3.5 hours were spent lying down and 0.7 hours standing without grazing.

4. Results of the study suggest the need for good pasture at night and, especially on warm days, an excellent daytime pasture. There appears to be a need for experimental trials to test the best method of providing supplemental feed to cows during their long periods in shade during warm summer days, and to determine the best methods for making them more comfortable during this same period.

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THE OXYGEN CONTENT OF THE ATMOSPHERE IN CONTAINERS OF DRIED MILK PACKED IN NITROGEN

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Previously reported experimental data indicate that the rate of autoxidation of milk fat varies directly with the oxygen concentration (4) and that the keeping quality of dried milks is increased greatly by reducing the oxygen concentration of the container atmosphere to 3 per cent or less (2, 4). A concentration of 3 per cent of oxygen in a container of dried milk is equivalent to 0.0324 ml. per gram of powder, or 0.125 ml. per gram of fat, or 11.5 per cent of the volume of the fat.

Lea, Moran, and Smith (3) studied the keeping quality of dried milks packed in atmospheres of 0.01, 0.02, 0.03, and 0.04 ml. of oxygen per gram of product or approximately 1.0, 2.0, 3.0, and 4.0 per cent of oxygen in the atmosphere of the container and concluded that oxygen concentrations below 2 per cent in the containers can be considered good and those below 1 per cent ideal for commercial packing. These concentrations of oxygen in the atmosphere of the container of dried milk are approximately 7.66 and 3.83 per cent, respectively, of the volume of the fat, which is greatly in excess of that necessary to render the fat tallowy (approx. 0.80 per cent by volume) if all of the oxygen reacted with the fat(4). However, as pointed out by Lea, Moran, and Smith (3), and also as we observed in our studies, the skim milk solids absorb oxygen and hence the actual percentage of oxygen in the container which will cause spoilage through autoxidation of the fat will be greater than the value indicated unless the fat is of such inferior quality that absorption of oxygen by it begins immediately or shortly after packing of the dried milk. The actual percentage of oxygen in the container which will cause spoilage through autoxidation should be expected to vary somewhat, therefore, with the quality of the milk and the processing treatment used in the manufacture of the product. In a sample used in our studies on the relationship of percentage of oxygen to keeping quality, the value seemed to be approximately 1.33 per cent (4).

Theoretically, evacuation to approximately 109, 72, and 36 mm. pressure should produce concentrations of oxygen of 3, 2, and 1 per cent respectively in the gases of the container. Evacuation to 10 and 5 mm. pressure should produce oxygen concentrations of approximately 0.28 and 0.14 per cent respectively.

$$\text{Per cent oxygen (volume)} = \frac{\text{Pressure used (mm.)}}{760} \times 20.9$$

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Thus, so far as the oxygen in the atmosphere of the container is concerned, it can be reduced readily to a low value. However, dried milks which have been subjected to evacuation contain sorbed gases which desorb slowly and diffuse into the inert gas and thus increase the oxygen content of the container atmosphere.

The rate of desorption has been studied by Lea, Moran, and Smith (3) and by Coulter and Jenness (1). Results obtained by them indicate that an equilibrium was reached in practically 5 to 7 days, though in some cases the oxygen concentration increased slightly with storage beyond these time periods.

With the use of two cycles of evacuation for 5 min. at 2 mm. pressure and an intervening storage period of at least 5 days, Lea, Moran and Smith (3) found that final oxygen concentrations of less than 2.0 per cent could be obtained. Similar results were obtained by Coulter and Jenness (1) with the use of a pressure of 1 and of 10 mm. and a 7-day intervening period of holding. The latter authors found also that the degree of percentage oxygen reduction varied somewhat with the two commercial samples used.

Experiments of this nature and similar in many respects to those of Lea, Moran, and Smith (3) and of Coulter and Jenness (1) have been carried on in these laboratories for the past two years, the specific aim being to determine the percentage oxygen concentration attainable in the atmosphere of containers of dried milk under varied conditions of pressure, temperature, holding time, and with different periods of storage.

EXPERIMENTAL

Single stage packing. Cans of 160 ml. capacity were packed with 86 grams of dried milk, sealed, tested for leaks, a hole of $\frac{1}{8}$ inch diameter was punched in the cover of each can, and the cans were placed in a large desiccator which served as an evacuation chamber.

The desiccator was then evacuated at different degrees of pressure for various lengths of time and at different temperatures, and subsequently filled with nitrogen. The cans were removed from the desiccator, solder-sealed and stored at room temperatures. At regular intervals the percentage oxygen concentration of the container gases was determined. The results upon a representative sample of commercial dried milk are shown in figure 1.

The results emphasize the importance of evacuation at relatively low pressures and agree with the conclusions from former experiments that increases in the time of evacuation from 3 to 30 minutes and increase in the temperature of evacuation decrease relatively slightly the sorbed gases in dried milk.

This is indicated more specifically by the values in table 1 obtained after 8 days of storage of the packed samples.

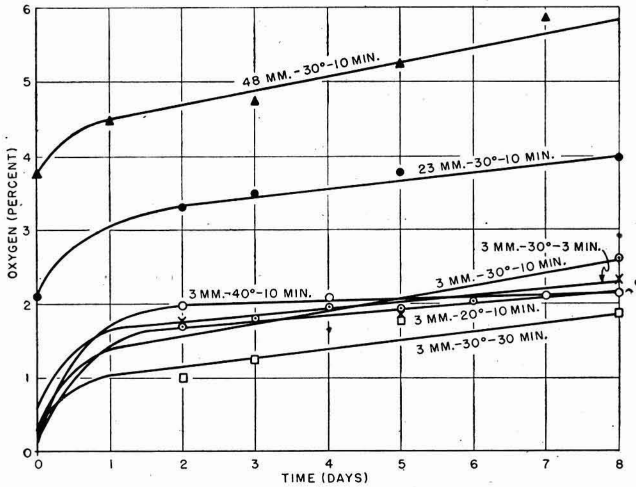

FIG. 1. The per cent oxygen in the atmosphere of containers of whole milk powder which had been evacuated under varied conditions of time, pressure and temperature, and stored for different periods of time.

Multiple-stage packing. The efficiency of oxygen removal by successive evacuations with intervening periods of 3 and 4 days to allow for desorption and diffusion is indicated in figures 2 and 3.

The relative efficiency of successive stages of evacuation and desorption is shown in figure 4, wherein are plotted the percentage oxygen concentration values after 3 and 4 days following each evacuation, as given in figure 3. The relatively high efficiency of a second evacuation over subsequent evacuations in lowering the final oxygen concentration of the containers is clearly indicated.

As indicated in figure 3, after 4 evacuations the final percentage oxygen in the container gas increased but slightly over that attained after the third

TABLE 1

The per cent oxygen in the atmosphere of containers of whole milk powder which had been evacuated under varied conditions of time, pressure and temperature

Pressure	Time	Temperature	Per cent oxygen in the head space	
			Before storage	After 8 days
mm.	*Min.*	*°C.*		
48	10	30	3.8	5.8
23	10	30	2.1	4.0
3	3	30	0.5	2.3
3	10	30	0.3	2.6
3	30	30	0.45	1.8
3	10	20	0.14	2.1
3	10	40	0.08	2.1

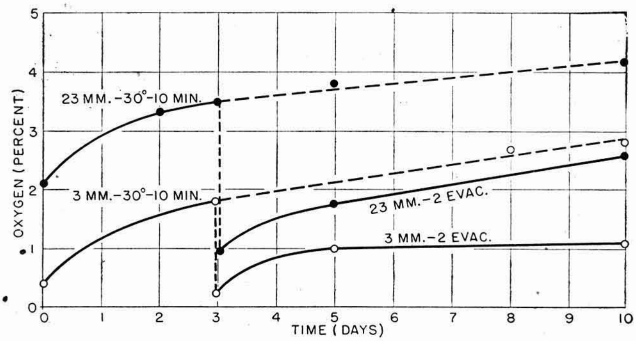

FIG. 2. The per cent oxygen in the atmosphere of containers of whole milk powder in which a second evacuation followed the first after a 3-day storage period.

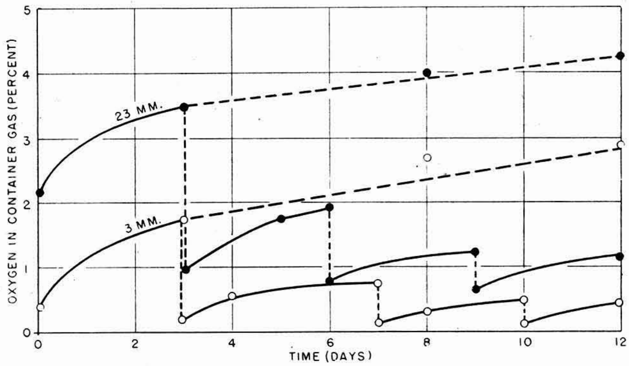

FIG. 3. The per cent oxygen in the atmosphere of containers of whole milk powder after each of 4 evacuations, with intervening storage periods of 3 and 4 days.

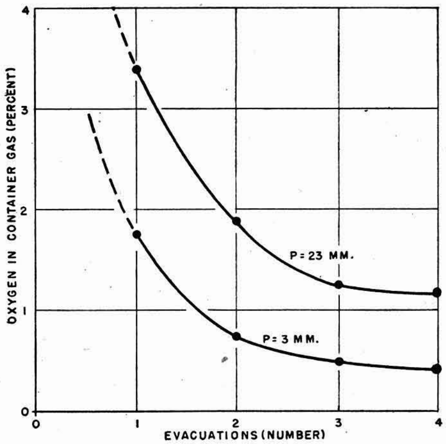

FIG. 4. The per cent oxygen in the atmosphere of dried whole milk containers after 3 or 4 days storage following each successive evacuation.

stage in 3 days of holding. Since, according to the data in figures 1 and 2, equilibrium of the gases is not reached in 3 or 4 days and since some of the sorbed gases are removed during each evacuation, the values given are not absolute but are those which can be attained under the conditions stated. The percentage oxygen in the container would no doubt increase somewhat more if the holding periods were longer, since, as indicated in the results obtained in these laboratories, some oxygen can be removed from dried milk with a Toepler pump at 70° C. after the rate of desorption becomes practically zero. If equilibrium had been attained after each evacuation, the percentage oxygen removed with each evacuation would have been constant and the rate of decrease of the final oxygen content in the containers would have been logarithmic. Under the experimental conditions used, this rate of decrease was not obtained.

SUMMARY

The results confirm those previously obtained by direct measurement of the amounts and composition of the container gases, with respect to the relative importance of time, temperature, and degree of evacuation in reducing the oxygen concentration of the container gases. That the amounts of adsorbed gases do not decrease to a great extent with increases in the value of these factors within practical limits is also indicated by the desorption values obtained. If equilibrium had been attained in each case, the rate of decrease of the final oxygen content in the containers should have been of a logarithmic nature, since the percentage oxygen removed in each evacuation is a constant. However, the rate obtained practically is not of a logarithmic nature, due presumably to the fact that the values for the per cent oxygen in the container atmospheres are not equilibrium values.

The relatively high efficiency of a second evacuation stage in decreasing the per cent oxygen content of the container gases is indicated. However, the rate of desorption seems to vary with different dried milks; hence, the efficiency of gasing procedures should be established for the product concerned in each case.

In our experience the use of two stages of evacuation at 3 mm. pressure with a 3- to 4-day intervening holding period will produce a final oxygen concentration in the container of approximately 1 per cent. Increasing the duration of the holding period will reduce further the final oxygen concentration.

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FACTORS WHICH CONTRIBUTE TO THE PHYSICAL STABILITY OF FROZEN CREAM

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Differences in milk, especially in the size and number of the fat globules, and changes in the temperature of the milk and cream, greatly influence the stability of the cream emulsion after freezing and brief storage as shown in an earlier publication (2).

Nine grams of cream frozen in a Babcock cream test bottle was the experimental unit, the freezing time was 30 to 40 minutes, the temperature of storage was – 15° C. and the duration of storage was less than 48 hours.

In the work which now will be described, about 150 ml. or one-third of a pint of cream in a small can was the experimental unit and the storage period was from less than two days to several months. Data were obtained on the influence of various factors, not only upon the stability of the emulsion, but also upon the body of the cream.

Canned cream was frozen in air at – 17° C., and in ethyl alcohol at – 17° C. and – 29° C. Solid carbon dioxide was used to maintain the alcohol baths at – 17° C. and – 29° C. and to agitate them during freezing of the cream. Under these conditions a sample became solid in 4 hours, 50 minutes, and 25 minutes, respectively. Cans were stored in air at – 9° C. and – 17° C. and in alcohol at – 29° C.

The emulsion stability of each sample was obtained by weighing 9 grams of the frozen cream into a funnel placed in a cream test bottle, washing the cream into the bottle with lukewarm water and proceeding as described by Bell and Sanders (2). Baldwin (1) according to Trelogan and Combs (5) secured results indicating that cream containing more than 30 per cent butterfat tended to freeze homogeneously and such cream could be accurately analyzed for fat by taking a sample from any part of the unfrozen or frozen portion.

Viscosity measurements were made with a MacMichael viscosimeter. Each sample was prepared for this measurement by leaving the opened can at room temperature for 2 hours, stirring the cold cream, placing the can in water at about 32° C., and warming the cream with occasional moderate agitation to 30° C. in the course of 30 to 45 minutes.

Forty per cent cream was used in most of the experiments. All cream was pasteurized by heating to 80° C. and cooling promptly to not lower than 30° C.

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EXPERIMENTAL RESULTS

Quick-freezing versus slow-freezing and variations in storage temperature with cream from cooled herd milk. The milk was a mixture of that obtained from Holstein, Jersey, and a few other cows of the Bureau of Dairy Industry herd at Beltsville, Maryland. It contained 4.2 per cent fat and was considered fairly representative in composition of herd milk that is delivered to factories in this country.

This morning milk was cooled to 10° C. and delivered to the Bureau's research laboratories in Washington, D. C., where it was warmed to 38° C., separated and the cream standardized to 40 per cent fat content with the warm skim milk. The raw cream was pasteurized, cooled to 30° C. and placed in the small cans. The freezing conditions were (1) overnight in air at − 17° C., (2) 2 hours in alcohol at − 17° C. and (3) 1 hour in alcohol at − 29° C. The storage temperatures for the samples frozen under each of these 3 conditions were − 9° C., − 17° C. and − 29° C.

Representative samples were removed from storage and inspected on the second day after the cream was frozen.

Only those samples which had been frozen quickly at − 17° and − 29° C. and stored at the latter temperature were unchanged in appearance after thawing. At this time and at later dates covering a period of over 3 months, samples prepared and stored under these conditions thawed into fluid homogeneous creams. Their initial emulsion stabilities, expressed as the percentage of the total fat which oiled off after centrifuging, were 45 and 20. During the next 3 months these figures increased to 60 and 40 per cent, respectively.

The initial viscosity values at 30° C. of these 2 satisfactory samples were 24 and 20 centipoises.

The other 7 samples thawed into semisolids which, after stirring, were flaky or coarse in texture and oiled off from 70 to 100 per cent. Samples of these creams which were examined during the next 3 months had similar body properties.

Cooled milk of relatively high fat content is not, in our experience, a good source of cream that is to be preserved by freezing and cold storage. Therefore, the milks in the following experiments were obtained from Holstein cows. If the differences for low fat milk which are shown in the figures had been obtained and plotted for creams from high fat milk, they would have been of greater magnitude, not as easy to present and less reliable because of the inferior body of some of the samples.

Cooled versus warmed low-fat milk. This morning milk was obtained from Holstein cows which were known to give milk of low fat content. It contained 3.1 per cent. Half of it was cooled to 10° C. and half was warmed to 43° C. before it was sent to the laboratory. Each half was separated at 38° C. and the cream standardized to 40 per cent with the skim milk. After pasteurization in the usual manner, cans of each warm cream were frozen in alcohol at − 17° C. and at − 29° C. with the aid of solid carbon dioxide and stored at these temperatures.

Figure 1 shows the viscosity and emulsion stability values of these thawed samples over a period of 22 weeks.

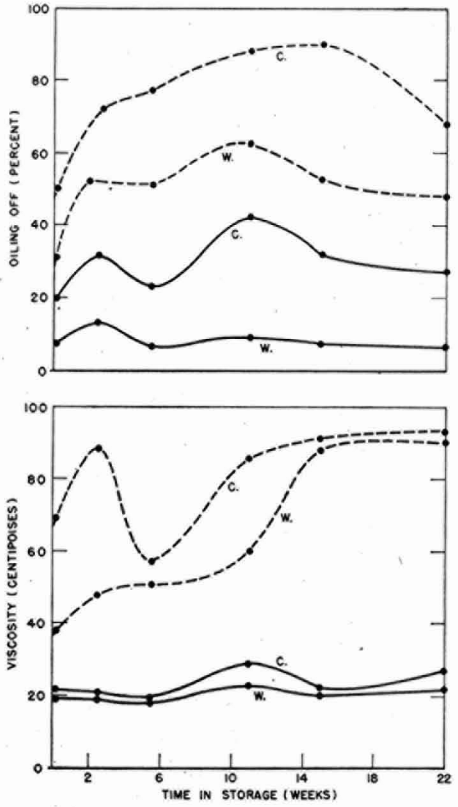

FIG. 1. Viscosity and oiling off values of 40 per cent cream from 3.1 per cent milk, part of which was cooled to 10° C. and part warmed to 43° C.. "C" refers to cooled milk cream and "W" to warmed milk cream. Solid lines represent creams quick-frozen and stored at − 29° C.; broken lines refer to creams quick-frozen and stored at − 17° C.

The samples from cooled milk that were frozen in less than an hour in alcohol at − 17° C. and held at − 17° C. thawed into coarse and milky creams; those from warmed milk were more homogeneous but not of good body. In contrast the samples frozen quickly at − 29° C. and stored at − 29° C. thawed into fluid and homogenous creams. Samples derived from the cooled milk thawed at a slower rate and into slightly more viscous samples than did those from the warmed milk. Oiling off values are more reliable than are those for viscosity, especially in instances in which the cream did not become homogeneous on thawing and stirring.

Uncooled versus cooled cream. This 40 per cent cream was a mixture of that obtained from warmed morning Holstein milk of 3.4 per cent fat content and from Holstein milk separated the day before and cooled to 10° C. for preservation. The latter was warmed to 30° C. before it was mixed with the fresh cream.

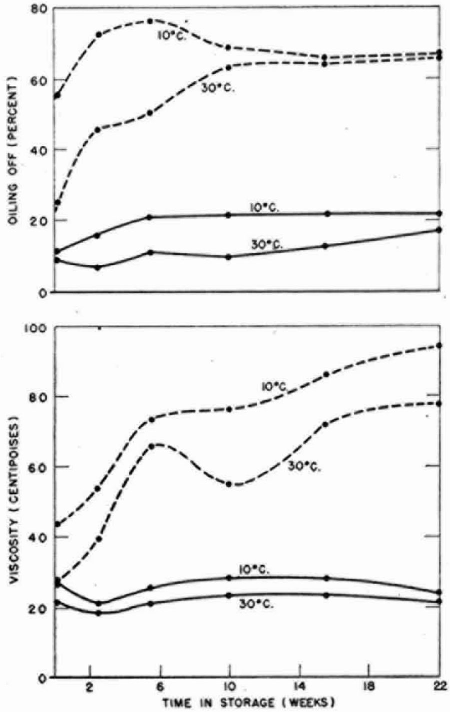

FIG. 2. Viscosity and oiling off values of 40 per cent cream, part of which was canned while still warm (30° C.) and part tempered to 10° C. over a surface cooler prior to canning. Solid lines represent samples quick-frozen and stored at − 29° C., broken lines refer to creams quick-frozen and stored at − 17° C.

Part of the cream was canned while still warm; the remainder was chilled over a tubular surface cooler to 10° C. and then canned. Samples were frozen in alcohol at − 17° and at − 29° C. Those samples which were frozen at − 17° C. were stored at that temperature; those at − 29° C. were stored at − 29° C.

Viscosity and oiling off values are shown in figure 2.

On the initial inspection, the 2 samples that had been stored at − 17° C. were coarser and more viscous than the 2 that had been stored at − 29° C.

They had a body resembling that of cultured butter-milk. The same was true but to a lesser degree of the 2 samples that were chilled over a surface cooler relative to the 2 that were not cooled before they were canned.

The samples frozen and stored at – 29° C. were superior in body and emulsion stability to those frozen at – 17° C. and stored at that temperature. As between the 2 frozen and stored at – 29°, the one which had been tem-

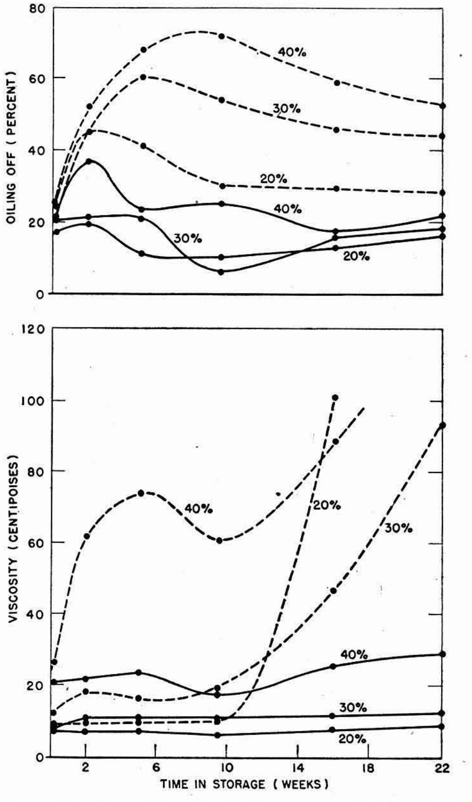

FIG. 3. Viscosity and oiling off values of creams of 40, 30 and 20 per cent fat content prepared from warmed Holstein milk. The cream was not cooled but was packaged while warm. It was quick-frozen and stored at – 17° C. (broken lines) and at – 29° C. (solid lines).

pered to 30° thawed sooner and more completely into a fluid than did the one that was cooled to 10° prior to canning and freezing. However, each was a homogeneous, satisfactory cream.

Viscosity values for the samples frozen at – 17° C. are not as reliable as those for the other samples because of partial separation of a discontinuous phase.

Creams of 40, 30 and 20 per cent fat content. Holstein milk containing 3.7 per cent fat was warmed to 43° C. and delivered to the Research Laboratories within 3 hours of milking. Its 40 per cent raw cream was divided into 3 parts. One was diluted with the fresh skim milk to 30 per cent fat content, another to 20 per cent and the 3 creams pasteurized and cooled to 30° C.

The samples were frozen quickly. Half of them were stored at – 17° C. and half at – 29° C.

Viscosity and oiling off values are presented in figure 3.

Samples stored at – 17° C. thawed at room temperature within 2 to 3 hours into fluid, homogeneous creams. Those stored at – 29° C. thawed into fluids somewhat sooner. The superiority of the latter samples was evident after the various samples had been in a 10° C. room overnight. They remained homogeneous whereas there was an upper layer and a milky lower portion in the others.

Before thawing, the 20 per cent and 30 per cent creams were not as attractive as those which contained 40 per cent fat. They were coarse and more icy and, of course, on thawing they were less viscous or creamy.

The data show that the creams of 20, 30 and 40 per cent fat content were preserved equally well at – 29° C. when advantage was taken of factors which contributed to the preservation of the physical stability of the freshly drawn milk and the cream.

DISCUSSION

Oiling off following freezing of cream is the result of coalescence of fat globules. According to Sommer (4):

> Freezing tends to break the fat emulsion especially in a product rich in fat such as the high fat cream used for frozen storage. The destabilization of the protein adsorption film may be involved, but the main factor appears to be the physical crowding of the fat globules as water is converted into ice. If the ice crystals are large in relation to the size of the fat globules, then there will be a large number of globules crowded together between adjacent ice crystals, the globules are inevitably deformed, fat to fat contact is likely to occur, and on later melting the fat naturally flows together to form a single large oil droplet.

It follows, therefore, that if cream is to be preserved unchanged in a frozen state it should be prepared and stored under conditions which will minimize the tendency of the fat globules to coalesce. Ideal freezing conditions would convert cream into a glass so quickly that all particles would be fixed in position. In thawing, the reverse would be ideal and after thawing orientation of all particles would be the same as it was before the cream was frozen. On the one hand heat would leave the liquid quickly and uniformly and the liquid would change into a homogeneous solid, and on the other, heat would return at a rapid and constant rate throughout the mass and reconvert the mass into a homogeneous liquid.

Thus the importance of the degree of dispersion of fat globules just prior to freezing cream becomes obvious. If the fat is already clumped, advantages of quick freezing will be only partially realized.

It has been shown (2) that 40 per cent cream from Holstein milk oils off after freezing less than does 40 per cent cream from Jersey milk, that the cream should be derived from milk that has not been cooled and the fresh cream should be warm at the start of the freezing operation. Such cream is fluid rather than viscous. Its fat globules have not been permitted to become semisolid and to clump. This is the reverse of the way to make cream appear rich and of heavy body. Viscous, thick cream is made by starting with milk in which the fat globules are large, and by causing the globules to form aggregates through cooling and holding of the milk and of the cream (3). This is not to say that high viscosity in cream is due to fat clumping only. Other concurrent changes contribute to the increased internal friction.

Whenever a sample thawed into a semisolid or viscous cream which did not have a good body, a large proportion of its fat oiled off. Whenever a sample thawed into a fluid, it had a low viscosity and oiled off only a little.

The data indicate that quickly frozen cream which does not oil off, is homogeneous, and has a low viscosity after brief storage, will retain its physical properties throughout a long storage period if a sufficiently low temperature is maintained.

Neither this paper nor the preceding one describes how to increase the resistance of a freshly separated cream to the disruptive forces of freezing and thawing. They do indicate, however, the importance of certain properties of the fresh milk and how to preserve them for the purpose of making a stable frozen cream.

CONCLUSIONS

Factors which contribute to the physical stability of frozen cream are:

(1) The use of freshly drawn milk which contains small, unclumped fat golbules.

(2) Maintenance of these globules in a fluid, completely dispersed state until freezing time.

(3) Quick freezing to retain this degree of dispersion.

(4) A storage temperature sufficiently low to prevent the physical changes which cause localized crowding, distortion and disruption of the fat globules and consequent oiling off on thawing.

Frozen cream which is prepared and maintained under these conditions will have a stable emulsion and a good body when thawed after several months storage.

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THE EFFECT OF MILK PRODUCTS ON THE HEAT-STABILITY AND VISCOSITY OF CREAM-STYLE FOODS

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Milk and cream are sometimes used in canned foods to improve flavor, body and nutritive value. Typical of these heat-processed foods are the cream soups. Other products such as canned white sauce and creamed vegetables have not been produced commercially on a large scale.

This investigation is concerned with the effect of variations in the composition and processing of simple cream-style mixtures upon their heat stabilities and viscosities. A better understanding of the behavior of milk constituents in the cream-style foods may assist in improving them and in extending the use of milk products to new canned foods. The ingredients of the sterilized milk foods which affect their heat stability and viscosity are the fat and protein of the milk, the starch of flour added as a thickener and binder, the salt and the type of vegetable or flavoring material which is used.

EXPERIMENTAL

Milk solids were largely derived from pure butter oil and specially dried samples of skim milk. These products provided a source of supply of milk constituents which did not change during the work. The conditions of manufacture and the heat stability of the dried skim milks are given in table 1.

Each starch-milk-salt mixture was heated with stirring to 176° F. (80° C.), canned and sterilized at 239° F. (115° C.) for the time specified, unless otherwise indicated. The canned samples were cooled, held overnight at 86° F. (30° C.), and observations on body and viscosity made the next morning.

Heat-stability data were obtained by heating the fluid products in small tins (208 × 208) in a pilot evaporated-milk sterilizer with the reel revolving at 4 r.p.m. The temperature of heating was 239° F. (115° C.) and the results were expressed as the time in minutes to develop a visible coagulation. The experimental error for this determination was ± 3 per cent of the values reported. Samples for viscosity determinations were sterilized in the same way. The sterilizer reel was kept in motion during processing unless otherwise indicated.

Viscosity was measured at 86° F. (30° C.) by means of a McMichael viscosimeter with standardized wires. Measurements were made in a uniform manner and without excessive agitation. The results were expressed

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TABLE 1

The effect of the pre-drying heat-treatment of skim milk on the heat-stability of its dried and reconstituted product

Sample No.	Pre-drying treatment					Heat-stability at 239° F. (115° C.) of powder reconstituted to 9% solids
	Forewarming before condensing		Condensed to T.S.	Forewarming concentrate before drying		
	Temp.	Time		Temp.	Time	
	°*F.*	*min.*		°*F.*	*min.*	*min.*
Spray 1	149	20	36	122	0	134
Spray 2	203	10	36	122	0	89
Spray 3	182	30	36	182	10	127
Spray 4	149	20	27	122	0	387
Spray 5	149	20	27	203	10	30
Roller 6	149	20	27	122	0	0
Roller 7	150	30	27	122	0	0

Samples 1, 2, 3, and 6 were from one batch of skim milk, samples 4 and 5 were from a second and sample 7 from a third lot of milk. Powders 1 to 5 were spray dried under normal operating conditions on a 9-foot Gray-Jensen unit. Samples 6 and 7 were drum dried on a laboratory size atmospheric double roll drier.

in centipoises but the values were not absolute. Plastic effects which were not measured were observed in most of the samples. The viscosity figures were a good indication of the "body" or "apparent" viscosity of the mixtures.

The quinhydrone electrode was used in the measurement of hydrogen-ion concentration.

RESULTS

The effect of starch and salt upon the heat-stability of the milk in a simple fat-free mix is shown in table 2.

Short patent and standard patent flours obtained from the states of Minnesota, Kansas, Texas and Washington, were tested in mixtures of 2 per cent flour and 8 per cent skim milk solids. The heat stability of the 8 per cent solids control milk at 239° F. (115° C.) was 235 minutes, whereas the samples containing flour coagulated in 54 to 77 minutes. Differences in the lowering of heat stability by the eight samples of flour thus tested were not very important.

TABLE 2

Effect of corn starch (#1) and salt upon the heat-stability of a reconstituted dried skim milk (milk #1)

Sample No.	Composition of mixture	Heat-stability at 239° F. (115° C.)
1	Milk solids concentration—9%	134
2	" " " —4%	285
3	4% M.S.N.F. + 2% corn starch	241
4	" " + ½% NaCl	129
5	" " + { 2% corn starch, ½% NaCl }	24

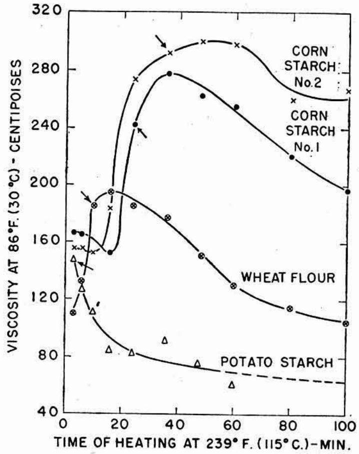

FIG. 1. The effect of different thickening agents upon the viscosity and heat-stability of some fat-free mixtures. Arrows indicate first visible casein coagulation. Each mixture contains 2% starch or 2½% flour, ½% salt and 4% solids derived from dry skim milk #1 (table 1).

A comparison of the effect of different starches and a sample of hard wheat, short patent flour upon the heat-stability and viscosity of some simple skim milk mixtures is presented in fig. 1.

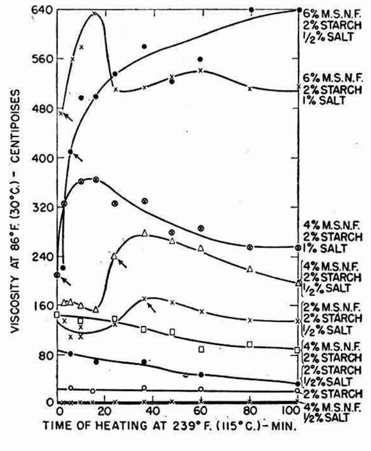

FIG. 2. The effect of increasing quantities of milk-solids-not-fat (M.S.N.F.) upon the body-forming properties of creamed bases. Arrows indicate first visible casein coagulation. No arrow indicates absence of coagulation. Skim milk #1 (table 1) and starch #1 (fig. 1) were used.

Figures 2 to 6 show the differences in kind and in quantity of the various components upon the heat-stability and viscosity of some basic mixtures. The data of figures 4, 5, and 6 were from mixes which contained fat and these were homogenized. The effect of different homogenization and sterilization procedures is shown in figures 5 and 6.

Data on the effect of different vegetable extracts upon the heat-stability of skim milk are given in table 3. Clear extracts were prepared by cooking the vegetable with an equal weight of water and filtering the mixture.

TABLE 3

The effect of the addition of different vegetable extracts upon the heat-stability of skim milk

Vegetable extract*	Reaction		Heat-stability at 239° F. (115° C.)†
	Aqueous extract	Milk-juice mixture†	
	pH	*pH*	*minutes*
No extract (equal parts of milk and water)	....	6.63	269
Stabilizing extracts:			
Cauliflower	6.04	6.59	448
Corn	7.38	6.73	518
Mushroom	6.20	6.49	> 550
Potato	6.08	6.62	435
Spinach	6.21	6.90	> 550
Destabilizing extracts:			
Cabbage	5.55	6.48	193
Celery	5.50	6.48	131
Onion	5.08	6.40	25
Pea	6.25	6.48	189
Tomato	4.48	6.18	0
Extracts with little effect:			
Asparagus	6.00	6.60	290
Beet	5.43	6.52	317
Carrot	5.18	6.49	279
Turnip	5.37	6.40	276

* The extract was obtained by cooking together equal weights of vegetable and water and filtering the mixture.

† This was a milk-juice mixture which contained equal weights of fresh skim milk and vegetable extract.

Tomato was found to destabilize the milk more than any other vegetable, because of its high acid content. Filtered tomato serum at pH 4.25 lowered the heat-stability of dilute skim milk with which it was mixed unless the serum was neutralized to a reaction above pH 5.7 to 5.9. The extent of neutralization of the tomato serum which was necessary to prevent it from affecting heat stability was dependent upon the concentrations of serum and skim milk and of the natural characteristics of the milk.

The presence of an inert phase produced a slight lowering in heat-stability as indicated by the data of table 4. Inert material such as tomato pulp or ground filter paper caused a fractional coagulation of the milk casein during sterilization of the mixtures. The progressive increase in the coagulum with increases in heating time made difficult any precise determination of heat stability.

The manufacture of cream-style soups was studied. Satisfactory formulas included 3 per cent to 4 per cent milk-solids-not-fat, 2 per cent to 4 per cent milk fat, 2 per cent to 3 per cent corn starch or flour, about 1 per cent salt and the remainder vegetable extract, vegetable pulp and soup stock. Homogenization of the basic mix, previously freed of large pieces of pulp

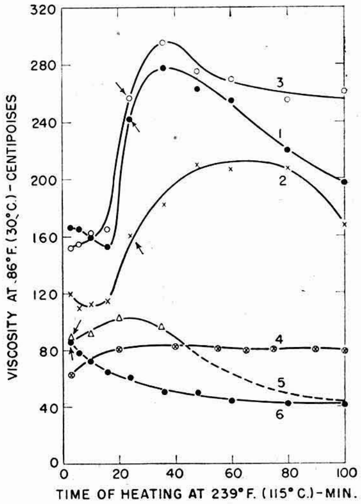

FIG. 3. The effect of the heat-treatment of skim milk before concentrating and before drying upon its heat-stability and viscosity-forming properties in creamed bases. Arrows indicate first visible casein coagulation. Milk #4 did not coagulate during the sterilization treatment. Each base contains 2% corn starch, ½% salt and 4% non-fat milk solids. The numbers on each curve refer to the manufacturing data for that milk given in table 1.

or other material which could not be homogenized, was conducive to the production of a smooth body. The mix containing the starch was heated to a temperature not above 113° F. (45° C.) before homogenization. The canned soup was heated to at least 240° F. for 60 minutes, the exact conditions depending upon the material in the can.

Whey protein was substituted for casein containing milk products in those instances in which coagulation was a problem. The whey protein, after coagulation, remained softer and more finely dispersed than did casein. Whey protein was generally added to the mix as whey cream containing about 12 per cent fat. This cream was separated from fresh sweet cheese whey. Cream sauce suitable for the preparation of creamed peas, mush-

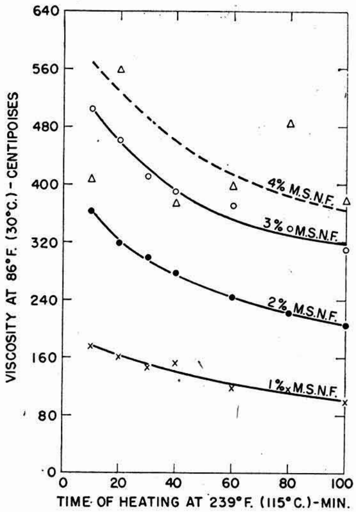

FIG. 4. The effect of increasing quantities of milk-solids-not-fat (M.S.N.F.) upon the viscosity of creamed bases sterilized for different periods of time. The complete mixes were heated to 149° F. and homogenized at 2500 pounds pressure before the usual heating to 176° F. and canning. All mixes coagulated during the first few minutes of sterilization. Mixes containing 4% M.S.N.F. were very badly coagulated, hence the broken line indicating the approximate location of this curve. Skim milk #1 (table 1) and corn starch #1 (fig. 1) were used. Each mix contained 4% butteroil, 2% starch and 1% salt in addition to the skim milk.

rooms or similar products contained 8 per cent to 12 per cent fat derived from whey cream, 3 per cent to 5 per cent starch or flour and 1 per cent salt. The sauce with the whole or chopped vegetables could be sterilized at 240° F. for as long as 90 minutes without serious damage to the body of the product. This sauce was homogeneous and in good condition after one year storage at room temperature. Plain, condensed, or dried sweet cheese

TABLE 4

The effect of the addition of an inert phase upon the heat-stability of skim milk. Fresh skim milk was diluted with an aqueous suspension of the inert phase. The final concentrations were milk solids not fat, 6%, and inert phase 1%

Inert phase added to milk	Heat-stability of milk at 239° F.
None—control	193
Tomato pulp, centrifugally separated, washed and adjusted to same reaction as milk	160
Filter paper, ground in 95% alcohol for 35 hours in a ball mill, filtered, washed, boiled in water, added to milk	152

whey was found to be an excellent source of non-fat whey solids for canned food products.

A plain but heavy-bodied white sauce was made which withstood storage at room temperature for several years with little change. This preparation contained 94 per cent whole milk by weight, 5 per cent flour, and 1 per cent salt. The mix was heated to 185° F. (85° C.) with constant stirring, canned and sterilized at 239° F. for 25 minutes. A gel structure was built up by

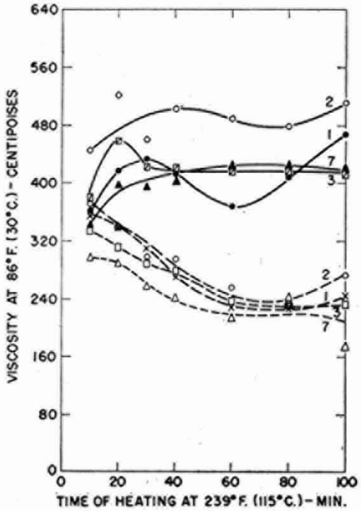

FIG. 5. The effect of agitation during sterilization upon the viscosity of creamed mixes made from different samples of dried skim milk. The complete mixes were heated to 149° F. and homogenized at 2500 pounds pressure before the usual heating to 176° F. and canning. The solid lines indicate samples sterilized without agitation, while the samples represented by the broken lines were sterilized with the real running at 4 r.p.m. The number on each curve refers to the milk of table 1 which was used in the mix. The casein of all mixes was coagulated before the 10-minute sterilization period was reached. Each mix contained: dry skim milk—3%, butteroil—3%, corn starch #1—2%, salt—1%.

the casein and the flour. The sterilization period was not long enough to allow the casein to gather into aggregates and expel whey.

DISCUSSION

Dried milk and dried whey of various types were used in the manufacture of cream soups and similar foods. Preliminary experiments showed that the heat stability of spray-dried milk was not significantly changed by the drying process. But the heat-treatment previous to spraying largely determined the heat-stability of the powder. High-temperature forewarming was found by Webb and Holm (3) to increase the heat-stability of milk only when it was concentrated after forewarming to a solids-not-fat content greater than 12 per cent. The skim milks of table 1 which received the most drastic heating were the least stable when reconstituted to 9 per cent solids. Fresh milk, cream and whey or the concentrated forms of these products were well adapted to use in cream-style foods. Their heat-stabilities were governed by processing steps commonly employed in the concentrated milk industry. However, the heat-stability characteristics of a milk product were important only in the simpler mixtures. Coagulation was unavoidable in cream soups and other products which contained destabilizing ingredients.

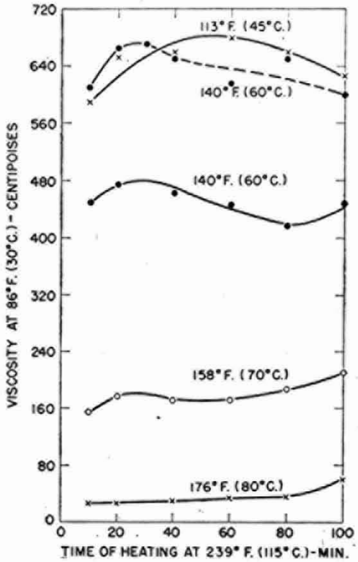

FIG. 6. The effect of homogenization at different temperatures upon the viscosity of creamed mixtures. Each mix except the one represented by the broken line was heated to the temperature designated on the curve and homogenized at 2500 pounds pressure. The starch and salt of the mix indicated by the broken line were added after homogenization. Before canning, all mixes were heated to 176° F. The sterilizer reel was held still during sterilization. Visible curd formed in all samples during the first 10 minutes of sterilization. The composition of the mixes was: dried skim milk (#1, table 1)—3%, butteroil—3%, corn starch (#1, fig. 1)—2%, salt—1%.

The problem was generally one of controlling the kind of curd which formed rather than in preventing its formation.

A processing temperature of 239° F. (115° C.) was used. Substantially the same results in terms of heat-stability and body development were obtained at 239° F. as were found in half the holding time at 250° F. (121.1° C). Temperatures higher than 239° F. were sometimes used for bacteriological reasons. For information on processing requirements for non-acid foods, reference may be made to the work of the National Canners Association (2).

In the preparation of the mixes it was found necessary to heat them to at least 176° F. (80° C.) with stirring before putting them into cans. This allowed the starch to swell and become evenly distributed in the mix and made a more homogeneous product. However, homogenization of the swollen starch granules caused severe destabilization of the casein during sterilization. For this reason the mixture containing starch was best homogenized at about 113° F. (45° C.). When a higher pre-homogenization temperature was used, the starch was added after homogenization.

Homogenization was useful in reducing the size of the fat globules and of the particles of fiber and pulp in the mix. The resulting improvement in the dispersion of the inert components of the product assisted in the development of a smooth body. The casein, when provided with innumerable nuclei, including those furnished by the starch binder, coagulated in a finely divided condition. The presence of a well-dispersed, inert material lowered heat-stability, but the formation of a uniformly smooth coagulum was ample compensation for this added instability.

Viscosity development in milk-starch-salt mixtures followed a pattern similar to that shown by evaporated milk during sterilization (1). Maximum thickening occurred at the coagulation point or shortly thereafter. Ideal conditions were reached when the heat stability of the product was equal to the heating time required to sterilize it. But the destabilizing nature of the ingredients of cream-style foods caused coagulation early in the sterilization period. When the sterilization process was continued beyond the thickening phase, moisture was expressed by the casein. A watery and lumpy body was produced by this moisture, and by the tendency of the casein to gather into firm aggregates. This condition was avoided by the use of a starch or flour binder, which was responsible, with the casein, for building body. The binder took up the moisture expressed by the casein as coagulation proceeded. The quantity of binder needed was dependent upon the percentage of casein present, the extent of its coagulation, and the amount of other water-holding constituents in the mix. Approximately 1 part by weight, of starch or flour binder was used for 2 parts of milk-solids-not-fat, but this ratio varied between 1:1.3 and 1:3.0.

SUMMARY

1. The use of milk products and their relation to the problems of coagulation and viscosity development in canned, sterilized cream-style foods including cream soups and sauces were studied. Milk constituents contributed to the flavor and nutritive value of the products and increased their viscosity.

2. The ingredients used in sterilized milk foods caused rapid coagulation of the milk protein in these mixtures. Factors which contributed to the production of a smooth, heavy-bodied product were: use of optimum quanti-

ties of starch and flour binders to take up moisture expressed by the casein, comminution of inert pulp and fibrous material by homogenization, sterilization with a minimum of agitation during the period when a coagulum was forming, maintaining maximum heat stability characteristics in the milk ingredients and substitution of whey protein for milk protein when coagulation of the casein in a product was excessive.

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CONTROLLED EXPERIMENTS ON THE VALUE OF SUPPLEMENTARY VITAMINS FOR YOUNG DAIRY CALVES

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Feeding of supplementary vitamins to young calves has recently attracted considerable attention. Since the publications on this subject by the Wisconsin workers (1, 2), some commercial concerns have sold vitamin preparations as a panacea for many types of calf losses. The true value, however, of extra vitamins to the young calf when added to a normal diet needed further study. Therefore, a series of experiments was begun early in 1942 to test the possible value of supplementary vitamins for very young calves under conditions in New York State.

EXPERIMENTAL

All calves in these experiments were allowed to remain with their dams for at least 24 hours and were fed their dams' milk for approximately 5 days after birth. This procedure insured an initial fill of colostrum, which has been shown by many workers to be beneficial in the early nutrition of the calf (4). Each calf was kept in a separate pen and was fed individually. Each calf was fed a limited amount of whole milk, according to the Cornell dry calf-starter system (5), and was weaned after receiving 350 pounds of milk over a period of 7 or 10 weeks depending upon the breed. Ayrshires and Holsteins were weaned at 7 weeks of age; Guernseys and Jerseys, at 10 weeks of age. Dry calf-starter and hay were supplied the calves at approximately 2 weeks of age. No skim milk whatever was fed.

Experiment I

In March, 1942, a preliminary trial was conducted with 5 Holstein heifer calves. Calves exhibiting varying degrees of scours were fed a gelatin capsule 3 times weekly. Each capsule contained the following vitamins: 48,000 U.S.P. units of vitamin A in oil, 1,000 units of vitamin D (irradiated yeast), 2.33 mg. of thiamin chloride, 2.33 mg. of riboflavin, 11.66 mg. of calcium pantothenate, 11.66 mg. of choline chloride, and 23.33 mg. of niacin.

Feeding the capsules produced no noticeable curative effect. The loose condition seemed to run a normal course before improvement occurred. There were no control calves in this preliminary study.

A more extensive controlled experiment with 18 purebred heifer calves was started in April, 1942. In one group of 9 calves, each calf received a gelatin capsule containing the above-listed vitamins at birth and three times

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TABLE 1

The effect of supplementary vitamins on the rate of growth and on the occurrence and severity of scours

Number	Breed	Date of birth	Body weight		Relation of age (weeks) to occurrence and severity of scours*							
			Birth	16 weeks	1	2	3	4	5	6	7	8
			lbs.	*lbs.*								
			Supplementary vitamins									
1484	Ayrshire	5/10/42	68	182	+	++	+++	–	–	–	–	–
1489	Ayrshire	5/30/42	84	215	–	++	++	–	–	–	–	+++
1502	Ayrshire	7/14/42	80	194	–	++	+	–	–	–	–	–
1478	Guernsey	4/20/42	......	......			No scours (died at 5 days of age).					
1486	Guernsey	5/14/42	70	168	–	++	+	–	–	–	–	–
1500	Guernsey	7/12/42	55	148	–	+	–	–	–	–	–	–
1480	Holstein	4/21/42	88	210	–	–	++	–	–	–	–	–
1491	Holstein	6/26/42	92	255	–	–	–	–	–	–	–	–
1504	Jersey	7/15/42	45	146	–	–	+	–	–	–	–	–
Average (% of normal)			99.9	102.7								
Gain as % of normal				104.4								
			No vitamin supplement									
1479	Ayrshire	4/20/42	68	175	–	+	++	–	–	–	–	–
1506	Ayrshire	7/20/42	90	192	–	–	–	–	–	–	–	–
1501	Guernsey	7/12/42	61	143	–	+	++	–	–	–	–	–
....	Holstein	5/17/42	......	......			No scours (died at 5 days of age).					
1493	Holstein	7/1/42	93	249	–	–	–	–	–	–	–	–
1507	Holstein	8/1/42	92	264	–	+	–	–	–	–	–	–
1477	Jersey	4/5/42	45	126	+	–	++	–	–	–	–	–
1481	Jersey	4/21/42	55	141	–	–	+	+	–	–	–	–
1485	Jersey	5/10/42	44	155	–	+	+	–	–	–	–	–
Average (% of normal)			98.8	100.3								
Gain as % of normal				101.4								

* – = No scours, + = Mild, ++ = Moderate, +++ = Severe.

a week thereafter until one month of age. A second group, serving as controls, was given the same care and management, but received no supplementary vitamins. Careful daily observations were made of the incidence and severity of scours and of the rate of recovery. Most of the calves received a dry calf-starter containing no animal protein, and were fed a second cutting Ladino clover hay of excellent quality. These results are shown in table 1.

One calf in each group died from unknown causes. Neither of these calves showed any indication of having scours. There was no evidence (table 1) that feeding supplementary vitamins at this level had any beneficial effect on the health of the experimental calves. The frequency of occurrence, severity, or duration of a scouring condition appeared to be unaffected by the addition of extra vitamins to the normal diet. Most of the cases of scours were treated by the administration of either sulfathiazole, sulfanilamide, or sulfapyridine. No severe cases of scours were encountered.

Up to 16 weeks of age, there was little difference in the rate of growth between the two groups of calves (table 1). The calves receiving supplementary vitamins had an average birth weight of 99.9 per cent of Ragsdale's normal (3) and showed an average gain from birth to 16 weeks of age of 104.4 per cent of normal. The control calves at birth averaged 98.8 per cent of normal weight and had an average gain up to 16 weeks of age that was 101.4 per cent of normal. This difference in gain was considered to be of little or no practical importance. It might easily be attributed to the number of Jerseys in the group since the Jerseys in the college herd as a rule are of a smaller type than those used in establishing Ragsdale's normal. At 16 weeks of age, there were no apparent differences in the physical condition or appearance of the two groups of calves. The Holstein calves appeared to experience somewhat less scouring than the other breeds although the numbers studied were too small to warrant a conclusion.

Experiment II

A second experiment was initiated in October, 1944, involving the use of 24 purebred Holstein heifers from the college herd. The calves were selected at random to serve as controls or to receive supplementary vitamins from birth to one month of age. One capsule was given daily during this period. Each capsule contained the following vitamins: 6,000 U.S.P. units of vitamin A, 1,000 U.S.P. units of vitamin D, 250 mg. of vitamin C, 100 mg. of niacin, 50 mg. of vitamin E, 10 mg. of riboflavin, 10 mg. of pyridoxine, 10 mg. of thiamin, 50 mg. of calcium pantothenate, and 1,000 mg. of choline. This combination of vitamins was fed to insure that most of the possible vitamin deficiencies would be met. It was felt that if beneficial results were obtained from this mixture, later work could be undertaken to determine the most effective vitamin combination.

The control group of calves received the same feed and management, but did not receive the supplement of vitamins. The results of this experiment are shown in table 2.

TABLE 2

The effect of vitamins on the incidence, severity, and duration of scours and the rate of growth in Holstein calves

Number	Date of birth	Body weight		Relation of age (weeks) and scours*							
		Birth	20 wks.	1	2	3	4	5	6	7	8
				Supplementary vitamins†							
		lbs.	*lbs.*								
1720	11/ 8/44	98	248	–	–	–	–	++	+	–	–
1721	10/20/44	105	302	–	+	+	+++	+++	++	+	–
1729	12/25/44	75	277	–	+	–	–	–	–	–	–
1732	12/29/44	78	249	+	++	–	+++	+++	++	++	–
1734	1/ 3/45	81	244	+	+	–	–	–	–	–	–
1745	2/11/45	84	305	–	–	–	–	–	–	–	–
1747	3/ 1/45	107	295	–	–	–	++	+	+	+	+
A1	3/17/45	70	248	++	+++	+	–	–	–	–	–
1749	3/18/45	82	264	++	+++	++	–	–	–	–	–
1756	4/ 1/45	96	290	–	++	+	–	–	–	–	–
1763	5/ 3/45	104	301	–	–	–	–	–	–	–	–
1769	5/18/45	102	311	–	–	++	–	–	–	–	–
Average		90.2	277.8								
Average (% of normal)		100.2	100.9								
Total gain (% of normal)		....	101.2								
				No vitamin supplement							
1718	10/20/44	92	228	–	–	–	+	–	+	–	–
1723	11/25/44	106	293	+	+	+	+	+	–	–	–
1724	12/12/44	90	286	–	–	–	–	–	–	–	–
1730	12/28/44	90	328	–	–	–	–	–	–	–	–
1731	12/29/44	95	293	–	–	–	–	–	–	–	–
1736	1/19/45	98	265	–	–	+	–	+	–	–	–
1742	2/ 1/45	93	314	+	–	–	–	–	–	–	–
1751	3/25/45	88	290	–	–	–	–	–	–	–	–
1752	3/20/45	98	269	–	–	+	+++	+	+	+	+
1758	4/ 4/45	87	290	–	–	–	–	–	–	–	–
1760	4/12/45	91	241	+++	+++	+	–	–	–	++	++
1765	5/10/45	85	304	–	–	–	–	–	–	–	–
Average		92.8	283.4								
Average (% of normal)		103.1	102.9								
Total gain (% of normal)		....	102.8								

* – = No scours, + = Mild, ++ = Moderate, +++ = Severe.
† These vitamins were supplied by Hoffmann-La Roche, Inc., Nutley 10, N. J.

From these data it is evident that under the conditions of the experiment, supplementary vitamins were of no value in preventing scours. In the group that received supplementary vitamins, only 2 calves failed to show some looseness during the first 8 weeks. Six of the 12 calves in the control group receiving no added vitamins showed no evidence of scours during the same period. The duration of scours or the severity of the condition seemed to be unaffected by the supplemental vitamin feeding. In fact, in this experiment there were more frequent cases and more severe scours in the group that received supplementary vitamin capsules than in the control group.

Figure 1 shows the growth of the two groups of calves from birth to 20 weeks of age. It is apparent that supplementary vitamin feeding in the amounts used in this experiment had no effect on gain in weight. At birth, the control group and the group receiving supplementary vitamins weighed 103.1 per cent and 100.2 per cent of Ragsdale's normal, respectively. At 20 weeks of age, the body-weight relationship was nearly the same; the control group, 102.9 per cent, and the group receiving added vitamins, 100.9 per cent of normal for Holstein calves at that age. Over the 20 weeks, the control group and the vitamin supplemented group gained at approximately the

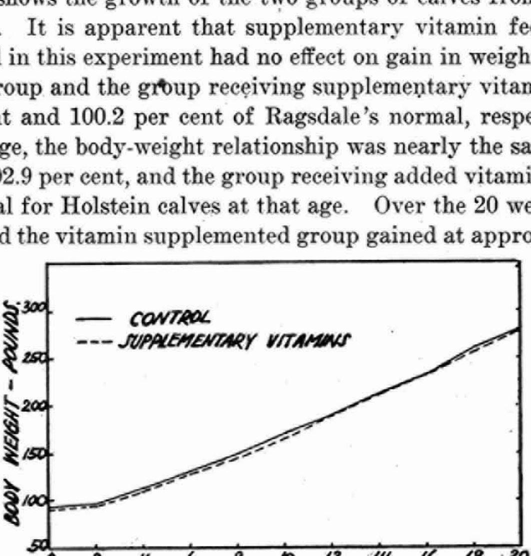

FIG. 1. The average birth weights and average weekly body weights of 12 Holstein heifer calves receiving supplementary vitamins and 12 Holsteins receiving no added vitamins.

same rate, 102.8 per cent and 101.2 per cent of Ragsdale's normal, respectively.

From the amount of fleshing, the condition of the hair coat, and the general appearance of the calves, it was impossible to distinguish the calves that had received supplementary vitamins from those that had received none.

Experiment III

A third experiment was set up in a Holstein herd maintained under somewhat less favorable feeding conditions. The calves were divided at random into three groups and were fed one tablet daily from birth to 30 days of age containing either the complete vitamin mixture used in the second experiment, no vitamins, or a tablet containing vitamin A, 5,000 U.S.P. units; vitamin D, 1,000 U.S.P. units; ascorbic acid, 250 mg.; and niacin, 100 mg. In general, the feeding practice and management were similar to that described above.

The results of this test, summarized in table 3, again show the ineffectiveness of vitamin supplements in preventing scours in calves. As an average, the calves fed the vitamins gained somewhat more in weight during the first 8 weeks, but the difference is not significant, statistically.

TABLE 3

The effect of supplementary vitamins upon the growth rate and the health of Holstein heifer calves

Number	Date of birth	Body weight		Relation of age to occurrence and severity of scours							
		Birth	8 wks.	1	2	3	4	5	6	7	8
				No vitamin supplement							
		lbs.	*lbs.*								
103	11/ 6/44	116	158	–	–	–	–	–	–	–	–
106	12/ 6/44	81	140	–	–	–	++	++	++	–	–
110	3/18/45	99	140	–	–	–	–	–	–	–	–
112	4/ 8/45	76	104	–	++	–	–	–	–	–	–
115	4/28/45	88	120	–	++	–	–	–	–	–	–
Average		92.0	132.4								
Average (% of normal)		102.2	93.1								
Total gain (% of normal)		....	77.4								
				Complete vitamin capsules*							
104	11/15/44	92	170	–	–	–	–	–	–	–	–
105	11/15/44	74	130	–	–	–	–	–	–	–	–
111	3/27/45	75	118	–	–	–	–	–	–	–	–
113	4/16/45	86	118	++	+++	+++	+	–	–	–	–
114	4/19/45	80	116	–	–	++	–	–	–	–	–
Average		81.4	130.4								
Average (% of normal)		90.4	91.7								
Total gain (% of normal)		....	93.9								
				Vitamins A, D, C, and niacin*							
107	12/ 6/44	90	130	–	–	–	–	–	–	–	–
108	12/ 7/44	84	135	–	–	–	–	–	–	–	–
109	12/23/44	99	144	–	–	+++	–	–	–	–	–
116	6/ 5/45	68	112	–	–	–	–	–	–	–	–
117	7/30/45	93	150	–	–	–	–	–	–	–	–
Average		86.8	134.2								
Average (% of normal)		96.4	94.4								
Total gain (% of normal)		....	90.8								

* These vitamins were supplied by Hoffmann-La Roche, Inc., Nutley 10, N. J.

DISCUSSION

The results of the tests reported show that over a three-year period, feeding extra vitamins to new-born calves did not prevent scours nor reduce the incidence, duration, or severity of scours. The vitamin supplements had no certain effect upon the growth rate or general appearance of the calves up to 16 or 20 weeks of age. Thus no justification was found for feeding extra vitamins in these tests. The writers are inclined to the view that the natural feeds furnished an adequate supply of the necessary vitamins for the growth and well-being of the experimental calves. Further investigations are needed to determine whether the same is generally true under average farm conditions in this area. This question is now being studied.

These results were based on close daily observations of the condition of the experimental calves. In some of the trials, choice second-cutting alfalfa hay was fed that should have insured a generous carotene intake in these cases. Acknowledging the possible laxative effect of alfalfa hay, it was observed that the calves showed no less tendency to scour than calves that received hay of a lower carotene potency.

It should be recognized that the calves received a limited amount of whole milk during 7 or 10 weeks following an initial feeding of colostrum. All calves received their dams' milk for 5 days after birth. Under conditions that exist on some farms, where whole milk is fed in greater amounts over a longer period and is finally replaced with skim milk, one might logically expect less benefit from adding extra vitamins to the diet than with less favorable feeding and management.

While it is known that a severe deficiency of vitamin A and possibly other vitamins will cause diarrhea, care must be exercised in assuming that scours in young calves is a definite indication of vitamin deficiency. It is difficult, if not impossible, to determine whether a particular case of scours is due to nutritional deficiency, specific bacterial infection, or faulty feeding and management practices of which there may be many.

SUMMARY

Studies are reported involving approximately sixty heifer calves of various dairy breeds, largely Holsteins, which show that supplementing a normal diet with capsules or tablets containing vitamins A, D, and E, ascorbic acid, and several of the B-vitamins did not reduce the incidence or severity of scours. Extra vitamins in the amounts fed had no certain effect on the rate of growth or the general appearance of the calves during the early months of life. Under the feeding and management conditions involved, there was no advantage to calves from adding extra vitamins to the normal ration.

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THE LOSS OF NUTRIENTS IN HAY AND MEADOW CROP SILAGE DURING STORAGE*

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Livestock men appreciate the value of having adequate amounts of good quality roughage for feeding between pasture seasons. All too often the quality of the material coming out of storage, either from the mow or silo, fails to come up to expectation. The losses in quality are generally quite obvious and include changes in color, aroma, physical condition, and palatability. Other losses in quantity of total dry matter, digestible nutrients and carotene may also have taken place. Although these are just as real as the visible losses in quality, they are not generally recognized. Of course, the ideal sought for in storage is to obtain a palatable feed with a minimum loss of dry matter and nutrients. The purpose of this review is to present the information concerning the losses taking place during storage of meadow crops under different conditions and treatments in the mow and silo.

STORING AS UNDERCURED HAY

Spontaneous combustion may result from storing undercured material in the mow. This results not only in a total loss of the stored material, but frequently in a loss of the building and sometimes in a loss of the surrounding buildings and their contents. It is estimated (48) that the farm losses from this cause in the United States amount to $20,000,000 annually. Different theories have been advanced regarding the nature and causes of the various processes involved in spontaneous combustion. These have been reviewed by Browne (11) and more recently by Henson (32). Investigators agree that a certain amount of moisture is necessary to start the processes leading to this trouble. Roethe (71) believes that the losses can be reduced if the hay is stacked (or put in the mow) with a moisture content not to exceed 30 per cent. Likewise, Henson (32) considers such hay safe from excessive heating. For hay put into stacks in England, Firth and Stuckey (19) recommend that the moisture be 25 per cent or less. Watson (83) points out that there is danger from relatively wet patches in the hay as put into storage or subsequently caused by a leaky roof or by drainage. Experience has shown that hay wet from floods is subject to spontaneous combustion (11).

Black and various shades of brown hay may also result from storing undercured hay. Swanson and co-workers (80) put up a stack of approxi-

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mately 40 tons of alfalfa containing 59.42 per cent moisture. On opening the stack it was found that several different kinds of hay had resulted, including black, two shades of brown, mouldy green, and a small amount of apparently good hay. However, the loss of organic matter had amounted to 39 per cent. The loss of nitrogen-free extract was calculated at 45 per cent and of protein at 33 per cent. A large portion of the hay was unfit for feed. Steers fed the black hay made unsatisfactory gains.

Hoffman and Bradshaw (38) show losses in brown hay of 22 per cent dry matter. The fats, sugars, and hemicellulose groups were especially affected, resulting in a hay of very inferior quality.

In some recently reported work by Bechtel and associates (6), analyses are given for a "normal" hay taken from the outside of a stack, brown hay from the inner portion of the stack, and a black hay, coarsely chopped, selected from the remains of a partially-burned stack on a nearby farm. The analyses for the three kinds of hay are given in table 1. The analyses

TABLE 1

Chemical composition of normal, brown, and black hays used in digestion trials

Description	Percentage composition of dry matter							
	Moisture	Ash	Crude protein	Crude fiber	N-free extract	Ether extract	Calcium	Phosphorus
Normal	20.4	9.72	21.51	25.20	41.16	2.40	1.53	0.29
Brown	11.4	10.60	21.04	28.17	38.37	1.93	1.56	0.30
Black	16.9	11.66	21.03	35.03	30.42	1.85	1.57	0.28

of the "normal" and brown hays are similar, but those for the black hay are markedly different, especially in respect to crude fiber and nitrogen-free extract. The loss of nitrogen-free extract in storage in the brown hay was 15 per cent and in the black hay 39 per cent more than the "normal" hay.

In a feeding trial the normal hay was found to be superior to the brown hay. The black hay was not fed in a comparative milk-production trial. The results obtained in feeding these hays indicated that the normal hay was adequate in feeding value, whereas the brown and black hays were decidedly inadequate.

The digestion coefficients for the three hays were determined and are shown in table 2.

Table 2 shows that, with exception of ether extract, the digestibility coefficients were lower in the brown and black hays than in the "normal" hay. The extremely low digestibility coefficient for protein in the black hay is in agreement with previous work as reported by Watson (83). The brown and black hays proved unpalatable.

Reed (70) also reports that brown hays lacked palatability. In his work, Holstein cows normally eating 17.9 pounds of a No. 2 Michigan hay consumed only 14.4 pounds of a brown hay. He encountered dry matter losses of 33.7 per cent and 49.5 per cent in producing the brown hay.

There is some disagreement in the findings on palatability and feeding value of brown hay as compared to "normal" hay. Maynard and coworkers (49) report brown alfalfa to be more palatable and slightly higher in feeding value for fattening lambs than a comparable green alfalfa. Grassman, as reported by Henson (32), found that dairy cows ate more of a brown hay than of a normal hay but that the digestibility of the hay was lowered according to the degree of browning. In some specially conducted palatability trials, Willard (89) found that alfalfa browned in the stack had retained its palatability, although the sugar content of the hay had been reduced by the browning process. The Kansas Station (15, 16), reports that dairy cows had to learn to eat brown hay. The results of two feeding trails showed 4.3 per cent less milk and 4.1 per cent less fat on the brown hay than on a green hay. Henson (32) and Folger (20) believe that the inferior feeding value of brown hay may be masked under practical feeding conditions by a greater consumption of such hay.

TABLE 2

Digestibility percentages and palatability comparisons of normal, brown, and black hays

	Normal hay	Brown hay	Black hay
Digestibility percentages:			
Dry matter	60	41	27
Crude protein	67	16	3
Crude fiber	41	36	14
Nitrogen-free extract	72	59	53
Ether extract	25	33	42
Palatability:			
Amount eaten per 1,000 lb. liveweight	20	15	10

As an explanation for this lack of agreement on "brown hay," there is reason to believe that considerable variation exists between different lots of "brown hay" and the processes by which they were produced. Thus, Fred and Peterson (23) produced "brown hay" by wilting alfalfa to 30 to 40 per cent moisture content and then packing it tightly in a silo under a heavy top seal. The resulting material had a brownish-green color and a pleasant odor and was readily eaten by cattle. The dry-matter loss was reported as only 5 per cent.

NORMAL HAY

"Well-cured" hay or that containing less than 30 per cent moisture also undergoes some changes in storage. Woodward and Shepherd (95) stored two 5-ton lots of hay containing 27 to 25 per cent moisture, respectively. When removed from storage approximately 3 months later, the moisture content had dropped to 9.5 per cent and 8.5 per cent, with total dry weight losses of 4.1 and 5.3 per cent, respectively. Repeating this work (74) with

TABLE 3

*Analyses of first-cutting alfalfa, as put into and taken out of the mow, with percentage losses of nutrients (dry basis)**

	Dry matter	Crude protein	Crude fiber	N-free extract	Ether extract
	%	%	%	%	%
Into mow	75.1	16.7	29.3	44.5	1.87
Out of mow	87.7	17.4	32.5	39.8	1.84
Losses, per cent	6.9	3.3	+ 3.1	16.8	8.90

* Vermont Bul. 494, table 4.

a drier hay (15.8 per cent moisture) gave a dry matter loss of 5.33 per cent. The authors state that this "consisted principally of nitrogen-free extract, with small losses of crude protein and ash and no losses of crude fiber or fat." Very similar losses, 3 to 8 per cent, in total dry weight of eight different hays stored with 12 to 28 per cent moisture were found by Camburn and associates (12, 13). The losses occurred principally in the nitrogen-free extract. Table 3 is taken from the tables presented by these workers on the analyses of hay going into and coming out of the mow.

A similar study has been made by Hodgson and associates (35) at the Washington Station. The authors describe the weather conditions as humid. Their work represents three successive years, with mows containing from 51 to 68 tons of hay. The losses were more extensive than those shown above from the Vermont Station. These data are summarized in table 3A.

Chopping hay into the mow requires that the moisture content be lower than when the forage is stored as long hay, in order to prevent excessive

TABLE 3A

*Weighted average percentage of first and second cuttings of hay made from grass and clover forage as put into the mow and as taken out, with the percentage loss of dry matter and nutrients sustained during the storage period for three different years**

	Dry matter	Crude protein	Crude fiber	N-free extract	Ether extract
1943 season	%	%	%	%	%
Into mow	73.0	7.9	31.9	52.1	1.5
Out of mow	83.3	9.2	32.8	48.8	1.8
Losses, per cent†	26.4	13.9	24.3	31.0	14.1
1935 season					
Into mow	78.2	7.9	28.9	55.5	2.1
Out of mow	78.2	7.8	31.5	52.8	1.9
Losses, per cent	8.9	10.0	0.6	13.3	17.4
1936 season					
Into mow	78.2	9.0	33.4	48.4	1.9
Out of mow	80.2	9.8	32.2	49.6	1.5
Losses, per cent	12.9	4.8	16.0	10.6	31.1

* Washington Bul. 366, tables 5, 6, and 8 (dry basis).

† Included in this loss was 12,272 pounds of hay discarded because it was musty and unfit to feed, which accounts for the unusually high losses for this year.

heating. At a given moisture content, chopped hay will heat more than long hay (51). As an important item in storage, chopped hay occupies one-half, or less, of the storage space of long hay. These points are illustrated in the work of Woodward and Shepherd (95, 74), as summarized in table 4.

Feeding trials with milking cows indicated a higher value for the long hay than for the coarsely chopped, brown, or finely chopped hay containing some black. This latter hay lacked palatability. In hay stored with the lower moisture content, there was little difference between long and chopped hay in feeding value. The advantages of chopped hay over long hay lie in the mechanics of handling and storing and in a reduction in feeding wastage. There appears to be no nutritional advantage from chopping (10,

TABLE 4

Comparison of long and chopped hay in storage

	Chopped ¼-in. hay	Long hay	Chopped ¾-in. hay	Long hay	Chopped ¾-in. hay	Long hay
Moisture when stored, %	27.0	27.4	25.3	25.3	15.8	15.8
Maximum temperature in storage, degrees F.	151	122	128	120	106	81
Loss of dry matter, %	6.5	4.1	3.2	3.5	4.9	5.3
Color out of storage	Brown–Black	1–25* green	Light brown	14–45* green	47–48* green	54–57* green
Storage space per ton, cu. ft.	152	475	218	475	227	592
Carotene preservation						
Carotene into storage, p.p.m.	46	46	74	74	75	75
Carotene out of storage, p.p.m.	0.9	2.9	3.9	3.9	20.7	31.9

* Refers to the range in percentage of green color as compared to that in the greenest commercially produced hay.

44, 57, 90). Likewise, there is no nutritional benefit from grinding hay; in fact, in some cases this has been shown to lower digestibility (21, 29).

Salting of hay may check bacterial growth and delay, but not inhibit, mold development according to the laboratory tests conducted by Stuart and James (79). In storage studies Henson (32) found salt "markedly beneficial" in one test, slightly beneficial in a second, and without effect in six other tests. He does not favor the general use of salt but believes that losses from excessive heating in under-cured hay may occasionally be reduced or prevented by the use of salt.

The work on this question conducted by the Bureau of Chemistry and Soils of the United States Department of Agriculture has been summarized by Roethe (71) as follows: "Although salt in liberal quantities may retard fermentation, there is no experimental evidence in the Bureau's possession that the addition of salt to hay as it is stored, at least in amounts safe for feeding, will prevent spontaneous ignition." Shutt (75) has compared additions of 10, 20, and 30 pounds of salt per ton of hay to no treatments in stacked clover-timothy hay. No outstanding differences were shown by chemical analyses. The salted hay had a better aroma, was less dusty, had more color, and was also more palatable than the unsalted hay. The 30-pound addition contained too much salt for satisfactory feeding and proved "very loosening on the steers."

Field baling of cured hay containing less than 25 per cent moisture may be practiced with good results, if precautions are taken to provide ventilation when the material is stored, according to studies conducted by Henson (32). He believes that the temperatures developed in hay bales correspond with those of mowed hay of the same moisture content.

Watson (83) presents data on the composition, digestibility, and quality of hay baled at moisture contents varying from 16 to 40 per cent. The most suitable moisture level was 20 to 24 per cent; below this there was a loss of color due to bleaching and above this range, brown patches occurred, due to fermentation and molds and dustiness were encountered. Miller and associates (52) report that hay containing from 24 per cent to 40 per cent moisture when baled molded when piled under conditions of adequate natural ventilation.

TABLE 5

Analyses of a first-cutting, artificially dried alfalfa hay as put into and taken out of storage. (Calculated to 90 per cent dry matter basis)†*

	Ash	Crude protein	Crude fiber	N-free extract	Ether extract
Into mow	6.59	14.09	25.90	41.38	2.02
Out of mow	6.79	13.91	28.78	38.67	1.85
Percentage change	+0.20	− 0.18	+ 2.88	− 2.71	−0.17

* Loss of total dry matter, 1.99 per cent.
† Vermont Bul. 494, table 4.

Artificially dried hays (kiln dried) would be expected to show only very small losses in organic matter in storage, because of their low moisture content. The analyses presented by Camburn and associates (12), in which the average loss amounted to 1 per cent, justifies such a belief. An illustration of their analyses on an artificially dried, first-cutting alfalfa going into and coming out of the mow is shown in table 5.

With the exception of a few instances in which the drying has been admittedly inefficient, the results obtained in feeding artificially dried hays and grasses have been satisfactory (3, 4, 14, 46). The digestibility (ether extract excepted (33)) and palatability are also high (27, 33). Hodgson and associates (36) have shown that grass could be dried at exhaust gas temperatures up to 350° F. without lowering the digestibility of the material. At 400° F. the digestibility of the protein was markedly decreased. In fact, the artificially dried material has been shown to have the same value as the green growing crop (62).

Artificially dried hays may at times be deficient in their vitamin D content (5), although this is not always true (25). Wallis (82) has shown that there may be marked differences in the vitamin D content of even sun-cured hays.

Since the process of artificial drying is essentially one of curing rather than of storing, it does not come within the scope of the present review. However, from the viewpoint of preserving nutrients, artificial drying comes close to being the ideal. From a practical viewpoint the cost of the drying operations and the lack of availability of equipment for the average farmer preclude the widespread farm adoption of this process.

Mow drying by forced ventilation may supply the means of overcoming some of the objections to artificial drying. Weaver and Wylie (87) believe that, in order to operate the barn driers economically, 75 per cent of the water in excess of that normally in dry hay should be removed in the field. Barn-dried hay averaged 2.3 per cent more leaves and 19 per cent more carotene than field-cured hay. The barn-cured hay had a superior feeding value. Dexter and Sheldon (18) also report that, "As a whole, the hay was of excellent quality." They encountered musty hay in the upper 2 feet. They favor putting the hay into mow-drier at approximately 35 per cent moisture. From observations on five farms in Virginia using mow driers, Connelly (17) reports that the resulting hay has been of good quality. Increases in milk production are attributed to feeding this mow-dried hay as compared to feeding the ordinary sun-cured hay. Investigators (39, 41, 50, 72) in this field have been chiefly concerned with the engineering features involved. Input-output data on the hay seem to be lacking. However, it is reasonable to suppose that the percentage preservation under this system would be determined by the extent of natural heating involved.

To speed up the drying of the hay, Strait (78) tried heated air. He was able to reduce the loss of carotene to 18.5 per cent during the mow-drying process.

Carotene losses in stored hay present a serious problem. Carotene (pro-vitamin A), the form in which vitamin A exists in forage plants, is unstable. It is readily oxidized and is subject to photolysis (26). Hauge (28) has shown that enzymes in the plant are also capable of destroying carotene. In a later publication (85) of which Hauge was a joint author, the opinion is expressed that the enzymes may be active in dried hays. Recent work by Mills and Hart indicate that this is the case (53, 54). In hays that have been subjected to a special heat treatment such as in artificial drying which inactivates the enzymes, the retention of carotene should be higher than in sun-cured hays. This tendency is shown in the reports of Camburn and associates (12, 13). These authors give the progressive losses of carotene in sun-cured and artificially cured hays by 2-month intervals for 360 days. After 300 days, the percentage retention of carotene was 55 for the artificially dried and 27 for the sun-cured hay.

In the storage of naturally cured hay the losses of carotene are also influenced by the extent of heating which the hay undergoes, which in turn is influenced by the moisture percentage. Thus, in the work of Woodward and Shepherd (74, 95) as shown in table 4, the hay stored with 27 to 25 per cent moisture and which had heated extensively, lost practically all of its carotene, whereas the hay stored with 15.8 per cent moisture retained a fair amount of this substance.

Guilbert (26) presents data to show that temperature (*per se*) has an effect on carotene losses. When alfalfa hay and meals were stored in heavy paper containers in the dark for 8 weeks at a temperature ranging from 23° to 41° F. there were no losses of carotene, but at 68° to 86° F., the loss was 30 per cent and at 154° to 176° F., the losses ranged from 62 to 87 per cent. More recent work by Wilder and Bethke (88) confirms these findings. Kane and associates (43) estimate a 3 per cent loss in carotene per month for baled hay in winter storage and a 6.5 per cent loss for storage in warmer weather. For summer storage the losses ranged from 11 to 21 per cent. Smith (76) also notes a seasonal effect in the alfalfa stored in bales. In samples of baled hay as found on the market, evidence of a caked or set condition or of a tobacco, sweated, or ground odor may be taken as an indication of a decidedly low carotene content (91). After comparing the colors of different hays with their carotene content, these authors conclude that "no definite quantitative relation between these factors can be expected." Work (43) in the same laboratory had previously shown that the percentage loss of carotene was more rapid than the loss of green color.

STORING GREEN FORAGES AS SILAGE

Losses in the silo come chiefly from top spoilage, the seepage of juices through the bottom or sides of the silo, and from fermentation. In addition, there may be some material at the extreme bottom of the silo that is unfit for feed and hence lost. Another loss, which is only partial, is generally encountered at the top of the silo following the removal of the top spoilage. This silage, although feedable, does not have the quality or palatability of the silage further down. In experimental work this is generally fed off before starting the experiment so that the silage will be of "uniform quality." In practical feeding, farmers have difficulty in getting their animals to eat a sufficient amount of this intermediate material. In some regions partial losses and unsatisfactory feeding results may be caused by the silage freezing.

Top spoilage on a percentage basis varies with the amount of silage or depth of the silo, according to Newlander and associates (59). They give estimates of top spoilage of 6.1 per cent for a 24-foot silo and 3.3 per cent for a 36-foot silo, as based on their experimental work. Nevens (58) shows that the amount of top spoilage can be materially reduced by applying a proper seal. Briefly, his plan is to provide an air-tight cover, such as roofing material and then add a sufficient weight of material to pack the silage near the surface. It seems reasonable to believe that an adequate top seal, in addition to reducing top spoilage, may also lessen the amount of "indifferent" silage beneath the spoilage.

Seepage losses have recently been reported by Archibald and Gunness (2) for a 100-ton wooden silo over a 7-year period. The losses in dry matter from the seepage have averaged 0.54 per cent, with a range from 1.08 to 0.12 per cent. The authors express the following opinion concerning this "loss"; "The improved quality of the silage when the juice is permitted to drain off will largely offset any small losses." No carotene was found in the juice. Peterson and associates (67) report a loss of 1.77 per cent dry matter in seepage from 17 tons of alfalfa ensiled by the A.I.V. process. The New Jersey Station (1) reports losses ranging from 2 to 18 per cent of the total weight ensiled. The dry matter percentage of the seepage ranged from 0.19 to 1.7 per cent. There was a greater loss with molasses than with phosphoric acid–treated silage.

Otis (63) presents seepage data from a 14 × 45-foot silo, especially equipped for such a study. One hundred and twenty-two tons of green alfalfa with a moisture content of 72.3 per cent were treated with phosphoric acid. The loss of dry matter by way of the seepage was found to be 1.6 per cent of the total dry weight of the ensiled material. The juice was found to contain 93.4 per cent water, 3.2 per cent crude protein, 2.0 per cent mineral ash, and 1.4 per cent nitrogen-free extract.

Fermentation losses as reported for silage may be too high where the oven-drying method of moisture determination has been used. This is the claim of Perkins (65), and also of King (45), who find that volatile products are driven off and accounted for as moisture in oven-drying. Perkins (65) recommends a toluene distillation method with corrections for the amount of volatile acids.

The losses (top spoilage excluded) in total dry matter, protein and carotene in a large number of silages made from various crops and with various treatments have been determined by Woodward and Shepherd (96). The summary of their results is presented in table 6.

The results were obtained largely with silos of one-ton capacity, which the authors believe yielded silage comparable to that from large silos. The dry-matter losses ranged from 5 to 10 per cent, top spoilage excluded; and protein losses from 2.8 to 6.6 per cent. In respect to palatability, the high-dry-matter silages, either wilted or treated with molasses, rated high; whereas the silages treated with mineral acids were low in palatability. The authors discourage the use of hydrochloric and sulfuric acids for silage preservation, regardless of the successful preservation of feed nutrients. They state: "The silage is definitely unpalatable." Special emphasis is

TABLE 6

*Dry matter, protein and carotene losses in grass silage, with palatability data**

Experimental difference	Moisture	Dry matter eaten†	Losses in the silo exclusive of top spoilage		
			Dry matter	Protein	Carotene
	%	*lb.*	%	%	%
Higher moisture	70.6	21.4	10.3	4.8	22.2
Lower moisture‡	45.0	24.8	8.3	2.8	38.3
Higher pH (4.76)	62.6	22.9	8.7	7.6	30.5
Lower pH (4.36) by molasses§	61.5	24.2	8.6	7.8	23.5
Higher pH (5.18)	66.8	23.6	7.7	6.6	26.2
Lower pH (3.66) by 2 N acids‖	67.9	16.3	5.0	2.9	9.3

* Taken from Woodward and Shepherd (96) tables 1, 2 and 3.
† Dry matter consumed per cow per day.
‡ By wilting or added dry matter. Average of 25 comparisons.
§ Various additions of molasses. Average of 19 comparisons.
‖ By additions of mineral acids.

placed upon the proper moisture content as a factor in making good silage. Similar conclusions have been reached by Hayden (30) and coworkers.

Taylor and associates (81) conclude that a loss of 10 to 15 per cent of the total dry matter is nominal and unavoidable in ensiling. Likewise, from an extensive series of tests the Vermont workers (12, 13, 60) show an average "intangible" loss of 11.5 per cent.

The feed analyses of the silages indicate that the silage is not materially different from the crop going into the silo. To illustrate this point, sample analyses taken from three different investigations and representing three different silage processing methods are shown in table 7.

TABLE 7

Comparison of analyses of crops going into and coming out of the silo

	Dry matter	Crude protein	Crude fiber	N-free extract	Ether extract
Clover—treated with 3 per cent molasses (actual composition basis)*					
In-going clover	32.56	3.59	10.21	15.63	0.77
Out-going edible silage	31.67	3.84	10.44	14.09	0.88
Mixed grasses—treated with phosphoric acid (actual composition)†					
Mixed grasses	29.30	3.30	9.10	13.90	0.80
Grass silage	26.80	3.00	8.60	12.40	0.80
Grass—untreated (dry matter basis)‡					
Material ensiled	28.90	11.80	23.70	54.60	3.30
Good silage (recovered)	26.90	12.60	27.70	45.50	4.40

* Vermont Bul. 494 (12).
† New Jersey Bul. 683 (81).
‡ Washington Bul. 348 (34).

The digestibility coefficients of the various feed constituents in grass silage were found to be approximately equal to those in the original grass, in trials conducted by French (24). Crude protein was less digestible in the silage than in the original grass—49 per cent as compared to 60 per cent. The ether extract was 10 per cent more digestible in the silage than in the original grass. That the ensiling process does not necessarily depress the digestibility of crude protein is indicated in the results obtained by several other investigators (22, 34, 61). Although these investigators have not compared the digestibility of the silages with the original material, the digestion coefficient for crude protein is higher than that found by French (24). Excessive heating as the cause of lowering the digestibility of protein in silage is suggested by Woodman (92), who obtained a digestibility coefficient of 12.2 per cent for crude protein in a stack silage that had heated. Watson and Ferguson (84) report a coefficient of 35.3 for the protein of a stack silage in which heating had occurred as compared to 67.7 for that of a tower ensilage in which little heating was noted.

Carotene preservation in meadow-crop silage has been shown to be high. In fact, in some cases the carotene values for silages have been reported as higher than the original material (31, 47, 60). These high values were shown by Quackenbush and associates (69) to have been caused by the presence of pigments produced by the action of the silage acids on xanthophyll. A method for separating the pigments has been worked out by Peterson, Hughes and Freeman (68), and further modified by Moore (56).

Camburn and associates (12) present carotene analyses on several different silages at the end of 8 months in the silo. The percentage retention of carotene for the different treatments was as follows: 57 with phosphoric acid treatment, 52 with no molasses, 47 with 8 per cent molasses, 29 with 2–4 per cent molasses. In another trial (13) these investigators obtained the following percentage retentions: 78 with A.I.V.-treated, 43 with phosphoric acid, 22 with molasses-treated and 18 with no treatment.

In the results obtained by Woodward and Shepherd (96), presented in table 6, the carotene retentions were higher than those indicated above. The silage preserved by the A.I.V. method headed the list. Carotene preservation was also shown to be high in the investigations of Taylor and associates (81), who state that "grasses or legumes, ensiled with acids or molasses contain two or three times as much carotene as does corn silage."

After an extensive series of trials including such treatments as wilting, phosphoric acid, salt, and corn-and-cob meal, Stone and co-workers (77) state, "The highest carotene values were usually obtained in alfalfa ensiled with molasses." This differs from the Vermont findings (12, 13) which favored the A.I.V. treatment. In all treatments a satisfactory fraction of the original carotene was preserved according to the work of Stone and associates (77).

Milk and butterfat produced from meadow-crop silages have been shown to contain increased amounts of carotene and vitamin A. Thus, with A.I.V. silage Peterson and associates (66) found 50 per cent more carotene and 40 per cent more vitamin A in the milk than when the ordinary well-balanced winter ration was fed. Bechdel and co-workers (7) also mentioned an increase in carotene content of the butterfat produced on the high-carotene legume silages. At the Purdue Station the feeding of alfalfa-brome grass silage treated with molasses was found to increase the carotene and vitamin A content over that produced on corn silage (86). Hodgson and associates (37) also indicate substantial increases in the vitamin A potency of butterfat from feeding grass silage. This same observation has been made repeatedly at the Ohio Station (30).

The "grass-juice" factor which has been shown to be present in grass silage is also transferred to the milk (42). Silage prepared with phosphoric acid contained somewhat more of the factor than molasses-treated and untreated silages. An alfalfa silage containing a soured-whey concentrate showed an excellent preservation of this factor. The "grass-juice" factor is so named because of its abundance in young grass. It is an unidentified water-soluble substance of a growth-promoting nature for rats and guinea pigs.

The viability of weed seeds as affected by the siloing process, although indirectly related to the subject of this review, has a practical significance in farming methods. Woodward (93) shows that the germinating powers of the seeds from a number of different weeds are destroyed in the silo.

The type of silo appears to be relatively unimportant in respect to the nutrient preservation. In the work reviewed several different kinds of silos have been used. Bohstedt (9) states, "The type of silo is important only in so far as it excludes air and provides means for compression of the silage."

MOISTURE EVALUATION AND CONTROL NEEDED IN STORING FORAGES

Probably the one single factor that calls for the most consideration in putting crops into either the mow or silo is simply the moisture content of the material. On most farms moisture is "determined" by the "feel," coupled with experience. Woodward (94) has described a mechanical device for estimating the moisture in crops intended for the silo. Another method based on the reaction of calcium carbide with moisture has been presented by Parks (64). Or, if electricity is available, the rapid-drying method (55) of blowing heated air through a sample can be used. This has been shown to agree within one per cent of the laboratory oven-drying method (77). With an adequate moisture control the losses in storage can be reduced to a minimum.

ROUGHAGE REVIEWS

Articles covering the general subject of roughage including the work on storage, have been published by Bohstedt (9), Huffman (40), LeClerc (48), Watson (83), and Woodward *et al.* (97). The subject of barn hay-driers has been reviewed by Schaller, Mitchell, and Dickerson (73) and the subject of grass silage by Bender and Bosshardt (8).

SUMMARY

Storing as hay. In "well-cured" long hay or that containing less than 30 per cent moisture, the dry-matter loss in storage will vary from 3.5 to 9 per cent and in some cases more. This loss occurs principally in the nitrogen-free extract and to a lesser degree in the ether extract.

Hay containing in excess of 30 per cent moisture is not considered safe for ordinary storage. In such cases, extensive heating results that may lead to either spontaneous combustion or to the production of charred, blackened or browned hay. Dry matter losses depend upon temperatures attained and their duration. In browned and blackened hay such losses may range from 15 to 40 per cent. Heating reduces the digestibility of the hays, especially of the proteins, and increases the carotene loss. Although some browned hays have been found palatable, in general, browned hay, and blackened hay especially, are less palatable than hays that have not heated.

At a given moisture content chopped hay will heat more than long hay. A "long chop" is preferable to a "short chop." Such hay should contain less than 25 per cent moisture for storage.

Salting hay will not prevent excessive heating in under-cured forage.

For field baling, hay should contain less than 25 per cent moisture.

The losses in dry matter and nutrients (carotene excepted) of artificially dried hay are practically negligible in storage.

Mow-drying of hay by forced ventilation with or without artificial heat has been shown to result generally in hay of good quality with a high feeding value. In cases where fermentations and heating have occurred, it is logical to assume that losses will be encountered just as in ordinary storage. Much more work on the nutrient content, feeding values and palatability of mow-cured hay needs to be done.

Losses in carotene take place in the storage of "well-cured" long hay in the mow, so that at the end of 300 days, such hays may have only one-quarter of their original value. In the heating of hay the carotene may be entirely lost. The losses are greater in warm weather than in cold weather.

Storing as silage. The percentage loss from top spoilage will vary with the size of the silo and the precautions taken in sealing the silo. A loss of 3 to 6 per cent of the total dry matter of ensiled material is a general estimate. The actual weight of spoiled material removed from the top of a silo may represent a proportionally larger amount of original forage, because of the loss of organic matter through decay and the drying out of the material.

The percentage losses through seepage also vary with the size of the silo and the moisture content of material ensiled. Normally the dry matter losses from this cause are less than 1 per cent, when the original forage contained 70 per cent or less moisture.

Fermentation losses in dry matter will normally vary between 5 and 10 per cent. This is exclusive of losses from top spoilage or seepage.

The feed analyses of silage is similar to the analyses of the material ensiled. The digestibility of the silage is likewise similar to the original green material, except in silage in which extensive heating has taken place. In such cases the digestibility of the protein is lowered.

Carotene is generally well preserved in the ensiling process. According to some work the carotene retained in the silage averaged from 60 to 90 per cent of that ensiled. Other investigators show lower carotene retentions. Considerable variation exists in the amount of carotene retained in silage. The type of treatment has been shown to have an effect on carotene preservation. In general, treatment with mineral acids shows high retention and no treatment or wilting has given the lowest retention.

The high carotene content of the silage is reflected in the carotene content of milk produced on such silage.

The "grass-juice factor" has been shown to be present in grass silage, especially in silage preserved with soured whey or with phosphoric acid.

The ensiling process destroys the germinating powers of a number of different weed seeds.

Proper moisture evaluation and control are needed for minimizing the losses in storing forages as hay and silages.

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ANNOUNCEMENT

Annual Meeting, Iowa State College

June 18–20, 1946

REGISTRATION AND HOUSING

Registration headquarters will be in the Memorial Union, Iowa State College.

Housing facilities will be available in college dormitories and local hotels. A return card relative to advance registration and housing will be sent to members by the Association Secretary in May.

PROJECTION EQUIPMENT

Lanterns will be available, upon request, for projection of standard and $2'' \times 2''$ slides. Projectors for 8 and 16 mm. movies also will be available by arrangement. Requests for projection equipment should be made at the time abstracts of papers are submitted to the respective section chairmen.

COMMITTEE MEETINGS

Those wishing rooms for Extension and Production Section committee meetings should contact Elmer Hansen. F. E. Nelson will assign rooms for meetings of committees of the Manufacturing Section.

SPECIAL MEETINGS

Rooms for a limited number of breakfasts, luncheons or dinners for special groups will be available at the Union. Shortage of help will not permit table service, so the groups will have to go through the cafeteria lines and thence to the reserved rooms. Requests for such reservations should be made to F. E. Nelson, Dairy Industry Department, Iowa State College, Ames, Iowa.

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JOURNALS

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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

BOOK REVIEW

101. Analysis of Foods. ANDREW L. WINTON AND KATE BARBER WINTON. John Wiley & Sons, New York, 1945.

A compilation of methods for the determination of the constituents of foods in six groups, methods which have been accepted by American National organizations or are standard in other countries. Others in addition are included which have been published in accredited journals but which are either tentative or have not been given that quasi-acceptance, yet are in extensive use. The compilers have been to great trouble to separate method proper from experimental and discussion entanglement in journal articles and putting it in a lucid and usable whole. In this they have succeeded admirably.

Part I. Brief treatment is given to General Microscopic and General Physical Methods. These are then followed by General Chemical Methods, which constitute about half of the content and cover: 1. Organic Elements; 2. Constituent Groups; 3. Water; 4. Protein; 5. Fat; 6. Nitrogen-free extract; 7. Fiber; 8. Ash (2 through 8 the six groups); 9. Alcohols; 10. Vitamins; 11. Natural Colors; 12. Artificial Colors; 13. Chemical Preservatives (10 through 13 are classed as Traces, while 12 and 13 are both classed as Extraneous Constituents).

Part II. Special Methods. This comprises the methods which have in large part become standard analysis procedure for: A. Cereal Foods; B. Fatty Foods; C. Vegetable Foods; D. Fruit Foods; E. Saccharine Foods; F. Alcoholic Beverages; G. Dairy Products; H. Animal Foods; I. Alkaloidal Products; J. Food Flavors; K. Leaven; L. Salt. 208 illustrations, numerous tables, and a liberal use of chemical formulas along with necessary mathematical computation methods. This book can serve to advantage as a time-saving instrument in the food analysis laboratory. L.M.D.

BACTERIOLOGY

102. An Improved Darkfield Quebec Colony Counter. O. W. RICHARDS AND P. C. HEIGN, Research Division, American Optical Co., Buffalo, N. Y. Jour. Milk Technol., *8*, No. 5: 253–256. Sept.–Oct., 1945.

The improved colony counter has an annular reflector which gives uniform oblique lighting. The colonies stand out against a darkfield clearly. Colonies can be examined in a colored culture medium by using a colored or light field. The counter has a single or double magnifying glass, designed to hold Jeffers, Stewart, or Wolffhengel guide plates. The instrument is protected from dust, is convenient to manipulate and does not become hot while in operation. H.H.W.

BREEDING

103. Livability and Glycolysis of Bovine Spermatozoa in Yolk-citrate, Incubated Eggs, or Chick Embryo Diluters. G. W. SALISBURY, J. A. ZELAYA, AND N. L. VANDENMARK, Cornell University, Ithaca, N. Y. Jour. Animal Sci., *4*, No. 3: 270–276. Aug., 1945.

Two different experiments were conducted, one with semen collected in August and the other collected in March. Each ejaculate of semen was diluted at the rate of one part semen to four parts of each diluter used. The chick-embryo diluent made from whole-fertile eggs incubated nine to eleven days was only slightly superior to the yolk-citrate in maintaining livability of the spermatozoa during low-temperature storing. The semen samples in the chick-embryo diluent produced slightly more lactic acid during storage than did the same semen samples in the yolk-citrate. This was associated with a loss of glucose and suggests that the chick-embryo material aided in the promotion of glycolysis by the spermatozoa. C.F.H.

BUTTER

104. Use of an Antioxidant in Preventing Hydrolytic Rancidity in Dairy Products. I. A. GOULD, University of Maryland, College Park, Md. Natl. Butter and Cheese Jour., *37*, No. 1: 40. Jan., 1946.

The addition of 0.75 and 1.5% Avenex concentrate to raw cream retarded lipolysis and rancidity in the resulting raw-cream butter. The addition of the same material to raw cream did not appreciably affect the lipolysis which resulted when the cream was subsequently homogenized at low pressure. It is possible that other antioxidants may control rancidity. Those factors affecting rancidity development in normal raw milk do not have the same effect on lipolysis induced by homogenization. W.V.P.

105. The Butter Industry at the Crossroads. RUSSELL FIFER, American Butter Institute, Chicago. Natl. Butter and Cheese Jour., *37*, No. 1: 36. Jan., 1946.

In the year 1945 milk production reached a new high, but butter was the shortest in history. This paradox was caused by military purchases and unfair price restrictions. Removal of these restrictions should bring a normal price relationship with other manufactured dairy products within a reasonable period. Consumer, industrial, and institutional markets must be attained by production of a quality product, and by emphasizing butter's nutritive properties. Surveys by American Dairy Association show that a large majority of consumers prefer butter to other spreads. W.V.P.

CHEESE

106. A Phosphatase Test for Cheddar Cheese. G. P. SANDERS AND O. S. SAGER, Division of Dairy Research Laboratories, U. S. Dept. Agr., Washington, D. C. Jour. Milk Technol., *8*, No. 4: 223–226. July–Aug., 1945.

The method is a modification of the phosphatase test used in testing inadequate pasteurization of milk. Complete details of the procedure will be available at a later date. Over 340 samples of Cheddar cheese with complete records of the milk treatment were tested. Cheese made from raw milk or under-pasteurized milk gave a positive phosphatase reading. Cheese from pasteurized milk at 143° F. for 30 minutes or 162° F. for 15 seconds gave values greater than 5 units, regardless of the age of the cheese. The addition of 0.1 per cent of raw milk to pasteurized milk could be detected in the cheese test. One sample of raw-milk cheese after five years and several cheeses held three years all gave a strong phosphatase test. H.H.W.

107. A Discussion on Standards for Soft and Semi-Soft Cheese. RAYMOND MIOLLIS, Natural Cheese Co., Maywood, Ill. Natl. Butter and Cheese Jour., *37*, No. 1: 72. Jan., 1946.

Moisture and fat regulations such as govern the Cheddar cheese industry would be unfair to use for controlling the soft cheese industry. Such regulations might discriminate against some types of cheese, might interfere with the development of new types, might introduce complications in controlling imports, might lead to frequent revisions of definitions for many varieties of cheese, and might be extremely laborious to enforce. The Dutch method of branding cheese with the minimum fat per cent in the dry matter would be preferable. W.V.P.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

108 Sanitary Standards Program of the Evaporated Milk Industry. E. H. PARFITT, Evaporated Milk Association, Chicago, Ill. Jour. Milk Technol., *8*, No. 2: 108. Mar.–Apr., 1945.

The Evaporated Milk Association has formulated a sanitary standards code, which has been adopted by 96 per cent of the industry.

The program and accomplishments are discussed. L.H.B.

109. Water Absorption of Plastics Molded from Acylated Casein. W. G. GORDON, A. E. BROWN, AND C. M. MCGRORY, Eastern Regional Res. Lab., U. S. Dept. Agr., Philadelphia, Pa. Jour. Indus. and Engin. Chem. Indus. Ed., *38*, No. 1: 90–94. Jan., 1946.

Casein plastics constitute only a small percentage of the total production of plastics, one reason being the relatively high water absorption properties of the protein. The modification of casein by acetic, propionic, and n-butyric anhydrides to produce derivatives which can be molded directly into articles having greater resistance to water was studied. Preparation of acylated products containing 3.4 to 10.1% acetyl, 2.7 to 13.4% propionyl, and 7.5 to 14.9% butyryl is discussed. Water absorption tests on disks molded from these materials demonstrated that the affinity of casein for water is curtailed progressively by increasing the number and size of the acyl groups incorporated in the modified protein. This reduction in water uptake is accompanied by a decrease in the strength of the molded articles. B.H.W.

110. **"Wonder Food" Made from Casein.** ANONYMOUS. Natl. Butter and Cheese Jour., *36,* No. 12: 34. Dec., 1945.

Amino acids prepared by the acid hydrolysis of casein are being distributed in sterile liquid and in powder forms. The product has possibilities in healing of wounds, rejuvenation of starved people and for the feeding of sick people who could not eat otherwise. W.V.P.

DISEASE

111. **Mastitis and the Plate Count of Milk. VI. The Contribution of Staphylococcal Mastitis to the Standard Plate Count of Milk, and Some Cultural Characteristics of the Organisms Isolated.** H. W. SCELEY, JR., E. O. ANDERSON, AND W. N. PLASTRIDGE, Storrs Agricul. Expt. Sta., Storrs, Conn. Jour. Milk Technol., *8,* No. 5: 259–263. Sept.–Oct., 1945.

Staphylococci were identified in samples of milk drawn aseptically from quarters affected with Staphylococcal mastitis. The numbers of Staphylococcus colonies ranged from 200 to 42,000 per ml.

A total of 289 cultures of staphylococci were isolated from the infected quarters; of these 209 were coagulase-positive or 72 per cent; 156 were hemolytic on blood agar or in blood broth. This constituted 36 per cent of the total staphylococci. Thirty-five of the cultures or 44 per cent produced some pigment ranging from a deep yellow to a white pigment.

No relationship existed between the leucocyte counts and the corresponding plate counts of the same samples. H.H.W.

112. **The Therapeutic Effect of Yeast and Pyridoxine on Poikilocytosis in Dairy Cattle.** J. T. REID, C. F. HUFFMAN, AND C. W. DUNCAN. Michigan State College, East Lansing, Mich. Jour. Nutr., *30,* No. 6: 413–423. Dec., 1945.

Young calves on semi-restricted ration and cows with large open fistulas of the rumen which showed poikilocytosis were used in this study. Dry brewers yeast, live yeast, or pyridoxine were effective therapeutic agents for the treatment of this condition, whereas the ingestion of nicotinic acid, riboflavin or a mineral mixture containing iron, copper, cobalt, and manganese did not elicit any curative effects on the disease. The occurrence and the degree of severity of poikilocytosis were independent of the hemoglobin content; red cell count, red blood cell volume, and the plasma concentration of calcium, inorganic phosphorus, and magnesium. The hypothesis was advanced that the primary defect responsible for the occurrence of poikilocytosis in dairy animals is due to a lack or an interference with normal ruminal activity. C.F.H.

113. A Review of Bloat in Ruminants. H. H. COLE, C. F. HUFFMAN, M. KLEIBER, T. M. OLSEN, AND A. F. SCHALK. National Res. Council Fourth Report of Committee on Animal Health, National Res. Council, Sub-com. on Prevention of Bloat. Jour. Animal Sci., *4,* No. 3: 183–236. Aug., 1945.

This is a review of the literature pertaining to bloat in the ruminant under the following headings: 1. Seriousness of the bloat problem; 2. Conditions under which bloat occurs; 3. Sources of rumen gases; 4. Factors influencing rate and type of gas formation; 5. Expulsion of gas from the rumen; 6. Experimental production of bloat; 7. Prevention of bloat; 8. Treatment of bloat; 9. Theories of bloat. C.F.H.

FEEDS AND FEEDING

114. Vitamin Requirement in Calves. J. M. LEWIS AND L. T. WILSON, Dept. Pediat., New York Univ. and Walker Gordon Lab., Plainsboro, N. J. Jour. Nutr., *30,* No. 6: 467–475. Dec., 1945.

Holstein calves of either sex, two to nine days of age, were placed on a ration nearly devoid of vitamin A in order to deplete their stores of this vitamin. Upon the cessation of gain in weight, they were divided into six groups of four calves each and placed on the following levels of vitamin A from shark liver oil (50,000 U.S.P. units per gm.) : 32, 64, 128, 256, 512, and 1023 U.S.P. units of vitamin A per kg. body weight per day, respectively. The results indicated that the minimum vitamin A requirement for growing calves is 32 U.S.P. units per kg. body weight and that the requirement for maximum growth is 64 U.S.P. units per kg. body weight. The concentration of vitamin A in the blood increased with the vitamin A intake to 512 U.S.P. units when maximum concentrations were obtained. The authors concluded that from the standpoint of both growth and liver storage, the daily intake of vitamin A for young calves should be about 250 U.S.P. units per kg. of body weight. C.F.H.

FOOD VALUE OF DAIRY PRODUCTS

115. The Dietary Importance of the Fatty Acids in Butterfat. ANONYMOUS. Natl. Butter and Cheese Jour., *37,* No. 1: 68. Jan., 1946.

A review of the subject released in "Dairy Council Digests," November, 1945, by National Dairy Council, 111 N. Canal Street, Chicago, Illinois.
W.V.P.

116. Nutritional Studies on Milk Fat. I. The Growth of Young Rats Fed Milk Fat and Certain Synthetic Glycerides as Supplements to a Fat-free Diet. J. L. HENDERSON, E. L. JACK, S. LEPKOVSKY, AND D. F. REID, Division Dairy Ind., Univ. Calif., Davis, and Div. Poultry Husbandry, Univ. Calif., Berkeley, Calif. Jour. Nutr., *30,* No. 3: 169–173. Sept., 1945.

Two trials were made using young rats fed a fat-free diet for the purpose of comparing the following supplements for growth. One group received twenty per cent butterfat as a supplement; a second group, twenty per cent triolein; a third group, twenty per cent trilaurin; and a fourth group, ten per cent each of triolein and trilaurin. The results showed that the rats fed the milk-fat diet and the triolein diet grew faster than those fed the other diets. There was no significant difference between the milk-fat diet and the triolein diet with respect to growth.
C.F.H.

117. Nutritional Studies on Milk Fat. II. The Growth of Young Rats Fed Glyceride Fractions Separated from Milk Fat. E. L. JACK, J. L. HENDERSON, D. F. REID, and S. LEPKOVSKY, Div. Dairy Ind., Univ. Calif., Davis, and Div. Poultry Husbandry, Univ. Calif., Berkeley, Calif. Jour. Nutr., *30,* No. 3: 175–181. Sept., 1945.

Ten groups of young rats were used in this study. Five glyceride fractions separated from milk fat by precipitation from a solvent were fed as supplements to a fat-free diet to weanling rats, and the gain in weight measured. The growth responses placed the fractions in three groups. The $-50°$ C. filtrate was superior to all other diets containing solvent-treated fat; the $-70°$ C. ppt. and the fat-free were the poorest; the others formed an intermediate group. The diet containing natural fat which had not been solvent-treated gave greater growth than any other diet. The diets containing the solvent-treated milk fats (natural, synthetic and composite) fell in the intermediate group with no significant difference between them. The authors suggested that either the oleic acid content or the total unsaturation might be a factor contributing to differences in growth. The $-53°$ C. fraction contained more oleic acid than the other fractions.
C.F.H.

ICE CREAM

118. How to Make Ice Cream without Fluid Cream. C. D. DAHLE, Pennsylvania State College, State College, Pa. Ice Cream Field, *46,* No. 6: 18. Dec., 1945.

It is pointed out that when fresh cream is not available, butter, plastic cream, and frozen cream may be used to supply the necessary fat in ice cream. Brief mention is made of the desirability of carefully selecting these products if good quality ice cream is to be produced. If difficulty occurs in getting the desired overrun in batch freezers when such products are used, the addition of one-half per cent egg yolk to the mix should improve whipping conditions. W.C.C.

119. The Future of Powdered Mix in Ice Cream. P. H. TRACY, Dept. of Dairy Husbandry, Univ. of Illinois, Urbana, Ill. Ice Cream Field, *46,* No. 6: 22. Dec., 1945.

Powdered ice cream mix—a development of World War II—will likely find household and commercial uses. It is stated that normally 15–20 per cent of the housewives make their own ice cream. This should serve as a potential market provided that powdered mix will reconstitute and whip readily and have a good flavor. It is predicted that packaged powdered mix will be generally available in grocery stores and that household mechanical refrigerators will likely be equipped with small ice cream whipping units and facilities for faster hardening. W.C.C.

120. Use of Homogenized Cream in Ice Cream. ALAN LEIGHTON, Bureau of Dairy Industry, U. S. Dept. Agr., Washington, D. C. Ice Cream Field, *46,* No. 6: 30. Dec., 1945.

Experimental mixes in which all of the ingredients were mixed, then pasteurized, homogenized, cooled, and aged were compared with mixes of the same composition in which the cream was pasteurized and homogenized before adding it to the rest of the ingredients after they had been pasteurized, cooled and aged. The author used as a measure of the whipping properties of the various mixes the maximum overrun obtainable under the experimental freezing conditions.

It is shown that 12 per cent butterfat mixes of satisfactory whipping properties can be made from pasteurized, homogenized and aged cream. If difficulty occurs, it is most apt to be with mixes made from 25 per cent cream, it is stated. Longer aging periods for the mix and the use of (a) alginate, (b) gelatin-monoglyceride, or (c) carboxy methyl cellulose as stabilizer improved the whipping properties of such mixes. W.C.C.

MILK

121. The Methylene-Blue Reduction Test as a Means of Estimating the Bacterial Content of Milk to Determine Its Suitability for Pasteurization or as a Basis for Grading. C. A. ABELE, Health Dept., Chicago, Ill. Jour. Milk Technol., *8,* No. 2 : 67. Mar.–Apr., 1945.

The U.S.P.H.S. Milk Ordinance specifies that raw milk produced for Grade A pasteurized milk must have an average plate count not in excess of 200,000 per ml. or an average methylene-blue reduction time of six or more hours.

Since it was impractical and costly to make plate counts on all raw samples of milk because of the large number of farms from which the Chicago supply is obtained, the methylene-blue reduction test was used. It was found, however, that milk supplies meeting the six-hour average reduction time requirement did not, in Chicago's experience, result in a pasteurized product, which uniformly met the requirement of a plate count of 30,000 or less per ml.

A study was made comparing the reduction times with the plate counts.

In this study it would appear to justify the assumption that any milk supply that had a reduction time of less than six hours is likely to have a plate count in excess of 200,000 per ml. However, it also shows that when the test is conducted according to Standard Methods (8th Ed.), that a relatively large percentage of samples having a reduction time of more than six hours will have a plate count over 200,000 per ml. It is obvious that the rising cream sweeps many bacteria up with it, thus extending the reduction time of the defatted portion, which is really the portion that determines the reduction time of the sample.

When tubes were inverted at 30-minute intervals during incubation to redisburse the fat and results compared with same samples when tubes were not inverted, it showed that inverting the tubes gave a higher degree of agreement betwen plate counts and reduction times. It was noted that most of the reduction times were shortened by inverting tubes. L.H.B.

122. Observations Concerning the Methylene-Blue Reduction Test. C. K. JOHNS, Dominion Dept. of Agr., Ottawa, Canada. Jour. Milk Technol., *8,* No. 2 : 80. Mar.–Apr., 1945.

The methylene-blue test was first used largely for the rapid detection of the poorer quality milks, and has been extremely useful in bringing about improvement in the quality of milk. It is not considered reasonably accurate by some investigators, however, when the reduction time exceeds 5½ hours. Therefore, it is not surprising that the reduction time on the better grades of milk have failed to show good correlation with the plate count.

The lack of correlation between plate count and reduction time may be due to a number of factors, namely, the reducing activity varies with the species of bacteria present, and unfortunately, many of the types which are heat resistant have weak reducing powers. The reduction time is influenced by the state of activity of the bacteria. Bacteria which are dormant from prolonged refrigeration will require a longer time to reduce methylene-blue than when in a more active state of growth. The sweeping of bacteria in varying proportions to the surface by the rising butterfat is also a great factor. Inversion of the tube at regular intervals will eliminate this factor. The incubation temperature of 37° C. is not the optimum temperature for many bacteria present in milk.

The plate count should not be considered as an infallible yardstick for measuring quality. It merely indicates the number of colonies which develop on a certain medium at a given temperature for a definite period. When any of these specifications are changed, marked variations in the counts may be obtained. Also, a colony on the plate count may be formed from a single organism or from a clump of 100 or more.

The methylene-blue reduction test has an advantage in the size sample used. On raw milk a dilution of 1:1000 or higher may be used for the plate count. Thus, only one thousandth of a milliliter or less of milk would be used as compared to 10 ml., or 10,000 times as large a quantity for the reduction test.

In view of the changes which have been made in both the methylene-blue test and the plate count since the equivalent values for these two tests were established by the U.S.P.H.S., it is suggested that it would be desirable for this organization to investigate the situation with a view to establishing a new set of equivalent values, if necessary. L.H.B.

123. Practical Applications of Several Coliform Tests to Pasteurized Milk. W. D. Tiedeman and S. E. Smith, State Department of Health, Albany, N. Y. Jour. Milk Technol., *8*, No. 6: 323–330. Nov.–Dec., 1945.

The authors conclude that bottled pasteurized milk is not free from coliform bacteria, particularly during warm weather. The fermentation test is not entirely satisfactory for examining the presence of coliform organisms because the method does not differentiate milk containing 2 or 3 coliforms per ml. as compared to milk with several thousands. A quantitative estimate of these bacteria can be obtained by using desoxycholate or violet red bile culture media.

A temporary year around standard for raw certified milk is less than 10 coliform organisms per ml. It may be possible to set a higher standard after plants have reached a higher sanitary standard. Coliform organisms in 1 ml. of pasteurized milk can be obtained in clean sanitary plants.

H.H.W.

124. Routine Examination of Milk for Added Water. HERMANN C. LYTHGOE, Director, Div. of Foods and Drugs, Mass. Dept. of Public Health, Boston, Mass. Jour. Milk Technol., *8,* No. 2: 101. Mar.–Apr., 1945.

The following procedure is used in the laboratory: 1. Total solids are determined by evaporation on a steam bath by Leach's method; 2. Fat is determined by the Babcock test.

From these tests, samples suspected of being skimmed or watered are set aside for further tests. Protein determinations are made on samples when skimming is suspected, and when watering is suspected, the following tests are made for the detection of added water: 1. The refractive index of the copper milk serum; 2. The freezing-point test; 3. The ash of the sour milk serum or the ash of the acetic acid milk serum.

The author reports that "the freezing point of milk is more susceptible to changes by the addition of water than are the other constants, but if watering is suspected by this figure, further examinations should be made to confirm this by using other methods of analysis. In all cases, where the figures are not far from normal, samples of known purity are desirable, if not necessary." L.H.B.

125. The Effect of Temperature on Coliform Organisms in Milk and Cream. ELIZABETH D. ROBINTON AND ELIZABETH F. GEMING, Dept. Bacteriology, Smith College, Northampton, Mass. Jour. Milk Technol., *8,* No. 2: 97. Mar.–Apr., 1945.

In tests made in this study, it was found that coliform organisms have a greater ability to multiply in cream than in milk. Cream is apparently a more favorable medium than milk.

Plates incubated at 20° C. for 48 hours showed much higher counts than duplicate plates incubated at 37° C. for 48 hours.

Coliform organisms develop rapidly even at refrigeration temperatures of 8° C.

Preliminary tests indicated that *Aerobactor aerogenes* organisms increased to a greater extent than did *Escherichia coli* organisms. In later tests this did not always hold true. L.H.B.

126. Report of Committee on Dairy Farm Methods. (Internatl. Assoc. Milk Sanit.) Jour. Milk Technol., *8,* No. 2: 95. Mar.–Apr., 1945.

The committee has undertaken certain studies pertaining to the cleaning and sterilizing of milking machines. The following four items were suggested for study:

Polyphosphates vs. Lye Storage.
Chlorine vs. Lye Storage.

Dry Storage vs. Certain Types of Wet Storage.

Wetting Agents vs. Ordinary Cleansers.

Some brief studies were made and reported on Chlorine vs. Lye, which indicated no advantage for either method.

Satisfactory results were reported in another instance regardless whether rubber parts were stored in chlorine, lye, or dry storage. Hot water, chlorine, or lye treatments also gave comparable results.

It was found that the attitude of the person doing the cleaning was important. The results obtained by those with the "just get by" attitude were invariably bad. L.H.B.

127. **Coliform Organisms in Dairy Products and Their Control.** E. L. FOUTS AND T. R. FREEMAN, Dairy Products Laboratory, Fla. Agr. Expt. Sta., Gainesville, Fla. Jour. Milk Technol., *8*, No. 2: 89. Mar.–Apr., 1945.

A brief history of both *Escherichia coli* and *Aerobacter aerogenes* and the possible significance of each is given.

Their presence in raw dairy products is generally accepted, but when good sanitary practices are used, their number will be small.

In well-managed and operated pasteurizing plants, coliform organisms are seldom found in 1-ml. portions of freshly pasteurized milk. When they are, it usually indicates recontamination after pasteurization, or improper pasteurization.

When fresh pasteurized bottle milk shows a positive coliform test, a "line test" should be made to find the source or cause of the contamination.

Thorough washing and sterilization of all equipment is of utmost importance.

Charts are given illustrating in a diagrammatic way the methods used in the laboratory to determine the presence of coliform organisms in dairy products. L.H.B.

128. **Efficient Refrigeration in the Dairy Plant.** LEON BUEHLER, Chief Refrigeration Engineer, Creamery Package Manufacturing Co., Chicago, Ill. Jour. Milk Technol., *8*, No. 2: 85. Mar.–Apr., 1945.

Adequate and properly controlled refrigeration is necessary for quality products in the dairy industry. The cost of producing this refrigeration is an important item in production costs.

The factors effecting the energy costs for operating the refrigeration plant are discussed and some simple basic rules for keeping energy requirements to a minimum are given. These rules are:

"1. Operate at lowest practical head pressure.
   a. Provide adequate condensing surface.
   b. Use coldest condensing water available in liberal quantity. Scarcity of water, high cost, or inadequate drainage may neces-

sitate reduced quantity or use of cooling tower, spray pond, or evaporative condenser.

c. Keep condensing surface clean and free from scale.
d. Keep system free of noncondensible gas. (Purge.)

2. Operate at highest possible evaporating temperature.
    a. Provide adequate cooling surface.
    b. Keep cooling surface clean of oil on ammonia side and clean of ice., etc., on other side.
    c. Avoid restrictions in suction line. Back pressure valves may be employed for temperature regulation and are a most effective control means. They do, however, violate this rule for highest efficiency.
    d. Balance compressor capacity closely to the load. (Refer back to conclusion number 5)—To attain highest efficiency with fluctuating loads, the plant must be very flexible. Capacity control means include multiple compressor units, speed adjustment, and control attachments to the compressor such as clearance control, cylinder by-pass, or holding suction valves open. Such attachments have rather large losses so that their use does not give the full saving one could expect from the rise in evaporator temperature. In practice it is not possible to provide enough flexibility for operation at optimum conditions at all times.
    e. Use direct expansion equipment. The use of chilled water or brine entails an extra temperature split and results in lower evaporator temperature.
    f. Where cooling to various temperature levels is required (example milk cooling and ice cream freezing), provide compressors for each level so as to operate at highest efficiency for each temperature.
    g. Cool product or space to temperature no lower than necessary.
3. Keep refrigeration requirements to a minimum.
    1. Provide adequate insulation.
    2. Cool product as low as possible by regeneration cycle in pasteurizing (incoming cold raw milk cools hot pasteurized milk) or by water before using mechanical refrigeration."

It is stressed that the refrigeration equipment be balanced against the load. Standby equipment is desirable. L.H.B.

129. **A Correlation of the Resazurin Grade with the Standard Plate Count of Raw Milk.** N. S. Golding and S. J. Gorgensen, Agricultural Experiment Station, State College of Washington, Pullman, Washington. Jour. Milk Technol., *8*, No. 4: 189–195. July–Aug., 1945.

The authors compared the resazurin test (Lovibond comparator at 10-, 30-, and 60-minute intervals) with bacterial count of raw milk as suggested in Standard Methods. The results were summarized as follows: (1) The resazurin test correlated with the standard plate count, even with milk from widely different sources, and (2) The 60-minute incubation period gave the most consistent results. H.H.W.

130. Clean Up or Close Up! Harvey Weavers, Wisconsin Department of Agriculture, Madison, Wis. Natl. Butter and Cheese Jour., *37*, No. 1: 42. Jan., 1946.

The demand in the dairy industry has changed from quantity to quality. Standards are being raised under which all foods are produced and marketed. Quality control is made difficult by acceptance of inferior milk, use of improperly cleaned or defective cans, faulty farm and plant sanitation, defective equipment, improper cleaning and sterilization, lack of pest control, inadequate toilet and hand washing facilities, improperly trained help, poor labor supervision, undesirable plant surroundings, and lack of coordination of plant responsibilities and activities. Undesirable conditions in the industry must be cleaned up. Leading plants are maintaining quality by special attention to the quality of milk and cream received. This is accomplished with quality records, field services, rejection of unsuitable delieveries, premium payments for superior quality, and discouragement of marginal producers.

PHYSIOLOGY

131. The Levels of Ovarian Hormones Required to Induce Heat and Other Reactions in the Ovariectomized Cow. S. A. Asdell, J. DeAlba, and J. S. Roberts, Cornell Univ., Ithaca. N. Y. Jour. Animal Sci., *4*, No. 3: 277–284. Aug., 1945.

Grade dairy heifers from two to three years of age were ovariectomized and used for this study. An average dose of 600 rat units of estradiol-benzoate per day for three days was required to bring ovariectomized heifers into heat. The duration of heat was usually less than one day even though the injections were continued. The mean dose of stilbestrol needed to bring the ovariectomized heifer into heat was 0.255 mg. Uterine muscles of heifers estrogenized after ovariectomy had the same reactions as that of heifers in heat. They were inert to pituitrin, epinephrin, lentin, and arecolin. Progesterone in doses of 35 rabbit units or more given for six days produced the same reactions in the uterine muscle as those found in heifers during the diestrum. The average length of the uterine muscle cells was greater in the estrogenized heifers than in the ovariectomized controls. C.F.H.

MISCELLANEOUS

132. **Refrigeration Abstracts.** Amer. Soc. Refrig. Engin. J. MACK TUCKER, University of Tennessee, Editor. Pub. Quarterly. Editorial Office, Ferris Hall, University of Tennessee, Knoxville, Tenn. General Office, 40 West 40th Street, New York 18, N. Y. $7.00 per year.

The first number of Volume 1 published January, 1946.

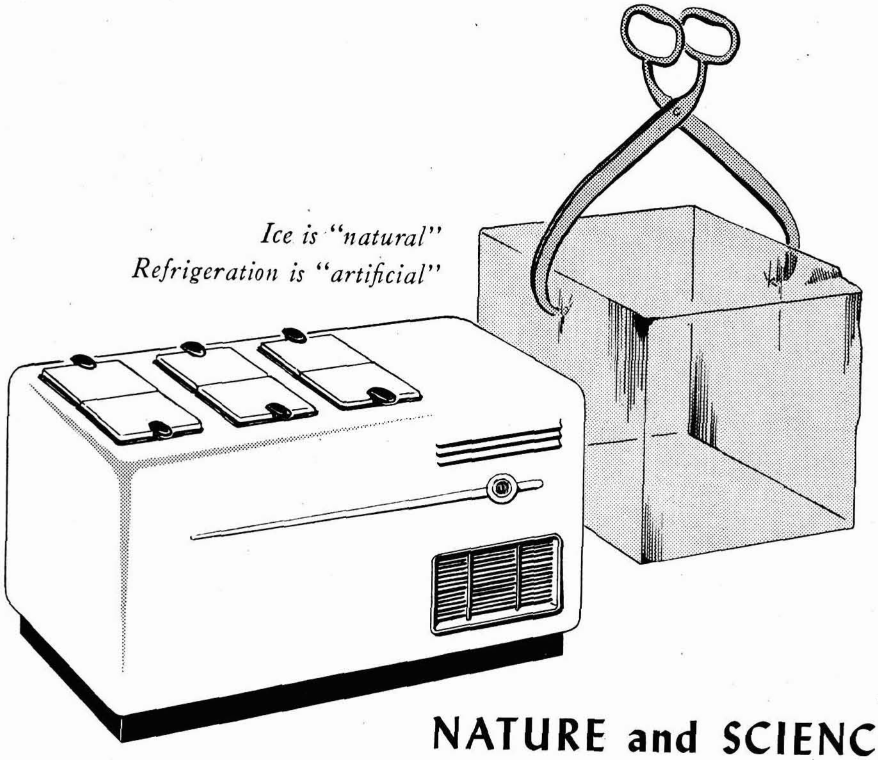
Refrigeration Abstracts is being inaugurated by the American Society of Refrigerating Engineers to provide the profession and industry with an adequate index to the literature of refrigeration and the allied fields. A staff of 58 abstractors has been chosen on the basis of their specialized knowledge of the subjects which are assigned to them and because of ther ability to prepare impersonal briefs or abstracts rather than critical reviews. The evaluation of the original articles will be left to the users of the journal. The abstracts are covered under the following classes: 1—General; 2—Natural Sciences; 3—Engineering; 4—Engineering Materials; 5—Refrigerating Media; 6—Thermal Insulating Materials; 7—Machinery and Equipment; 8—Foods; 9—Patents. A list of 347 publications is given which the abstracting staff will cover. Two pages of abbreviations and symbols are presented which will be used in the abstracts to conserve space. The final pages are devoted to the author index. It is to be hoped that in future numbers there will be less abstracts that are titles of articles only. The user of an abstracting service should be provided with at least a modicum of digest of the subject matter of an original article if it is deemed worthy of consideration at all. L.M.D.

133. **High Speed Defrosting of Frozen Eggs.** WM. H. CATHCART, Director, National Bakery Div. Lab., Great Atlantic & Pacific Tea Co. Ice Cream Field, *46*, No. 6: 64. Dec., 1945.

Quality as applied to eggs is defined as pureness, freshness, good flavor and high nutritional value. In addition to proper freezing and storage, rapid defrosting is necessary if quality is to be maintained.

Various methods of defrosting eggs now in use by the industry are outlined. The best of these methods requires about 9 hours to thaw a 30-pound tin of frozen eggs and results in about 40 per cent increase in bacteria content and is the only one of these that gives a product that is normal in body and consistency, the author states. An adaptation of electronic equipment devised for several industrial uses not related to food, made possible defrosting 15-hour items in 15 minutes and 4-hour items in 15 seconds, the author claims. Electronic defrosting is so rapid that there is no time for chemical changes to occur during the process, furthermore, it is stated that there is no breakdown in the fiber and structure of the food, and bacterial growth is held to a negligible minimum. W.C.C.

Ice is "natural"
Refrigeration is "artificial"



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