JOURNAL OF DAIRY SCIENCE

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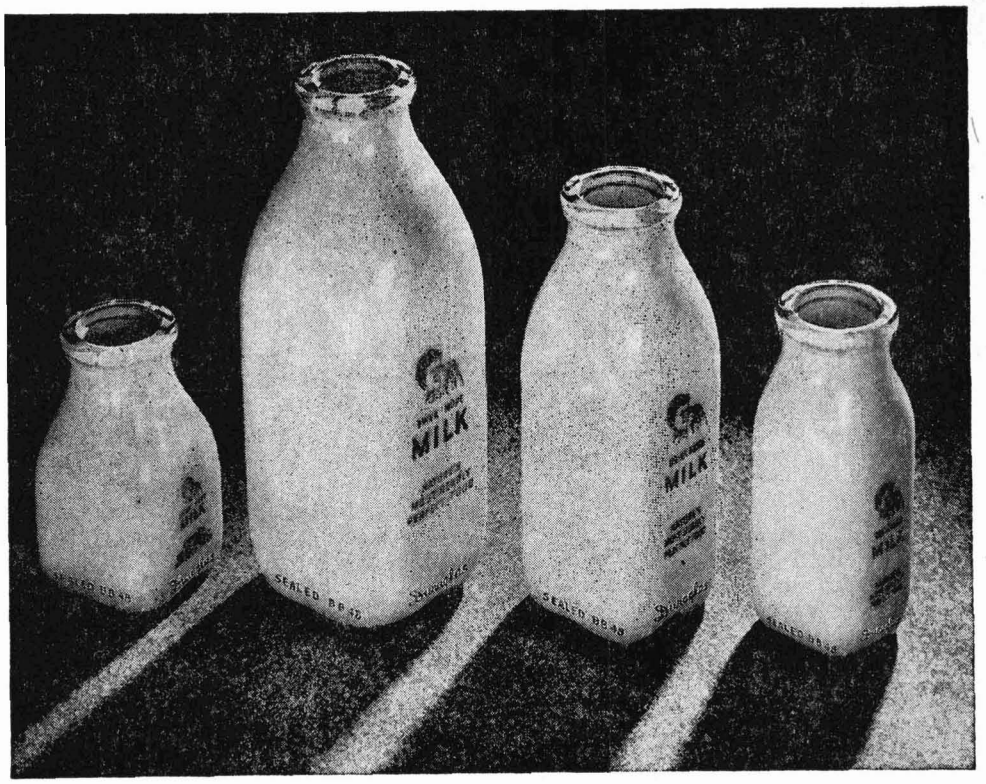

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STUDIES ON KETOSIS IN DAIRY CATTLE. VII. THE EFFICACY OF B VITAMINS AND METHIONINE IN THE TREATMENT OF KETOSIS[1]

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Following the report by Carlström *et al.* (1) that ketosis in cattle could be cured by thiamine administration, a number of articles have appeared in the literature supporting the claim and thiamine has been given wide usage in the treatment of ketosis in ruminants. Unfortunately little or no chemical data have been reported to confirm the diagnosis of ketosis or the reported recovery of the animals following thiamine therapy.

In the present investigation a study was made of the therapeutic value of thiamine and other B vitamins in the treatment of ketosis in dairy cows. Observations were also made on the effectiveness of methionine in the treatment of this condition. The B vitamins and methionine were furnished through the courtesy of Merck and Company.

EXPERIMENTAL

Only cows with uncomplicated ketosis were used in these studies. Diagnosis was made on the basis of the recognized signs and symptoms of ketosis in cows supported by data on blood glucose and acetone bodies. During the course of treatment every effort was made to maintain environmental conditions as they were when the condition developed. In particular no changes were made in feeds or in feeding practices.

Seven cows with ketosis received thiamine alone or in combination with other B vitamins. The B vitamins were supplemented with glucose administration in two cases. Two cows with ketosis received methionine.

Cow D.E. 73 (table 1) received 100 mg. thiamine hydrochloride per os daily for seven days, followed by a mixture of B vitamins daily for 10 days. This included 100 mg. thiamine hydrochloride, 60 mg. riboflavin, 60 mg. pyridoxine, 1200 mg. nicotinic acid, and 1200 mg. calcium pantothenate. During this period there was only slight improvement, the blood glucose

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1 This project is financed in part by a grant from the Eastern States Farmers' Exchange.

increasing from 19.0 to 26.6 mg. per cent and the blood acetone bodies decreasing from 27.23 to 15.33 mg. per cent. This developed into a chronic case in which the blood glucose and acetone bodies remained abnormal for some time after the symptoms of ketosis had disappeared.

Cow D.E. 74 (table 2) had received glucose injections before this study was initiated and appeared to have recovered. With the recurrence of symptoms 22 days after parturition, B vitamins were administered per os for a period of 17 days. The dosage was the same as in the previous case. There

TABLE 1

The efficacy of B vitamins in the treatment of ketosis (D.E. 73)

Days	Blood glucose	Blood acetone bodies (as acetone)	Milk production	Treatment	Comments
	mg.%	*mg.%*	*lbs.*		
1	.....	.....	.....	.....	Calved
8	19.0	27.23	49.5	100 mg. thiamine per os daily	Lethargy, inappetence
11	24.0	12.65	53.0	"	.....
13	34.0	14.00	56.7	"	.....
15	18.6	14.90	61.5	B vitamins* daily per os	Appetite improved
17	20.8	16.35	62.3	"	.....
19	.....	18.18	64.0	"	.....
21	.....	25.02	64.1	"	.....
23	42.6	26.07	65.8	"	.....
25	24.6	19.46	67.0	"	.....
27	26.6	15.33	68.4	Discontinued treatment	.....
31	28.8	14.04	67.0	.....	.....
34	26.8	10.40	67.9	.....	.....
37	26.4	19.23	69.6	.....	Slight inappetence only
39	20.0	16.99	69.8	.....	Appeared normal
42	25.2	12.00	72.1	.....	"
45	29.0	12.81	72.6	.....	"
48	34.6	13.43	77.1	.....	"
61	41.3	.....	68.9	.....	"

* 100 mg. thiamine hydrochloride, 60 mg. riboflavin, 60 mg. pyridoxine, 1200 mg. nicotinic acid, 1200 mg. calcium pantothenate.

was some improvement in the blood picture and in the general appearance of the animal during this period. Milk production increased for a few days and then fell off again.

Cow D.E. 75 (table 3), representing a mild case of ketosis, received 100 mg. of thiamine hydrochloride per os daily for seven days followed by B vitamins for 10 days. During the first seven days of treatment the condition of the animal became worse, as shown by the blood picture and the symptoms. After seven days of treatment the animal recovered rapidly.

Cow D.E. 76 had a severe case of ketosis as shown by both the blood picture and the symptoms. As indicated in table 4, B vitamins were administered per os for a period of five days. By the sixth day the condition

TABLE 2

The efficacy of B vitamins in the treatment of ketosis (D.E. 74)

Days	Blood glucose	Blood acetone bodies (as acetone)	Milk production	Treatment	Comments
	mg.%	*mg.%*	*lbs.*		
1	.....	.....	.....	.....	Calved
6	.....	.....	69.4	250 gm. glucose intravenously	Lethargy, inappetence
8	.....	.....	74.2	"	"
18	.....	.....	79.0	.....	Improved
22	21.4	14.16	72.6	B vitamins* per os daily	Lethargy, inappetence
24	18.0	17.05	71.3	"	Same
26	20.6	12.87	74.0	"	"
29	23.4	15.07	79.9	"	"
32	30.4	10.81	90.4	"	Appetite improved
36	32.8	5.84	94.4	"	.....
39	29.4	12.38	82.5	"	Slight lethargy
41	30.4	12.13	79.9	Discontinued treatment	"
45	32.6	8.31	78.1	.....	"

* 100 mg. thiamine hydrochloride, 60 mg. riboflavin, 60 mg. pyridoxine, 1200 mg. nicotinic acid, 1200 mg. calcium pantothenate.

of the cow was so poor that glucose was administered intravenously, after which recovery was fairly rapid.

Cow D.E. 77 (table 5) exhibited severe ketosis the day following parturition. B vitamins were administered in the dosage indicated in table 5 for a period of four days. The condition became so severe that glucose was

TABLE 3

The efficacy of B vitamins in the treatment of ketosis (D.E. 75)

Days	Blood glucose	Blood acetone bodies (as acetone)	Milk production	Treatment	Comments
	mg.%	*mg.%*	*lbs.*		
1	.....	.....	.....	.....	Cow calved
4	35.6	18.98	.....	100 mg. thiamine hydrochloride per os daily	Slight lethargy
6	30.0	23.54	.....	"	.....
8	18.8	28.44	.....	"	.....
10	23.6	30.25	31.7	B vitamins* per os daily	Lethargy, inappetence
12	36.8	8.38	39.0	"	Appetite improved
18	55.6	7.40	46.2	"	.....
20	47.4	6.99	48.2	Discontinued treatment	Normal appearance
25	43.6	3.76	47.7	.....	.....
30	41.4	3.20	47.8	.....	.....
35	41.6	3.24	48.0	.....	.....

* 100 mg. thiamine hydrochloride, 60 mg. riboflavin, 60 mg. pyridoxine, 1200 mg. nicotinic acid, 1200 mg. calcium pantothenate.

injected intravenously on the sixth and eighth days after parturition. Some slight response was noted. B vitamins were then administered per os for a period of 10 days supplemented by feeding three pounds of glucose daily mixed with the grain. After seven days of such treatment, glucose was again injected intravenously because of the acute condition of the animal. This cow was consuming from 18 to 20 pounds of concentrate and approximately 20 pounds of mixed hay throughout most of this period but became quite emaciated. When it became apparent that the B vitamins were ineffective,

TABLE 4

The efficacy of B vitamins in the treatment of ketosis (D.E. 76)

Days	Blood glucose	Blood acetone bodies (as acetone)	Milk production	Treatment	Comments
	mg.%	*mg.%*	*lbs.*		
1	.....	.....	.....	.....	Calved
9	.....	.....	57.4	.....	.....
10	16.0	30.50	51.0	B vitamins* per os daily	Lethargy, incoordination
11	19.6	36.05	52.2	"	No change
12	22.4	38.90	50.0	"	"
13	14.4	40.54	51.5	"	"
14	18.6	31.52	52.7	"	"
15	18.0	38.60	52.3	280 gm. glucose intravenously	Inappetence, paresis of neck, marked incoordination
16	29.2	.....	60.5	No further treatment	Definite improvement
17	26.7	29.86	54.6	.....	.....
19	26.8	24.65	54.3	.....	.....
20	32.6	.....	57.0	.....	.....
21	36.7	16.88	59.5	.....	Normal appearance
24	28.6	18.00	58.5	.....	.....
26	41.2	.....	61.5	.....	.....
29	37.3	.....	64.0	.....	.....
31	42.7	.....	64.5	.....	.....
35	33.4	.....	61.7	.....	.....
39	35.4	.....	64.8	.....	Normal appearance

* 100 mg. thiamine hydrochloride, 60 mg. riboflavin, 60 mg. pyridoxine, 1200 mg. nicotinic acid, 1200 mg. calcium pantothenate.

the cow was used for other studies. This cow eventually recovered and produced over 700 pounds of butterfat.

D.E. 198 (table 6) exhibited the first symptoms of ketosis the tenth day after parturition and gradually became worse. The cow was not treated and the condition became acute by the thirtieth day. Relatively massive doses of B vitamins were used in this case. For the first four days one gram of thiamine hydrochloride per day was injected intravenously. By the fifth day it was necessary to administer glucose to save the cow. Two intravenous injections of 250 grams each were made in three days. For the next three days the following vitamins were administered daily by the intravenous

route: thiamine hydrochloride, 1 gm.; pyridoxine, 1 gm.; nicotinamide, 5 gm.; and calcium pantothenate, 5 gm. The condition of the cow again became so acute that glucose was again administered intravenously. The blood picture showed some improvement during this period but it was apparent that the cow was on the verge of collapse. The sharp rise in blood sugar,

TABLE 5

The efficacy of B vitamins in the treatment of ketosis (D.E. 77)

Days	Blood glucose	Blood acetone bodies (as acetone)	Milk production	Treatment	Comments
	mg.%	*mg.%*	*lbs.*		
1	68.0	2.83	.....		Calved
2	31.4	7.97	.....	B vitamins* per os daily	Incoordination
3	35.8	5.99	.....	"	Slight improvement
4	21.2	13.26	41.9	"	No change
5	17.8	21.42	46.1	"	Marked incoordination
6	12.4	21.92	48.0	290 gm. glucose intravenously	Marked incoordination, inappetence
7	.....	.....	48.4	No treatment	Marked incoordination
8	23.4	21.60	49.5	250 gm. glucose intravenously	Marked incoordination
9	.....	.....	50.9	No treatment	Slight incoordination
10	21.2	29.64	49.0	No treatment	Slight incoordination
11	24.6	36.15	50.7	B vitamins* + 3 lbs. glucose per os	Slight lethargy
12	24.7	23.00	56.5	"	"
13	.....	.....	58.8	"	"
14	.....	.....	56.4	"	"
15	16.8	.....	58.8	"	Lethargy
16	.....	.....	57.7	"	"
17	21.8	21.82	55.1	B vitamins* + 3 lbs. glucose per os + 250 gm. glucose intravenously	Paresis of neck, marked incoordination, weak
18	.....	.....	56.8	B vitamins* + 3 lbs. glucose per os	Slight improvement
19	.....	.....	58.2	"	Incoordination
20	17.0	19.41	57.8	"	"

* 100 mg. thiamine hydrochloride, 60 mg. riboflavin, 60 mg. pyridoxine, 1200 mg. nicotinic acid, 1200 mg. calcium panthothenate.

to a level considerably above normal, which occurred after the cow was allowed to graze has frequently been observed in cows which recover quickly from ketosis. Such a rise was also noted in cow D.E. 75, table 3, and in a number of other cases not reported. The return to a normal level of glucose within a day or so from the abnormally high level observed in these two cases has also been noted before.

Probably the most conclusive study on the use of B vitamins for ketosis in cows was that conducted on cow 230 (fig. 1). This cow refused to eat grain and ate but very little hay. Sufficient response was obtained by the

initial injection of glucose and calcium gluconate to indicate that the cow would have recovered rather quickly had glucose therapy been continued. The blood calcium was 9.62 mg. per cent, showing that the condition was not complicated with milk fever. Blood hemoglobin was 11.48 per cent. Massive doses of B vitamins were given in capsules at daily intervals for 12 days. Intravenous administration of B vitamins was also made on each day during the first eight days of treatment. The B vitamins included thiamine hydrochloride, nicotinic acid, calcium pantothenate, riboflavin, pyridoxine, para

TABLE 6

The efficacy of B vitamins in the treatment of ketosis (D.E. 198)

Days	Blood glucose	Blood acetone bodies (as acetone)	Treatment	Comments
	mg.%	*mg.%*		
1	.....	.....	.....	Calved
10	.....	.....	.....	Inappetence
30	26.9	48.38	1 gm. thiamine intravenously	Paresis of neck, scoliosis, general stiffness, eating hay only
31	23.3	52.06	"	"
32	25.5	48.76	"	"
33	23.3	48.28	"	"
34	22.0	.....	250 gm. glucose intravenously	"
35	.....	.....	No treatment	Some improvement in general condition
37	23.1	54.50	250 gm. glucose intravenously	Paresis of neck, scoliosis, general stiffness
38	32.5	23.66	B vitamins* intravenously	Slight improvement
39 A.M.	25.6	28.92	"	No change
P.M.	34.3	30.65	0.5 gm. riboflavin intravenously	"
40	34.4	23.66	250 gm. glucose + B vitamins† intravenously	Paresis of neck, scoliosis, general stiffness
41	44.5	14.44	.....	Slight improvement
42	56.3	5.12	On pasture	Marked improvement

* 1 gm. thiamine hydrochloride, 1 gm. pyridoxine, 5 gm. nicotinamide, 5 gm. calcium pantothenate.

† 0.5 gm. riboflavin added to above vitamins.

aminobenzoic acid, inositol, biotin, and choline. The dosage is shown in figure 1. It will be noted from the data in figure 1 on blood glucose, blood acetone bodies, and milk production that the massive doses of B vitamins were completely ineffective in alleviating the condition of the cow. There were no complications, the cow recovering several days later after a change of treatment.

In table 7 data are presented on two cases which received *dl*-methionine for several days. Cow D.E. 263 received 12.5 gm. of methionine intrave-

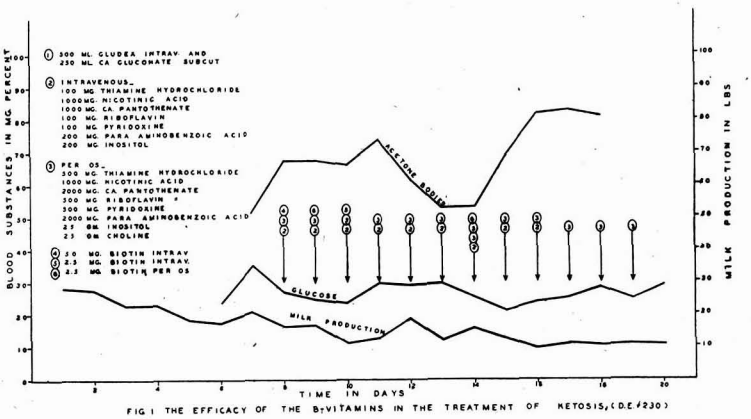

FIG. 1. The efficacy of the B vitamins in the treatment of ketosis (D.E. 230).

nously for five days, during which time the condition of the cow became worse. Improvement was rapid following glucose administration. Cow D.E. 265 received daily administrations of 12.5 gm. of methionine intravenously and 12.5 gm. orally for a period of eight days. The condition of the

TABLE 7

The efficacy of methionine in the treatment of ketosis

Cow	Days	Blood glucose	Blood acetone bodies (as acetone)	Treatment	Comments
		mg.%	*mg.%*		
D.E. 263	1	28.3	49.36	12.5 gm. methionine intravenously	Inappetence, lethargy
	2	25.5	55.11	"	"
	3	27.7	46.67	"	"
	4	25.0	47.39	"	"
	5	20.4	.....	"	"
	6	24.9	.....	250 gm. glucose intravenously	No improvement to date
	7	35.2	.....	.....	Improved appetite
	8	43.6	11.58	.....	Alert, improved appetite
D.E. 265	1	29.2	.....	12.5 gm. methionine intravenously + 12.5 gm. per os	Inappetence, incoordination
	2	29.0	24.61	"	"
	3	16.4	26.09	"	"
	4	16.8	.....	"	"
	5	13.5	.....	"	"
	6	19.5	37.24	"	"
	7	21.3	39.94	"	"
	8	.....	.....	"	"
	9	15.1	36.23	.....	"

cow was acute by the ninth day and use of methionine was discontinued. Both cows recovered within a relatively short period of time after the intravenous administration of glucose.

DISCUSSION

In evaluating the results of this investigation it is important to bear in mind that the majority of cases of uncomplicated ketosis in cattle will recover without treatment, some rapidly and others only after a protracted period of time. D.E. 75 was the only cow which recovered rapidly following the administration of B vitamins. However, in this case the condition of the cow deteriorated rapidly during the first four days of treatment when thiamine hydrochloride was being administered, after which other B vitamins were added and recovery was prompt. In the other cases there was little or no apparent response. There was likewise no indication that glucose therapy was more effective when supplemented by thiamine and other B vitamins. Cow D.E. 77 received thiamine hydrochloride, riboflavin, pyridoxine, nicotinic acid, calcium pantothenate, and three pounds of glucose daily for a prolonged period of time without any apparent beneficial effect.

Blood chemistry data are presented on cows D.E. 73 and D.E. 77 over some period of time following cessation of treatment because these two cases are quite typical of a large number of cases in the field which appear to have recovered following treatment but which continue to exhibit hypoglycemia and ketonemia for a prolonged period. Similar observations were made in earlier reports (2, 3). Frequently such cases suffer a relapse which could have been avoided in the majority of cases by feeding some form of readily available carbohydrate for a few weeks after intravenous glucose administration was discontinued. It is entirely possible that many of the cases of ketosis which are reported to occur several weeks or months following parturition may be merely outward symptoms of a condition which has existed for some time, in which symptoms may or may not have been in evidence at an earlier date.

CONCLUSIONS

1. Thiamine hydrochloride when administered alone either orally or intravenously or in combination with nicotinic acid, calcium pantothenate, riboflavin, pyridoxine, para aminobenzoic acid, inositol, choline, and biotin, was ineffective in the treatment of ketosis in lactating cows. Likewise the efficacy of glucose did not appear to be enhanced by the administration of thiamine hydrochloride, riboflavin, pyridoxine, nicotinic acid, and calcium pantothenate.

2. Methionine was ineffective in the treatment of ketosis when administered either orally or intravenously.

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THE ESTIMATION OF THE WEIGHT OF BULLS FROM HEART GIRTH MEASUREMENTS

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Though significant relationships between heart girth measurements and weight of dairy cows (1, 5) and beef cattle (2, 3, 4, 6, 7) have been found, no evidence of this nature has been reported on mature dairy bulls. Wanderstock and Salisbury (7) concluded that the most significant single measure for estimating weight of beef cattle is heart girth measurement. If this method could be used as a practical means of estimating the weight of mature dairy bulls, it would be of great help when scales are not available.

The object of the analyses in this paper was to study the relationship of heart girth measurements and weight of mature dairy bulls, also, to test the accuracy of the estimation of the weight of a dairy bull from heart girth measurement.

SOURCE OF DATA

The bulls from which the data used in this study were obtained were 50 Holstein and Guernsey bulls in the New York Artificial Breeders' Cooperative, Inc., herd. All of these were mature bulls except for two Holstein bulls and one Guernsey bull of about two and one-half years of age. The bulls were in good breeding condition but carried no excess flesh. Except for seven experimental bulls, all were being fed and routinely used by the Cooperative at the time the measurements and weights were taken.

After the animal was weighed on a set of platform scales, it was placed squarely on all four feet with its head in the normal position. A cloth tape, about one inch wide and graduated in inches, was used to take the heart girth measurements. The measurement was taken by placing the tape around the animal at the point of smallest circumference just behind the forelegs. It was pulled snugly about the animal, tight enough to keep the hair down but not tight enough to indent the flesh.

ANALYSIS OF DATA

For purposes of analysis, the data on all bulls were used to calculate the correlation coefficients and regression. Then the data were separated according to breeds and calculations made. All calculations of correlation coefficients and regression lines and their significance were made and interpreted according to Snedecor (8).

RESULTS

The weights of the bulls ranged from 852 to 2351 pounds. The mean weight was 1659.88 $\pm$ 377.07 pounds and the mean heart girth measurement

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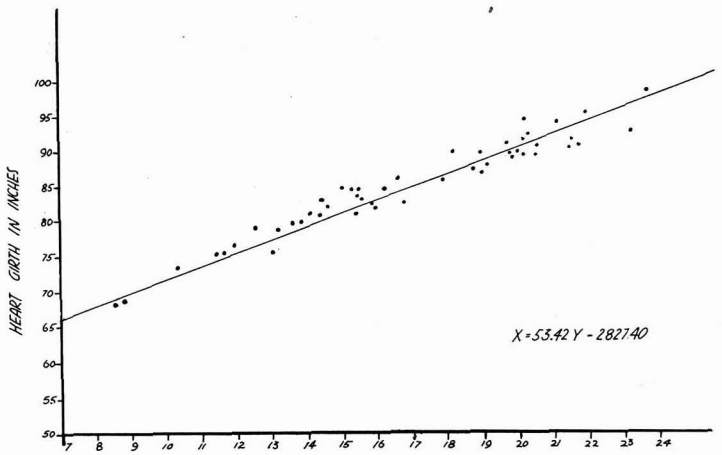
was 83.92 ± 6.89 inches. The correlation coefficient showing the relationship between the heart girth measurement and body weight of 50 Holstein and Guernsey bulls was 0.976. Correlation coefficients for 25 Holsteins and 25 Guernseys were 0.954 and 0.958 respectively. All correlation coefficients were highly significant mathematically.

A calculation of the regression of actual live weights on the heart girth measurement indicated a straight-line relationship existed. The equation for the line was $X = 53.42\ Y - 2827.40$, where X = the calculated estimate of the weight and Y = the measured heart girth. The standard error of the regression line was 83.8 pounds, or 5.05 per cent of the mean, a relatively low standard error for data of this type. The regression line for all bulls is given in the accompanying graph.



REGRESSION OF BODY WEIGHT ON HEART GIRTH MEASUREMENT OF DAIRY BULLS

Having the body weights and semen volume data on hand, the authors were interested in knowing whether or not there was a relationship between weight of a bull and semen volume. The average volume of semen was calculated from collections made from bulls between May 15 and August 15, 1945, considering all ejaculates. The correlation coefficient between body weight and semen volume was 0.2079, which was not significant mathematically.

SUMMARY

A study was made of the relationship between heart girth measurement and the body weight of 25 Holstein and 25 Guernsey bulls ranging in weight from 852 to 2351 pounds.

The coefficients of correlation between heart girth measurement and body weight were 0.976 for all of the 50 bulls, 0.954 for the Holstein bulls, and 0.958 for the Guernsey bulls; all were highly significant statistically.

A calculation of the regression of body weight on heart girth measurements indicated a straight line relationship. The error of estimate of body weight based on heart girth measurement was 83.8 pounds or 5.05 per cent. Estimates of the body weights of bulls were, therefore, very accurate.

It was also of interest to note that the correlation coefficient between body weight and semen volume was 0.2079, which was not mathematically significant.

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THE RATE OF AUTOXIDATION OF MILK FAT IN ATMOSPHERES OF DIFFERENT OXYGEN CONCENTRATION*

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Henderson and Young (1) determined the rate of autoxidation of oleic acid in atmospheres of 21 to 100 per cent oxygen and concluded that it varies as the square root of the oxygen concentration. Although oleic acid constitutes approximately 90 per cent of the unsaturated fat acids in milk fat, it is doubtful if Henderson and Young's conclusion is applicable to milk fat under conditions wherein lower oxygen concentrations are concerned. Lea, Moran, and Smith (2) noted the effect of low initial oxygen concentrations in containers of dried milk on the tendency of the fat to become tallowy and concluded that concentrations below approximately 3 per cent are satisfactory for use in a commercial pack. The results did not lend themselves to an estimation of the rate of oxidation.

Greenbank, Wright, Deysher, and Holm (3) determined the keeping quality of commercial samples of dried milks packed in atmospheres of different percentages of oxygen and stored at different temperatures. The conclusion with respect to the O_2 concentration that would be effective in greatly retarding deterioration was similar to that arrived at by Lea, Moran, and Smith, but the data obtained were not extensive enough to indicate the variations in rate of oxidation with variations in oxygen concentration.

EXPERIMENTAL

Autoxidation of milk fat. A certain degree of oxidation of a fat can occur before tallowy flavors are produced. This degree of oxidation varies with the type of fat and also with the temperature at which the oxidation occurs, becoming greater as the unsaturation of the fat increases and less as the temperature increases.

With milk fat the degree to which oxidation can occur before tallowy flavors are produced is small at relatively low temperatures of storage, hence the amount of available oxygen must be small if the development of tallowy flavor is to be prevented during long periods of storage. Since the products of decomposition of the initial oxidation products (peroxides) are responsible for the tallowy flavor and since the decomposition proceeds progessively with increases in time even at low temperatures, a value of interest in the

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packaging of milk fat or dried milk in an inert gas is the minimal amount of oxygen which when it reacts with milk fat will produce a tallowy flavor. This value for milk fat was determined as follows:

Samples of milk fat varying from 15 to 50 g. in weight were placed in ampoules and evacuated thoroughly at a temperature of 80° C. with continuous shaking. When all of the dissolved air had been removed in this manner, calculated amounts of oxygen were bled into each tube, a 3-ml. azotometer with mercury as the confining liquid being used as the measuring device. Nitrogen was then allowed to flow in until atmospheric pressure was attained, and the tubes were sealed. In this manner a series of ampoules containing oxygen concentrations of from 0.5 to 9.0 per cent by volume was prepared and samples of each series were stored at temperatures of 70°, 50°, and 30° C.

After prolonged storage only those samples of less than 0.80 per cent oxygen in the ampoules did not develop tallowy flavors. This concentration of oxygen is equivalent to approximately 0.009 ml. of oxygen per gram of fat. A concentration of 0.013 ml. per gram of fat (1.19 per cent by volume oxygen concentration) produced a distinctly oily and tallowy flavor after 16 weeks of storage at 55° C. Hence, to prevent the production of a tallowy flavor in butteroil through oxidative changes under severe conditions of storage, the amount of available oxygen should be less than 0.80 per cent of the volume of the fat (4).

To obtain an approximation of the variation in rate of autoxidation of milk fat with variations in the oxygen concentration of the atmosphere in which it is packed, experiments with pure milk fat were carried out in which the oxygen concentration of the atmosphere was varied from 1.70 to 100 per cent.

In the experiments with butteroil the autoxidation was carried out at 70° C. and the rate measured by determining the peroxide value at intervals in the reaction.

The extent to which the rate of autoxidation of a fat is dependent on the concentration of oxygen of the atmosphere with which it is in contact is indicated in figure 1, by the value for the rate of peroxide formation in pure milk fat with nitrogen-oxygen mixtures of different oxygen concentration. In figure 2 is shown the time required for the peroxides to reach a value of 5.0 in atmospheres of different concentrations of oxygen.

These values indicate that, comparatively, there is not a great difference in the time required for the fat to reach a given degree of peroxide formation when pure oxygen and when air is used. Reduction of the oxygen concentration below that of air seems to increase this time very markedly. The values given in figure 2 indicate that the relationship between the time required to effect a certain degree of oxidation and the percentage of oxygen concentration is of a reciprocal nature, or inversely proportional. Hence,

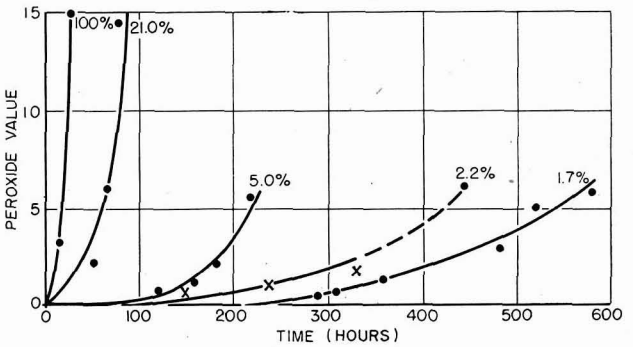

FIG. 1. The development of peroxides of butteroil at 70° in atmospheres of different oxygen concentration.

the rate of autoxidation—reciprocal of the time—is directly proportional to the oxygen concentration.

Autoxidation of the fat in dried milk. The preceding experiment was carried out under conditions wherein an excess amount of gas mixture of the given oxygen concentration was always present in each case. In the case of packed dried milks, conditions are static and the concentrations of oxygen decrease somewhat as the time of storage increases. However, for practical purposes the values of the initial oxygen concentrations are of direct interest and can be used for obtaining an approximation of the change of rate of oxidation with that of oxygen concentration.

An experiment of a type similar to that conducted with milk fat was conducted with a dried milk in which the oxygen content of each container was lowered to desired levels by single and double "gassing" procedures. The final percentage of oxygen concentration in each container was deter-

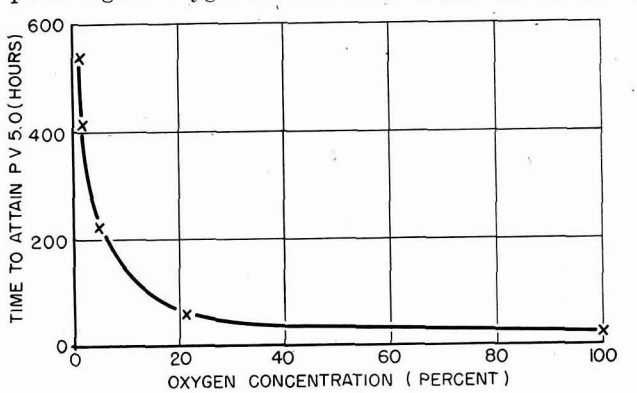

FIG. 2. The time required for the peroxides to reach a value of 5.0 in atmospheres of different oxygen concentration and at 70° C.

mined after 7 days of storage. The samples were stored at 37° C. and the time in days necessary for the production of tallowy flavors and odors was determined.

The dried milk on which these data were obtained was not of good keeping quality but the results serve to indicate the relative effect of different concentrations of oxygen in the packed containers, on the keeping quality.

It should be indicated here that the samples in the atmospheres of higher oxygen concentration were decidedly tallowy, while those in the atmospheres of low oxygen concentration were faintly tallowy, at the period of time indi-

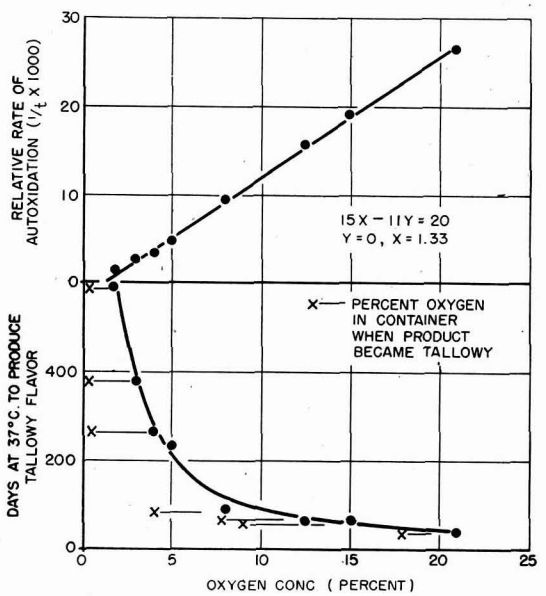

FIG. 3. The time of storage at 37° C. required to produce a tallowy flavor and the relative rate of oxidation of the fat in a dried milk at different oxygen concentration.

cated in figure 3. The samples stored in atmospheres of 1.8 per cent oxygen concentration were not judged tallowy unanimously by the judges, at the end of the period indicated.

The data emphasize the importance of reducing the concentration of oxygen in the atmosphere of the container to less than 5 per cent in order to improve keeping quality greatly. As in the case of the experiment with butteroil, the time required for the production of a tallowy flavor is inversely proportional to the oxygen concentration. In figure 3 are shown also the reciprocals of the time periods required at different oxygen concentrations to produce a tallowy flavor. The rate of oxidation varies directly with the oxygen concentration.

However, as stated, the sample used was not of good keeping quality and more data on dried milk of all grades of keeping quality are being obtained to determine precisely the rate of spoilage in atmospheres of different oxygen concentration and to determine if these rates of autoxidation are the same for products of good and poor keeping quality.

In this connection is should be pointed out that, while theoretically the keeping quality should be infinite at zero oxygen concentration, actually it may become infinite at some low finite value of the oxygen concentration.

In the case of pure milk fat this value is approximately 0.80 per cent of oxygen by volume. To ascertain the concentration of oxygen of the atmosphere of a dried milk container which would be equivalent to this ratio, it is necessary to know the density of the dried milk and the volume of the container. The density of the dried milk was determined by evacuating thoroughly a vessel containing a known weight of dried milk and determining the amount of helium necessary to displace the air. The volume of the container was determined to the nearest milliliter. The density of the dried milk was found to be 1.29 and the volume of a 1-pound dried milk container 840 ml. The actual space occupied by the dried milk was therefore 453/1.29 or 351 ml., and the unoccupied space was 840–351 or 489 ml. The amount of fat in a pound of dried milk is approximately 118 grams, or 128 ml., and the minimal amount of oxygen necessary to produce tallowiness in this fat is 128×0.008, or 1 ml. On the basis of the unoccupied space in the container, this is equivalent to approximately 0.20 per cent.

It has been found difficult and commercially impractical to reduce the oxygen concentration of the atmosphere of dried milk containers to a concentration of 0.20 per cent. Previously published data as well as those presented here indicate that it is not necessary to attain an oxygen concentration of this value in order to increase greatly the keeping quality of the product. The present data indicate also that in the case of dried milk the amount of available oxygen can be greater than 0.20 per cent of the atmosphere of the container and yet prevent entirely the development of a tallowy flavor, presumably since the skim milk solids absorb some of the oxygen. For the dried milk on which data are given in figure 3, the value can be as high as 1.33 per cent. The value will no doubt vary with different dried milks, its magnitude depending on the rate with which the fat oxidizes and the rate and extent to which the skim milk solids absorb oxygen.

With initial concentration of oxygen greater than 1.33 per cent in the atmosphere of the container of dried milk, the rate of spoilage through oxidation varied directly with the oxygen concentration.

SUMMARY

Data have been presented which indicate that autoxidation of milk fat with 0.80 per cent by volume of oxygen is sufficient to render it inedible.

In the atmosphere of a container of dried milk this is equivalent to 0.20 per cent of oxygen. This level of oxygen concentration is difficult to attain even by "regassing" procedures. However, studies of the relative keeping quality of samples of milk fat and samples of a dried milk in atmospheres of different oxygen concentration indicate that the keeping quality increases markedly with decreases in the oxygen concentration below 5 per cent. The relationship of keeping quality in days to the initial oxygen concentration of the container atmosphere in per cent seems to be of a reciprocal nature, that is, the time required to produce tallowy flavors in packed dried milks or to reach a given peroxide value of pure milk fat, and the oxygen concentration used, are inversely proportional to one another.

The data presented seem to indicate that the rate of autoxidation of milk fat varies directly with the oxygen concentration.

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STUDIES ON KETOSIS IN DAIRY CATTLE. VIII. SPONTANEOUS RECOVERY

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In the course of investigations in this laboratory it has been observed that many cows recover from ketosis without treatment and often without any detectable change in feeding or management. If these observations are representative of other areas it is obvious that considerable caution must be exercised in attempting to evaluate the efficacy of any substance in the treatment of ketosis.

EXPERIMENTAL

The data for this report are taken from numerous records on field cases of ketosis in which the animals have recovered without treatment. Blood acetone bodies were determined by the method of Barnes and Wick (1). The method used for glucose was that of Shaffer and Somogyi (2) as modified by Somogyi (4, 5).

TABLE 1

Spontaneous recovery from ketosis (D.E. 151)

Days	Blood glucose	Blood acetone bodies (as acetone)	Comments
	mg.%	*mg.%*	
1	.....	.....	Parturition
10	.....	.....	Inappetence
16	24.4	56.34	Inappetence, decreased milk production
17	31.6	61.10	Improved appetite
19	38.7	46.31	Improved appetite
21	33.2	49.88	Inappetence
22	.....	.....	Improved appetite
23	48.6	20.92	Improved appetite
27	42.5	5.14	Normal appearance

Cow D.E. 151 (table 1) exhibited inappetence for approximately a week before the first blood sample was drawn, refusing all grain and eating hay sparingly. Although this animal was not treated for ketosis and environmental conditions were not altered, recovery took place within a period of 11 days as shown by the return to normal of both the blood glucose and acetone bodies. The increase in blood glucose was paralleled by an increase in food consumption.

Cow D.E. 173 (table 2) exhibited inappetence 31 days after parturition. On the basis of previous work (3) in which the blood picture was followed during the development of ketosis, it can be assumed from the marked hypo-

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TABLE 2

Spontaneous recovery from ketosis (D.E. 173)

Days	Blood glucose	Blood acetone bodies (as acetone)	Comments
	mg.%	*mg.%*	
1	.....	.....	Parturition
31	.....	.....	Inappetence
34	15.4	69.32	Inappetence
43	32.8	35.79	Improved appetite
44	28.9	20.82	Improved appetite
46	32.3	17.54	Improved appetite
48	46.1	3.88	Normal appearance

glycemia and ketonemia at this time that the condition had been developing for some time prior to the drawing of the first blood sample. Plans had been made to treat the cow on the following day but treatment was postponed due to unavoidable circumstances. Nine days later when the second blood sample was drawn, the cow had improved so much that treatment was again postponed. Recovery took place within 18 days of the drawing of the initial sample as shown by both the blood glucose and blood acetone bodies and by the improvement in the appearance of the animal at that time.

Cow D.E. 168 developed symptoms of ketosis 17 days after parturition at which time the sodium-nitroprusside test on urine indicated ketosis. A blood sample was not taken until two days later when the cow had already shown considerable improvement. As noted in table 3, recovery was rapid, both the blood picture and the appearance of the animal returning to normal within five days. The increase in blood glucose from 34.1 to 60.8 mg. per cent within 24 hours, followed by a decrease to a normal level of 45.9 mg. per cent one day later, is of considerable interest and has been observed in a number of cases.

Cow D.E. 195 (table 4) had exhibited symptoms of ketosis for several days before the first blood sample was drawn. The appetite of this cow had shown considerable improvement on the day the initial blood sample was taken. It is apparent from the blood picture that the cow was recovering rapidly at this time. The blood glucose was almost normal but the rela-

TABLE 3

Spontaneous recovery from ketosis (D.E. 168)

Days	Blood glucose	Blood acetone bodies (as acetone)	Comments
	mg.%	*mg.%*	
1	.....	.....	Parturition
17	.....	.....	Inappetence, urine qualitative 4+
19	34.1	28.92	Improved appetite
20	60.8	10.04	Improved appetite
21	45.9	4.30	Normal appearance

TABLE 4

Spontaneous recovery from ketosis

Cow	Days	Blood glucose	Blood acetone bodies (as acetone)	Comments
		mg.%	*mg.%*	
D.E. 195	1	.....	.....	Parturition
	20	.....	.....	Inappetence
	23	.....	.....	Inappetence, urine qualitative 4+
	24	43.2	35.50	Improved appetite
	25	55.6	21.30	Improved appetite
	26	51.3	3.92	Improved appetite
D.E. 257	1	.....	.....	Parturition
	10	25.7	17.96	Milk off flavor, cow on low plane of nutrition, grain increased
	12	42.9	6.20	.....

tively high blood acetone bodies indicated that the glucose had been much lower a few hours previously. As was observed in the case of D.E. 168, the hypoglycemia was over corrected for a short period followed by a decrease towards a normal level within 24 hours. The cow had not received any treatment.

Data on an interesting case of ketosis due at least in part to inanition are also given in table 4. Cow D.E. 257 had exhibited ketosis the previous year. The blood glucose level at that time was 18.98 mg. per cent and the blood acetone bodies 55.24 mg. per cent. The owner detected the same off flavor in the milk as had been observed the previous year and suspected the cow had developed ketosis. The animal did not exhibit any symptoms of ketosis although the blood glucose was 25.7 mg. per cent and the blood acetone bodies 17.96 mg. per cent. The cow had been underfed purposely in an attempt to hold down milk production but was producing 30 pounds of five per cent milk at that time. Concentrate feeding was immediately increased from three to fifteen pounds per day. As will be noted in table 4 the blood glucose and acetone bodies were almost normal within two days.

TABLE 5

Spontaneous recovery from ketosis (D.E. 77)

Days	Blood glucose	Milk production	Comments
	mg.%	*lbs.*	
1	.....	.....	Parturition, cow exhibited symptoms of ketosis for 34 days
34	19.5	55.3	Inappetence, lethargy
36	18.2	52.3	Inappetence, lethargy
37	20.0	51.7	Inappetence, lethargy
43	22.4	69.8	Improved appetite
47	35.0	70.7	Improved appetite
50	40.2	77.8	Improved appetite

Data are given on Cow D.E. 77 because this case is typical of many that recovered suddenly after exhibiting ketosis for some period of time. This particular animal was used for various studies including liver glycogen, insulin sensitivity and glucose tolerance tests. No treatment had been given since the thirtieth day after parturition. There was little improvement in either blood glucose or milk production from the thirty-fourth to the thirty-seventh day after parturition. A gradual improvement then took place in both. Within 13 days the blood glucose increased from 20.0 to 40.2 mg. per cent and milk production increased from 51.7 to 77.8 pounds.

DISCUSSION

Probably the majority of cows with ketosis would recover without treatment, a few quickly and many more over a longer period of time. The fact that many do recover without treatment or following treatment with substances which were later proved to be completely ineffective, emphasizes the need of caution in evaluating the results of investigations of the therapeutic value of various substances in the treatment of ketosis. To be conclusive the case should be severe and the response should be prompt. Numerous cases are highly desirable and the percentage of cases responding following treatment should be high. So far a readily available form of carbohydrate is the only substance which has been found to elicit such a response. However, ketosis could not be prevented by feeding readily available carbohydrate during the period immediately preceding parturition (3). Since ketosis began to develop within one to three days following parturition in the cases studied (3), it is difficult to subscribe to the theory that the condition is caused by a lack of soluble carbohydrate in the diet.

On the other hand, it is entirely possible that many of the milder cases of ketosis are merely cases of fasting ketosis due to an insufficient energy intake as was the case with D.E. 257 (table 4). Any deficiency which results in an impairment of appetite may be expected to produce some degree of fasting ketosis, particularly during the period immediately following parturition when the energy requirement is high. As yet, however, no deficiency other than that of a deficiency of energy in the form of carbohydrate has been proved to be responsible for the development of ketosis in cattle under farm conditions.

The reason for the spontaneous recovery which has been observed from time to time is not clear. In some cases it appeared that recovery may have been due, at least in part, to a marked decrease in milk production as recovery has been noted after milk production had decreased to a low level. In those cases where there is danger of losing the animal, cessation of milking in order to decrease the energy requirements should be helpful.

CONCLUSIONS

Data are presented on several cases of ketosis in which the cows recovered without treatment. It is emphasized that since cows do recover spontane-

ously, caution must be exercised in evaluating the efficacy of various substances in the treatment of ketosis in dairy cattle.

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RELATION OF CORN AND ALFALFA SILAGE TO THE QUALITY OF CHEESE AND ITS CAROTENE AND VITAMIN A CONTENT*

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INTRODUCTION

There seems to be a general belief among cheese makers that the use of grass (alfalfa) silage for producing cheese milk is undesirable. This is particularly true with respect to Swiss cheese where certain bacteria that may be associated with silage are blamed for low quality in the product (1, 4, 5, 6, 7, 9). An opportunity to investigate the quality of cheese as related to type of silage arose during experiments on the effect of feeding corn and alfalfa silages upon the vitamins of winter milk (8). Several lots of cheddar cheese were made from these milks during January and February of 1944, and after suitable periods of curing were sampled and graded as to quality and analyzed for carotene and vitamin A. Before the analyses could be made a satisfactory procedure for the chemical determination of carotene and vitamin A had to be developed.

EXPERIMENTAL SILAGES AND MILKS

The alfalfa silage was made with 200 pounds of corn and cob meal per ton added to the forage as it was run through the silage cutter. The alfalfa was of good quality and contained about 22 per cent dry matter at the time of ensiling. When fed during the months of November to February inclusive, the silage averaged 245 μg. carotene per gram dry matter.

Hybrid corn was used for the making of the corn silage. It was quite green and succulent and averaged about 22.5 per cent dry matter. The silage when fed averaged 72 μg. of carotene per gram of dry matter.

The milks used for the experimental cheese were obtained from three lots of cows of five animals each. The animals were selected so that the period of lactation and butterfat production would be approximately equal for each lot. All animals were fed grain and hay and in addition Lot I was given corn silage as the silage part of the ration, Lot II received both corn silage and alfalfa silage, and Lot III was given only alfalfa silage.

The amount of carotene ingested by the animals in the three lots varied according to their rations. Lot I received approximately 400 mg. per cow

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TABLE 1

Feed and milk data

Items	Lot I	Lot II	Lot III
	Ration		
	lbs./day	*lbs./day*	*lbs./day*
Grain	8.5	8.7	8.7
Hay	14.0	14.0	14.0
Alfalfa silage	.....	20.2	40.8
Corn silage	40.3	20.2	.....
	Carotene ingested		
	mg./day	*mg./day*	*mg./day*
From silage	289	659	1039
From hay	125	125	125
	Milk production, 4% fat basis		
	lbs.	*lbs.*	*lbs.*
Total for period	10,780	10,512	10,250
Ave./cow/day	25.67	25.02	24.41
	Carotene and vitamin A content of milk		
	μg./gm. of butterfat	*μg./gm. of butterfat*	*μg./gm. of butterfat*
Carotene, ave.	4.58	5.39	5.74
Vitamin A, ave.	5.56	5.89	6.94

per day, Lot II received about 800 mg. per cow per day and Lot III received about 1200 mg. per cow per day. As would be expected, high carotene ingestion was reflected in the carotene and vitamin A content of the milks, but the correlation was not directly proportional.

Milk production on a 4 per cent fat-corrected basis showed no practical difference among the three lots of cows.

The data on the composition of the ration, the amount of carotene ingested by each cow per day, the milk production on a fat-corrected basis, and the carotene and vitamin A content of the milk-fat produced are presented for each lot in table 1.

EXPERIMENTAL CHEDDAR CHEESE

Preparation and grade. Experimental cheese was made from each of the three lots of raw milk on eight occasions during January and February of

TABLE 2

Average scores of cheese at three months

Lot	Silage	Flavor	Body and texture	Color and finish	Total
I	Corn silage	37.5	28.0	24.9	90.4
II	Corn and alfalfa	37.9	28.4	24.9	91.2
III	Alfalfa silage	38.0	28.3	25.0	91.3

1944. After a three months' curing, the cheeses were scored by members of the Dairy Industry Department. The results showed practically no difference in quality among the three lots of cheese. There did seem to be a slight margin in favor of the alfalfa silage lot. The scores based on flavor, body, texture, color, and finish were as follows: 90.4, 91.2 and 91.3, for Lots I, II, and III, respectively. Complete data are given in table 2.

METHOD FOR THE DETERMINATION OF CAROTENE AND VITAMIN A IN CHEESE

The method used for butter by Berl and Peterson (2) was modified to make it suitable for the analysis of cheese. Calibration curves were constructed for both carotene and vitamin A by means of standards as described in their paper. It has been found desirable in our experience for each analyst to standardize his own curve in order to avoid personal variations. Only a brief statement covering the essential points in the procedure will be given. For details see the original paper.

A 10-gm. sample is minced and saponified in a methanol-potassium hydroxide solution. After cooling and diluting with water, the nonsaponifiable matter is extracted with several portions of ether. The extract is washed with water and dried over sodium sulfate. The ether is removed over a water bath under reduced pressure, replaced with Skelly-Solve B and the extract is made up to 50 ml. in a volumetric flask. A 25-ml. aliquot is extracted three times with 10-ml. portions of 94 per cent diacetone to remove noncarotene pigments, the residue is washed with water, made up to 25 ml. in a volumetric flask and read for carotene in the Evelyn colorimeter, at

TABLE 3

Check on analytical method by means of added carotene and vitamin A

Type of cheese	Carotene or vitamin A per 10 gm. sample	Carotene or vitamin A added	Carotene or vitamin A found	Recovery
	Carotene			
	μg.	μg.	μg.	%
Brick	12.2	9.4	20.7	96
Cheddar	14.3	9.4	22.9	96
Cheddar	17.0	28.2	42.0	93
Swiss	16.8	19.3	33.5	93
Swiss	18.8	19.0	36.0	95
	Vitamin A			
	μg.	μg.	μg.	%
Brick	19.5	12.6	30.6	95
Cheddar	27.4	12.6	38.1	95
Cheddar	30.2	28.0	56.2	96
Cheddar	19.8	5.2	25.2	101
Swiss	31.5	35.1	62.5	94

440 mμ. For the determination of vitamin A a 5-ml. aliquot of the original extract is placed in a colorimeter tube, evaporated under reduced pressure and the residue redissolved in 1 ml. of chloroform. This is treated as usual with the antimony trichloride reagent and the resultant blue color is read at 620 mμ.

The method was found to give approximately 95 per cent recoveries of amounts of both carotene and vitamin A added to the cheese prior to saponification. Data are given in table 3.

TABLE 4

Distribution of carotene and vitamin A in cheese-making

Date	Lot	Milk			Cheese			Whey			Recovery in products	
		Lbs.	Carotene	Vitamin A	Lbs.	Carotene	Vitamin A	Lbs.	Carotene	Vitamin A	Carotene	Vitamin A
			μg/lb.*			μg./lb.			μg./lb.		%	%
1/ 6/44	I	63	78	96	7.0	635	784	56.9	8.1	9.1	100	99
	II	63	94	98	6.7	780	815	55.9	9.3	8.6	97	98
	III	63	76	111	6.2	717	1020	56.4	8.9	7.7	103	96
1/12/44	I	54	84	112	5.9	690	920	48.1	6.1	9.5	96	97
	II	54	92	122	5.7	648	960	47.6	7.3	9.1	81	90
	III	54	81	122	5.4	658	938	48.5	6.3	7.2	87	82
1/18/44	I	52	82	99	5.7	630	788	45.4	6.0	6.8	91	93
	II	52	95	119	5.6	753	734	45.8	8.8	6.8	93	72
	III	52	97	99	5.2	708	1020	45.7	9.2	9.9	81	110
1/26/44	I	52	77	104	5.2	644	914	45.9	8.2	9.1	98	95
	II	52	87	109	5.4	671	806	45.9	6.8	8.1	87	84
	III	52	76	100	5.2	558	752	46.3	6.0	7.2	80	81
2/ 2/44	I	52	67	104	5.5	626	882	45.7	4.5	7.7	104	96
	II	52	91	120	5.5	694	960	45.7	5.6	8.1	86	90
	III	52	90	113	5.2	716	1180	46.6	6.4	7.2	86	110
2/ 3/44	I	52	(67)	(104)	5.4	544	828	46.7	5.2	7.7	91	96
	II	52	(91)	(120)	5.5	694	906	45.7	6.4	8.6	86	86
	III	52	(90)	(113)	5.2	704	978	46.6	6.0	6.8	84	92
2/ 9/44	I	52	69	97	5.5	640	828	46.4	6.4	11.3	106	100
	II	52	83	110	5.4	716	928	46.8	8.9	11.7	99	97
	III	52	85	123	4.9	685	1040	44.8	7.6	9.5	84	86
2/10/44	I	52	(69)	(97)	5.3	566	834	46.0	5.3	9.0	90	96
	II	52	(83)	(110)	5.2	680	840	45.6	8.1	10.4	90	95
	III	52	(85)	(123)	5.0	694	1060	45.2	8.4	8.2	86	89

* Figures in parentheses are those for the day immediately preceding as analyses were run on only the first of the two consecutive days.

DISTRIBUTION OF CAROTENE AND VITAMIN A IN CHEESE MAKING

The carotene and vitamin A contents were determined on the milk, cheese and the whey. The procedure for milk and whey was by the method of Dornbush, Peterson and Olson (3). The distribution of vitamin A potency of milk in cheese making was shown to be as follows: 85 per cent was retained in the cheese, 7 per cent accompanied the whey and 8 per cent was unaccounted for. These figures apply to both carotene and vitamin A.

Losses probably occurred in the adherence of milk fat on containers and equipment during processing. The three lots of milk gave cheese of increased vitamin A potency in the order Lot I, Lot II and Lot III. It was evident that alfalfa silage was superior to the corn silage or the corn silage–alfalfa silage mixture. Data are given in table 4.

Effect of storage. After the original analysis made immediately upon production, repeated analyses were made of the cheeses at intervals of 8 weeks, 12 weeks and 42 weeks. The carotene content of the samples ranged from 1.20–1.57 μg./gm. for Lot I, 1.43–1.79 μg./gm. for Lot II, and 1.45–1.79 μg./gm. for Lot III. The vitamin A content ranged from 1.68–2.05 μg./gm., 1.62–2.20 μg./gm., and 1.66–2.53 μg./gm. for Lots I, II, and III, respectively. Data are given in table 5.

TABLE 5

Changes in carotene and vitamin A content of cheese in storage

Lot No.	Carotene content after				Vitamin A content after			
	0 weeks	8 weeks	12 weeks	42 weeks	0 weeks	8 weeks	12 weeks	42 weeks
		μg./gm.				μg./gm.		
I	1.37	1.36	1.40	1.44	1.87	1.86	1.86	1.85
II	1.55	1.66	1.67	1.72	1.98	1.98	1.98	1.97
III	1.50	1.62	1.63	1.67	2.21	2.24	2.28	2.26

Each value represents the average of 8 samples.

No significant change in vitamin A potency occurred during nearly a year in storage. The carotene content showed a slight increase while the vitamin A content was quite constant. As possible explanations for the apparent increase in carotene content several factors such as drying of the cheese, a change in the characteristics of certain of the noncarotene pigments, etc., may be considered, but the effect was too small to warrant extended investigation.

SUMMARY

Eight lots of cheese made from three types of silage milk were studied with respect to quality and vitamin A potency.

Cheese made from milk produced on an alfalfa silage ration equalled or excelled in quality and vitamin A potency, cheese made from milk produced on a corn silage ration.

A method for the determination of carotene and vitamin A in the cheese was devised.

The distribution of vitamin A potency in cheese-making was shown to be as follows: 85 per cent was retained in the cheese, 7 per cent was found in the whey and 8 per cent remained unaccounted for. A pound of milk, which contained on the average 83 μg. of carotene and 109 μg. of vitamin A, gave cheese containing 69 μg. of carotene and 93 μg. of vitamin A. The whey

accounted for 6.5 μg. of carotene and 7.5 μg. of vitamin A; thus leaving about 7.5 μg. of carotene and 8.5 μg. of vitamin A unaccounted for.

The vitamin A potency of cheese during curing and storage was practically unchanged over almost a year.

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Credit is due J. J. Stefaniak for making the carotene and vitamin A analyses of the milks reported in table 4.

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THE VITAMIN CONTENT OF MARE'S MILK*

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According to Associates of Rogers (1), mare's milk is commonly used as a food in some sections of Western Asia. It is not used for human food in this country, but one may very properly consider the feasibility of using mare's milk for infant feeding, since its composition resembles that of human milk more nearly than cow's or goat's milk, which is commonly used for infant feeding. This is particularly true with respect to milk sugar. According to Gardner and Fox (6), and Brown and co-workers (3), human milk contains 7.38 per cent and 6.79 per cent of lactose, respectively, while Linton (18) and Hildebrandt (8), respectively, report mare's milk contains 6.14 per cent and 6.42 per cent. Furthermore, Turner (29) found that mare's milk is digested (in vitro) more readily than either cow's or goat's milk. However, at the moment far more interest is centered upon the nutritive value of mare's milk for raising foals. The observation at Massachusetts Agricultural Experiment Station that the body weight of Percheron foals when they are weaned varied from 685 to 830 pounds, naturally raised a question concerning whether the variability in weight results primarily from differences in the milk-producing capacity of the mares or in the quality of the milk. A review of the available literature produced relatively little information concerning the vitamin content of mare's milk. Furthermore, one should not attempt to estimate the vitamin content of mare's milk from data concerning cow's milk even when, as at Massachusetts Agricultural Experiment Station, the mares and cows feed in the same pasture and on hay grown in the same or similar fields, for cows are ruminants and mares are nonruminants. Wegner, Booth, Elvehjem, and Hart (31), Hunt, Kick, Burroughs, Bethke, Schalk, and Gerlaugh (15) and others have shown that cattle can synthesize riboflavin in the rumen. Furthermore, Bechdel, Honeywell, Dutcher, and Knutsen (2) found that the microflora of the rumen enabled cows fed a vitamin B deficient ration to produce milk of normal vitamin B content. Also McElroy and Goss (19) found appreciable amounts of thiamine in the milk of a fistulated cow whose rumen contained no thiamine; but mares do not have a rumen in which to synthesize vitamins. In view of the paucity of data, this study was conducted to accumulate additional information regarding the vitamin content of mare's milk.

DESCRIPTION OF MARES

At the time the study was undertaken, only three Percheron brood mares,

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Bay State Laurette, Bay State Laura and Bay State Lady Lou were available as a source of milk.

Data concerning the age, weight, and breeding records of the mares in question are reported in table 1.

It will be noted that the body weight of Laura and Lady Lou are somewhat greater than that of Laurette, but this was to be anticipated since the latter worked regularly, often in the hot sunshine, sweating profusely while the other two were idle in a cool barn. The stage of lactation reported in table 1 pertains to the beginning of the experiment. When comparing the results of this study, it should be remembered that Laura is the mother of Laurette, and that Lady Lou and Laurette are half-sisters of the same age. During the period of this experiment, the mares and foals were main-

TABLE 1

Data concerning some of the physical and physiological aspects of the mares studied

Name	Breed	Age	Weight	No. of foal	Stage of lactation	Bred	Activity
		yrs.	*lbs.*		*mo.*		
Bay State Laurette	Percheron	7	1640	First	3	No	Works constantly
Bay State Laura	"	14	1800	Tenth	2	Yes*	Worked before foaling, idle since
Bay State Lady Lou	"	7	1900	Fourth	4	Yes*	Idle entire life
Dutchess	Saddle pony	9	1040	?	1.5	No	Ridden every day

* No recurrence of oestrus.

tained on a good pasture during the nights and were fed grain and hay in the barn during the day. Each mare received 3–4 quarts of crushed oats and 5 or 6 large ears of thoroughly matured, dry corn daily.

COLLECTION OF MILK

A pint or more of milk was required for the various assays. Hence it was necessary to separate the foals from the mares for an hour or more previous to collecting the sample. Since some of the assays were to be made by microbiological procedures, it seemed preferable to keep the bacterial content of the milk as low as possible. Accordingly, the milk was drawn directly into one-half-pint, sterilized milk bottles which were immediately capped.

It was of course recognized that the composition of the milk would not be truly typical for the animal in question unless the entire volume of milk was removed from the udder and thoroughly mixed before sampling, but since the foals were nursing, that procedure could not be followed, and only

enough milk was drawn for assay purposes. Thus all samples of milk from the Percheron mares represented the fore-milk. It was drawn just prior to or, in case the mare refused to "give down her milk," simultaneously with the foals nursing.

The freshly drawn mare's milk was very white with a slightly bluish tinge and thus its appearance was more like human milk or cow's skimmed milk than normal cow's or goat's milk. When the milk was drawn from the mare's udder or was subsequently poured from bottle to bottle, it foamed excessively due probably to a higher albumin content than is characteristic of cow's milk. The mare's milk had a sweetish taste, which perhaps might have been anticipated from its high lactose content.

During the progress of the study, a privately owned saddle mare, Dutchess, lost her 6-week-old foal by tetanus (lockjaw). It was necessary to milk the mare while terminating lactation. Assays were made of her milk, which was always cream-colored, but the results should be considered as applying to abnormal milk, since the intervals between drawing the milk increased and the volume of milk decreased. Samples 2 and 3 were obtained from the same milking. Sample 2 is representative of one pint of fore-milk and sample 3 represents one and one-half quarts of the last milk drawn. Likewise sample 4 represents the fore-milk and sample 5 the last portion of the milk drawn 72 hours after samples 2 and 3. Sample 6 was drawn the following day (24 hours later) and was representative of all the milk obtained. Sample 7, which was drawn more than two days (52 hours) later, was deep cream color and was representative of the one pint of milk, which was the total quantity that could be obtained.

EXPERIMENTAL

The milk was taken directly to the laboratory and assayed for ascorbic, nicotinic and pantothenic acids, riboflavin, thiamine, bacteria, fat, size of fat globules, and total solids. The bacterial and ascorbic acid assays were started within approximately 15 minutes after the milk was drawn from the mares. The remaining assays were started within the next hour. The reduced ascorbic acid was assayed by Sharp's (26) rapid method. The microbiological method of Krehl, Strong, and Elvehjem (16) was employed for determining the amount of nicotinic acid. The Neal and Strong (21) microbiological method was used for pantothenic acid. Riboflavin was assayed by the Holmes and Jones (12) method and thiamine by a modification of the Hennessy and Cerecedo (7) procedure. The number of bacteria was estimated in accordance with "Standard Methods for the Examination of Dairy Products" (28), and fat was determined by the Babcock (17) method, modified to the extent that only 15 cc. of acid were used. The size of the fat globules was measured by an adaptation of the hanging drop procedure, and the Mojonnier and Troy (20) method was followed for determining the total solids.

RESULTS

Forty samples of milk from 3 Percheron mares and a saddle pony, were assayed for ascorbic acid, riboflavin, bacteria, fat, size of fat globules, and total solids. Nearly all the samples were assayed for nicotinic acid and thiamine, but only three samples were assayed for pantothenic acid. The results of these assays are reported in detail in table 2. For convenience, these results are discussed under the appropriate headings.

Ascorbic acid. The ascorbic acid content of the individual samples of milk from each mare varied. The average values were 13.7 for Laurette, 12.2 for Laura, and 12.7 mg. per liter for Lady Lou. Judged by these values, the milk of Percheron brood mares contained only about two-thirds as much reduced ascorbic acid as that previously reported (11) for cows which consumed forage produced on the same land and under essentially the same conditions as the hay and grass consumed by the mares. However, Sigrist (27) claims that the vitamin C content of mare's milk is not dependent upon the age or the type of ration but varies with individual animals.

Nicotinic acid. The nicotinic acid content of normal milk varied from 0.53 mg. for sample 7 from Laurette to 0.83 mg. per liter for sample 8 from Laura. The average values were 0.67 mg. for Laurette, 0.77 mg. for Laura and 0.72 mg. per liter for Lady Lou. The amount of nicotinic acid in the milk from Dutchess varied from 0.53 mg. to 0.94 mg. with an average of 0.72 mg. per liter, but, as mentioned before, this milk was obtained during the cessation of lactation. These values are somewhat lower than 1.1 mg. per liter obtained for milk (9) from the college herd of cows during the late summer.

Pantothenic acid. Due to unforeseen developments, it was possible to assay only three samples of mare's milk for pantothenic, namely sample 1 from each of the three Percheron mares. The values obtained were 3.47 mg. for Laurette, 2.55 mg. for Laura and 2.28 mg. per liter of milk from Lady Lou. These data are too meager to permit any general conclusions concerning the pantothenic acid content of mare's milk, but it is of interest to note that the average value, i.e., 2.77 mg. per liter, is somewhat lower than 3.66 mg. per liter previously reported (10) for the milk from the college herd of cows.

Riboflavin. The riboflavin content of the milk from the Percheron brood mares was quite variable. The average values obtained were 0.11 mg. for Laurette, 0.13 mg. for Laura, and 0.09 mg. per liter for Lady Lou. These values are less than one-tenth that obtained for cow's milk previously studied (13) in this laboratory. However, they are in agreement with the findings of Rasmussen, Bogart, and Maynard (24), who state that limited studies by the fluorometric method indicated that the lactoflavin content of mare's milk is very low. Later, Rasmussen (25) reported that the riboflavin content of mare's milk was about one-tenth the amount found in cow's milk.

TABLE 2

Results of assays of mare's milk

Sample No.	Ascorbic acid	Nicotinic acid	Riboflavin	Thiamine	Bacteria	Fat	Size of fat globules	Total solids
			Bay State Laurette					
	mg./l.	*mg./l.*	*mg./l.*	*mg./l.*	*per cc.*	%	μ	%
1	14.5	.....	0.08	.....	150	0.6	3.0	9.73
2	6.5	.....	0.07	.....	420	0.7	3.0	9.87
3	13.5	0.75	0.09	0.45	1340	1.3	3.0	10.34
4	10.0	0.64	0.08	0.52	500	0.8	3.0	10.12
5	17.5	0.56	0.11	0.49	990	0.4	3.0	9.84
6	16.5	0.58	0.11	.....	880	1.8	4.0	10.80
7	14.5	0.53	0.14	.....	550	1.3	3.0	9.86
8	16.5	0.62	0.12	0.44	150	1.0	4.0	9.76
9	14.5	0.81	0.13	0.42	260	1.1	2.5	10.17
10	14.0	0.73	0.17	0.46	810	1.1	3.0	10.02
11	12.5	0.81	0.15	0.41	60	0.8	3.0	10.11
Average	13.7	0.67	0.11	0.46	555	1.0	3.1	10.06
			Bay State Laura					
1	11.5	.....	0.05	.....	60	0.8	4.0	9.67
2	12.0	.....	0.11	.....	950	1.3	4.0	10.41
3	10.5	0.80	.....	0.32	630	0.7	4.0	9.63
4	11.0	0.81	0.07	0.46	130	1.5	4.0	10.40
5	15.0	0.81	0.15	0.46	170	0.8	4.0	10.08
6	17.0	0.75	0.09	.....	160	1.3	3.5	10.41
7	13.5	0.66	0.16	.....	410	1.5	3.0	10.25
8	10.5	0.83	0.20	0.42	190	1.8	3.0	10.57
9	10.0	0.77	0.15	0.38	340	0.8	3.0	9.88
10	12.0	0.80	0.15	0.42	140	1.1	3.0	10.13
11	11.5	0.72	0.19	0.38	130	1.0	3.0	10.22
Average	12.2	0.77	0.13	0.41	301	1.1	3.5	10.15
			Bay State Lady Lou					
1	15.5	.....	0.06	.....	80	1.6	2.5	10.41
2	9.0	.....	0.07	.....	610	1.8	3.5	10.88
3	10.0	0.75	0.07	0.40	230	1.9	4.0	10.87
4	10.5	0.68	0.07	0.33	510	1.1	3.5	9.96
5	15.5	0.81	0.09	0.34	380	1.2	4.0	10.28
6	20.0	0.65	0.09	.....	310	2.5	4.0	11.21
7	13.0	0.68	0.12	.....	210	1.5	3.5	10.25
8	15.5	0.67	0.08	0.25	20	2.5	4.0	10.63
9	10.0	0.71	0.14	0.30	270	1.0	3.0	9.74
10	12.5	0.77	0.13	0.30	50	1.8	4.0	10.34
11	8.5	0.76	0.09	0.28	170	0.9	3.5	9.84
Average	12.7	0.72	0.09	0.31	258	1.6	3.6	10.40
			Dutchess					
1	15.0*	0.65	0.15	.....	.....	6.5	5.0	13.74
2	16.5	0.53	0.22	.....	30	0.4	2.0	8.42
3	10.5	0.53	0.28	.....	.....	1.6	7.0	9.20
4	22.0	0.80	0.36	0.24	900	2.5	3.0	9.29
5	23.5	0.93	0.36	0.25	200	9.5	9.0	17.49
6	16.0	0.69	0.26	0.24	900	1.5	4.0	10.47
7	17.0	0.94	0.22	.....	190	7.1	5.0	16.33
Average	17.2	0.72	0.26	0.24	444	4.2	5.0	12.13

* For details regarding samples drawn during the rapid cessation of lactation see page 165.

Thiamine. The average values for seven samples of milk from each of the Percheron mares were: 0.46 mg. for Laurette, 0.41 mg. for Laura, and 0.31 mg. per liter for Lady Lou. Judged by these values for individual animals, mare's milk contained slightly more thiamine than 0.33 mg. per liter which was found in raw, mixed, herd milk (9) produced by Ayrshire, Holstein, Guernsey, and Jersey cows, and slightly less than 0.45 mg. per liter previously reported as an average value for goat's milk (14).

Bacteria. The average number of bacteria in the mare's milk was 550 for Laurette, 300 for Laura and 260 per cc. for Lady Lou. These relatively small numbers of bacteria in freshly drawn mare's milk indicate that it, like cow's milk, is probably sterile or nearly so when drawn by the foal directly from the udder. If this assumption is tenable, one must naturally conclude that if foals synthesize vitamins in the intestinal tract, such synthesis is not initiated by the bacteria present in the mare's milk supplied to the foal.

Fat. The fat content of all the samples of milk from the Percheron mares was extremely low as compared with values reported by Overman, Sanmann, and Wright (22) which ranged from 3.55 per cent for Holstein to 5.19 per cent for Guernsey milk. The average values were 1.0 for Laurette, 1.1 for Laura and 1.6 per cent for Lady Lou. Possibly the low fat content may have been a cause for the very white appearance of the milk. However, it should be noted that the mare's milk used in this study was the fore-milk and Van Slyke (30) and others have shown that during milking the percentage of fat increases and unless the udder is carefully stripped and the total milk thoroughly mixed, the sample will not be truly representative with respect to the fat. In fact, in one instance the fore-milk contained less than one-tenth as much fat as the last portion (stripping). Linton (18) found that the fat content of mare's milk increased with the length of time the foal was separated from the mare. In fact, he claims that if the foal is kept from the mare for several hours, the fat content of the milk will increase to a level higher than is well tolerated by foals and he points out that the empirical procedure of milking out a mare that has been working or otherwise separated for several hours from her foal, has a sound scientific basis.

Size of fat globules. The size of fat globules (table 2) represents the average obtained for each sample. While the variation in size is not as large as that reported for cow's milk fat globules (1), i.e., 0.10 μ to 22.0 μ, the average values 3.1 μ for Laurette, 3.5 μ for Laura and 3.6 μ for Lady Lou are essentially the same as the average size of fat globules in cow's milk; namely, 3.0 μ. They are larger than 2.0 μ reported (1) for goat's fat globules.

Total solids. The total solids in the milk varied somewhat for each animal. The average values were 10.06 for Laurette, 10.15 for Laura and 10.40

per cent for Lady Lou. These values are defintely lower than the value of 12.57 per cent reported by Eckles and Shaw (5) for Shorthorn cow's milk and 12.00 per cent, 12.72 per cent, 14.49 per cent, and 14.70 per cent for milk (22) from Holstein, Ayrshire, Guernsey, and Jersey cows respectively.

Hydrogen ion concentration. The pH values obtained for the forty samples of mare's milk varied for the different animals and also varied from day to day for the same animal. The range was from pH 6.66 to 6.98 with an average of 6.81 for normal milk from the Percheron mares. The milk obtained from the saddle mare during the cessation of lactation had a higher pH reading. The value 6.81 is definitely higher than pH 6.37 previously reported (14) for goat's milk, slightly higher than pH 6.6 computed (1) for cow's milk, but less than 6.97 found by Davidsohn (4) for human milk.

Mare's milk during cessation of lactation. The seven samples of milk obtained from Dutchess during the cessation of lactation differed from the milk produced by the Percheron mares. The average values were ascorbic acid, 17.2; nicotinic acid, 0.72; riboflavin, 0.26; and thiamine, 0.24 mg. per liter, fat, 4.2 per cent; size of fat globules, 5.0 μ and total solids, 12.13 per cent. Of these values, the ascorbic acid, riboflavin, fat, size of fat globules, and total solids were greater than for the milk from the Percheron mares; the nicotinic acid was about the same; but the thiamine content was less than that of the other mares. To what extent these differences were brought about by differences in size, breed, and stage of lactation is not known. The very rapid cessation of lactation may have been a major cause of some of the differences in the composition of the milk, for Palmer and Eckles (23) and others have found that as cows and women approach the end of lactation, the protein and fat content of their milk increases.

SUMMARY

Forty samples of milk were obtained from three Percheron mares during the normal lactation and from a saddle pony during very rapid cessation of lactation. The milk was very white with a bluish tinge, foamed excessively and had a sweetish taste. The average values for mare's milk during normal lactation were as follows: ascorbic acid, 12.9 mg.; nicotinic acid, 0.72 mg.; pantothenic acid (three samples), 2.77 mg.; riboflavin, 0.11 mg.; thiamine, 0.39 mg. per liter; fat, 1.2 per cent; fat globule size, 3.4 μ; total solids, 10.20 per cent. Of these values ascorbic and nicotinic acid, riboflavin, fat, and total solids were lower than the corresponding values for cow's milk, but the thiamine values were higher.

The milk obtained from the saddle pony during the period of rapid cessation of lactation contained more ascorbic acid, riboflavin, fat, and total solids, and had larger fat globules than was found for the other three mares experiencing normal lactation; the amount of thiamine was much less.

The greatest difference in vitamin content between mare's and cow's milk was in riboflavin; the former having only about one-tenth of the latter.

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PROPIONIC ACID, SODIUM PROPIONATE AND CALCIUM PROPIONATE AS INHIBITORS OF MOLD GROWTH. II. STUDIES PERTAINING TO THE ACTIVE AGENT RESPONSIBLE FOR THE INHIBITORY EFFECT OF THE PROPIONATES*

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Recent studies (4, 9, 11) have shown that aqueous solutions of sodium or calcium propionate, when used in treating parchment paper for wrapping prints of butter, were effective in restraining the growth of mold on the butter surface.

Investigators in several branches of biology have been interested in the action of organic acids and their salts on microorganisms and many have sought to determine the active agent responsible for the physiological responses observed. A more detailed review of the literature on this subject has been reported (10). Variations in the concentration of ions and in undissociated molecules of different acids evoking similar responses in organisms studied have been noted (1, 14, 16). Marked differences in inhibitory qualities of different acids at the same pH for several species of molds, bacteria and yeasts have been observed (3, 7, 8, 15). Attempts to depress ionization of organic acids have resulted in increased inhibition of the organisms studied (2, 5, 6, 12, 13). Wynne (17) used thirty representative inorganic and organic acids in a study of their relation to the growth of *Cl. acetobutylicum*. His results indicated that certain lower members of the fatty acid series owed their toxicity primarily to certain critical concentrations of hydrogen ions. However, in the case of the higher members of the series other factors influenced the inhibiting pH.

In short, the growth inhibitory action of organic acids for various organisms has been attributed to each component of the dissociated acid system. From the equation for acid dissociation,

$$Ka = \frac{(H+)\ (A-)}{(HA)},$$

it is apparent that the concentration of unionized acid may be increased by two methods: 1) by increasing the hydrogen ion concentration; 2) by in-

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creasing the anion. In an aqueous solution of sodium propionate or calcium propionate it may be assumed that hydrogen ions, propionate ions, sodium or calcium ions, and undissociated acid exist. Further addition of hydrogen ions or propionate ions to such a system will drive the equilibrium in the direction of increased unionized acid. By rearrangement, the above equation may be written,

$$(HA) = \frac{(S)\ (H+)}{Ka + (H+)}$$

Thus, if the pH and the concentration of total acid (S), *i.e.*, the concentrations of total material containing the acid's main group in the form of ions or ionogens, are known, the concentration of the undissociated acid may be calculated. If any one of the components of the system is solely responsible for inhibition of growth of a particular organism, growth should be inhibited at a specific concentration of that component.

In this report the effect of the various components of the propionic acid dissociation system on the growth of certain molds is described.

EFFECT OF PROPIONIC ACID IN A NUTRIENT MEDIUM ON THE GROWTH OF SEVERAL SPECIES OF MOLDS

Preliminary studies indicated that different molds varied in their resistance to the inhibitory action of the propionates. This was investigated further using several different concentrations of propionic acid in potato dextrose agar medium (4.5 gm. Bacto dehydrated potato-dextrose medium per 100 ml. of solution). This basal medium was used to prepare a series of media in which propionic acid concentrations ranged from 0.006 M to 0.02 M. Prior to the addition of the acid, the medium was adjusted to pH 7.0. After the acid was added, a sample of each medium of the series was back titrated electrometrically to pH 7.0 to check the concentration of propionic acid. Spores from the respective molds were suspended in distilled water. Then 0.05-ml. quantities of these suspensions were placed in Petri dishes. The dishes then were poured in duplicate with each medium. Incubation was at room temperature. Several species of mold were used including *Penicillium intracatum, Alternaria tenuis, Hormodendrum cladosporioides, Stemphylium congestum* and a *Cladosporium species.* Figures 1 and 2 show the appearance of representative plates which illustrate the effect of propionic acid on growth of these molds and the variation in resistance to its inhibitory effect by different molds.

EFFECT OF SODIUM PROPIONATE IN A MEDIUM AT VARIOUS pH LEVELS ON THE GROWTH OF MOLD

Potato-dextrose-agar medium containing two per cent sodium propionate was adjusted to various pH levels, lactic acid being used to make the adjustments. A number of preliminary trials were made using several molds to

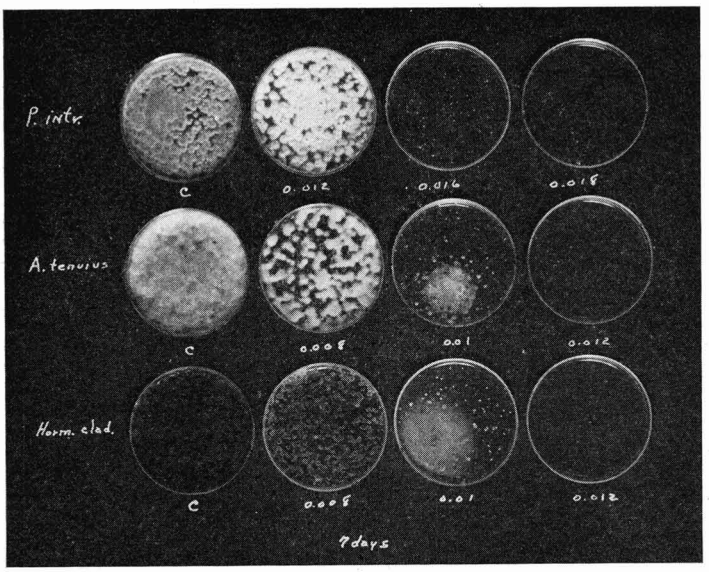

FIG. 1. This photograph shows the appearance of representative plates from Experiment I. Four plates each of *Penicillium intracatum*, *Alternaria tenuis*, and *Hormodendrum cladosporioides* are shown. The plates marked "C" contained no propionic acid.

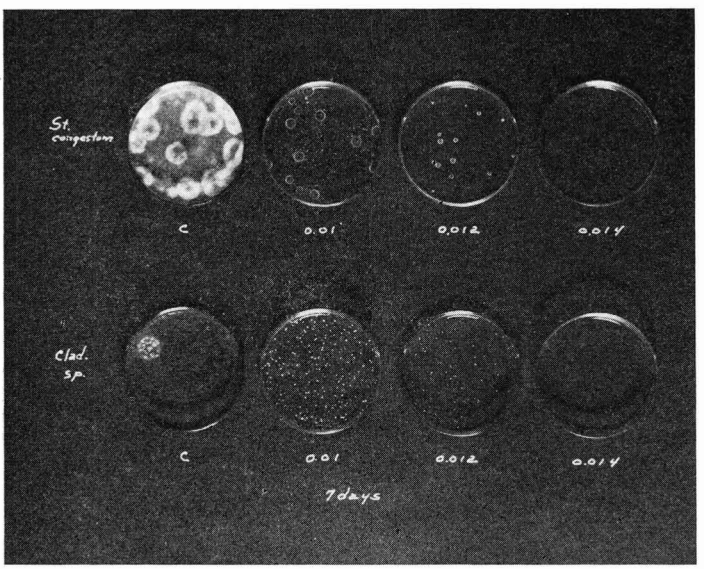

FIG. 2. This photograph shows the appearance of representative plates from Experiment I. Four plates each of *Stemphylium congestum* and *Cladosporium species* are shown. The plates marked "C" contained no propionic acid.

TABLE 1

The effect of reducing the pH of a medium containing two per cent sodium propionate on the growth of mold

Concentration of sodium propionate in potato-dextrose medium	pH of medium	Relative amount of growth of *H. cladosporioides* after 7 days
per cent		
0.0	5.25*	7+
2.0	6.96*	6+
2.0	6.73	5+
2.0	6.63	4+
2.0	6.49	3+
2.0	6.38	2+
2.0	6.27	1+
2.0	6.18	+(−)
2.0	6.11	−
2.0	6.09	−
2.0	5.85	−

Note: Lactic acid used to reduce pH.
* No lactic acid added.

determine the pH range within which a gradual restraint of growth could be demonstrated. In the initial trial, abundant growth was obtained in the control medium (no propionate added) and in the medium containing two per cent sodium propionate without any addition of lactic acid. The pH of

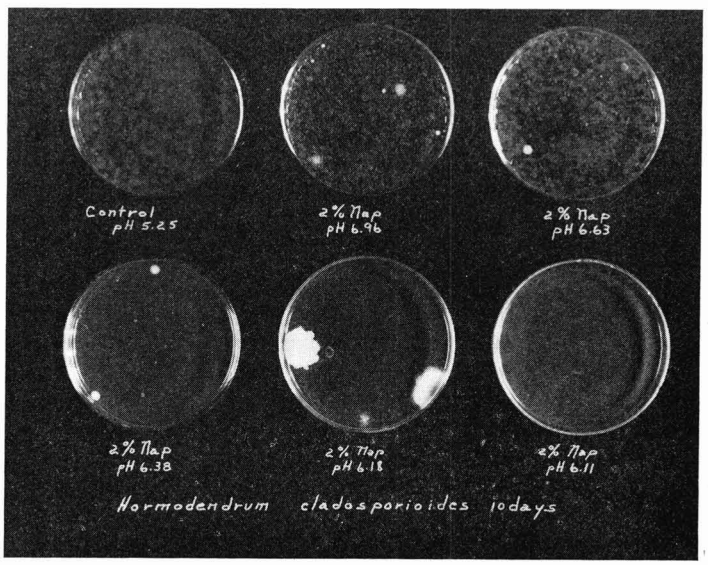

FIG. 3. This photograph shows the appearance of representative plates from Experiment II. The growth of *Hormodendrum cladosporioides* on six plates containing the same medium at different pH levels is shown.

these two media was 5.43 and 6.62, respectively. The next medium in the series at pH 5.28, containing two per cent sodium propionate, completely inhibited growth. The control medium adjusted to pH 3.5, by the addition of lactic acid, showed abundant growth which was expected, as it is a common procedure in the routine determination of yeast and mold counts to lower the pH of a medium by the addition of lactic acid to check bacterial growth. The results of a subsequent trial in which the range of pH varied between 6.96 and 5.85 are shown in table 1. *Hormodendrum cladosporioides* was used. A diminishing amount of growth may be noted as pH was decreased. Figure 3 shows representative plates from this trial. A few contaminants are noticeable, particularly on the medium at pH 6.18. If the plate is examined closely, two small colonies of *Hormodendrum cladosporioides* may be observed.

In this experiment, the addition of hydrogen ions to the propionate system, which would depress the ionization of propionate acid present, resulted in a gradual decrease in growth.

THE EFFECT ON MOLD GROWTH OF ADDING VARYING AMOUNTS OF SODIUM PROPIONATE TO A NUTRIENT MEDIUM CONTAINING A DEFINITE QUANTITY OF PROPIONIC ACID

Sodium propionate was added in varying amounts to potato dextrose medium containing 0.009 M propionic acid. Growth obtained on such media was compared with growth on a series of media containing the same amounts of salt but no acid, and also with a series of media containing different molar concentrations of propionic acid. In this case 0.009 M propionic acid was used as the concentration in the medium to which the salt was added because, in that concentration, growth of molds previously used was relatively abundant, yet it was near the critical concentration and any effect of the salt addition should be shown readily. Two molds were used, *Cladosporium sp.* and *Hormodendrum cladosporioides.* The data are shown in table 2.

It may be observed that growth was relatively abundant in the series of media containing only sodium propionate. In the medium containing only propionic acid, growth gradually diminished as the concentration was increased. However, when a combination of both propionic acid and sodium propionate was present growth also decreased as the amount of sodium propionate was increased. No growth was observed in the medium containing 0.009 M propionic acid plus 0.4 gm. of sodium propionate. Either of these compounds when present in the medium at the exclusion of the other did not result in complete inhibition of growth. Apparently the addition of the common propionate ion to the propionic acid system present in the medium resulted in an increase in the inhibitory power of the system. One effect of this would be an increase in the undissociated acid.

TABLE 2

Comparison of mold growth on media containing; (a) sodium propionate, (b) propionic acid, and (c) propionic acid plus sodium propionate

Composition of medium	pH of medium	Relative amount of growth of	
		Cladosporium sp. (6 days)	*Hormodendrum cladosporioides* (6 days)
Potato-dextrose medium (control)	5.80	7+	7+
" " " + 0.1 gm. sodium propionate	6.10	6+	6+
" " " + 0.2 gm. " "	6.30	5+	6+
" " " + 0.3 gm. " "	6.38	5+	6+
" " " + 0.4 gm. " "	6.50	5+	6+
0.009 M propionic acid in potato-dextrose medium + 0.1 gm. sodium propionate	4.90	2+	3+
0.009 M " " " " " " + 0.2 gm. " "	5.14	1+	2+ (−)
0.009 M " " " " " " + 0.3 gm. " "	5.30	1+	1+
0.009 M " " " " " " + 0.4 gm. " "	5.42	−	−
0.009 M propionic acid in potato-dextrose medium	4.52	3+	4+
0.010 M " " " " " "	4.55	2+	3+
0.012 M " " " " " "	4.46	1+ (−)	1+ (−)
0.014 M " " " " " "	4.37	−	−

Note: Sodium propionate concentrations shown are per 100 ml. of medium.

DISCUSSION

A recapitulation of the results shown in tables 1 and 2 is presented in table 3. The equation for acid dissociation was applied to the data and the concentrations of undissociated propionic acid, propionate ions, and total propionate in the media are given, showing their relationship to the inhibition of *Hormodendrum cladosporioides*. No correlation between growth and concentration of total propionate or propionate ions is apparent. Increased

TABLE 3

Effect of various components of the propionic acid dissociation system on mold growth

	Concentration of		pH	Growth of *H. cladosporioides*	Concentration of		
	Sodium propionate	Propionic acid			Undissociated acid (HA)	Propionate ion (A−)	Total propionate (S)
	moles per liter	*moles per liter*			*moles per liter*	*moles per liter*	*moles per liter*
From table 2	None	.....	5.80	7+	.....	.....	.....
	0.0104	.....	6.10	6+	0.0005	0.0099	0.0104
	0.0208	.....	6.30	6+	0.0007	0.0207	0.0208
	0.0312	.....	6.38	6+	0.0009	0.0303	0.0312
	0.0416	.....	6.50	6+	0.0009	0.0407	0.0416
From table 2	.....	0.0090	4.52	3+	0.0061	0.0029	0.0090
	.....	0.0100	4.55	2+	0.0066	0.0034	0.0100
	.....	0.0120	4.46	1+	0.0085	0.0035	0.0120
	.....	0.0140	4.37	None	0.0105	0.0035	0.0140
From table 2	0.0104	0.0090	4.90	2+	0.0091	0.0103	0.0194
	0.0208	0.0090	5.14	1+	0.0101	0.0197	0.0298
	0.0312	0.0090	5.30	1+	0.0106	0.0296	0.0402
	0.0416	0.0090	5.42	None	0.0108	0.0398	0.0506
From table 1	0.2080	.....	6.96	6+	0.0034	0.2046	0.2080
	0.2080	.....	6.27*	1+	0.0076	0.2004	0.2080
	0.2080	.....	6.18*	1+(−)	0.0093	0.1987	0.2080
	0.2080	.....	6.11*	None	0.0109	0.1971	0.2080
	0.2080	.....	5.85*	None	0.0190	0.1890	0.2080

* pH lowered by addition of lactic acid.
\+ Indicates extent of growth.

inhibition of growth may be observed with a corresponding increase or decrease of pH. The undissociated acid is the only component for which a correlation with growth inhibition was obtained. Growth gradually diminished as the concentration of undissociated propionic acid increased. The critical concentration at which growth was completely inhibited was within the range 0.0105–0.0106 M. Within the range of these data, at least, hydrogen ions and propionate ions are of importance only insofar as they affect the concentration of undissociated acid.

CONCLUSION

From the data presented it is concluded that the undissociated propionic acid molecules play the major rôle in inhibiting the growth of molds used in this study.

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PROJECTION EQUIPMENT

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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.

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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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Milk Plant Monthly

National Butter and Cheese Journal
New Zealand Journal of Science and Technology

Oil and Soap

Pacific Dairy Review
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

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

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BACTERIOLOGY

62. A Swab-slant Test for Equipment Sanitation and Its Correlation with a Standard Method. M. C. JAMIESON AND K. H. CHEN, Department of Animal Pathology and Bacteriology, The University of Manitoba, Winnipeg, Canada. Jour. Milk Technol., *8*, No. 3: 134–139. May–June, 1945.

The authors prepared wooden applicators with 0.05 g. of good absorbent cotton and packaged and sterilized in glassine bags.

Sterile water was prepared in screw-scapped vials of 40 ml. capacity for moistening the swabs. The material tested was swabbed and streaked on suitable culture medium at the time the swab was taken.

The results obtained by the investigators lead to their conclusion that the swab-slant test correlated very closely with standard procedure as outlined in Standard Methods, except that the slants and plates were incubated at 25° C. for 48 hours. Colonies were counted with the aid of a Quebec Colony Counter.

The "swab-slant test" offers possibilities as a simple and practical test for checking the sanitization of dairy food handling and beverage dispensing equipment. H.H.W.

BUTTER

63. Production of Butter from Neutralized Sour Cream. E. W. BIRD, Professor of Dairy Industries, Iowa State College, Ames, Iowa. Milk Plant Monthly, *34*, No. 11: 39. 1945.

Proper reduction of cream acidity and production of uniform quality butter from processed cream is dependent upon paying attention to certain details and principles such as (1) correct sampling of the cream; (2) correct manipulation of the acidity test; (3) exact knowledge of the neutralizing factor of the material employed; (4) knowing the exact weight of the cream in the vat; (5) reduction of the cream acidity to a pH between 6.6 and 7.2; (6) use of neutralizing charts; (7) accurate weighing of neutralizers to one-tenth of a pound. G.M.T.

64. Why Color of Butter is Standardized. FRED H. ABBOT, University of California, Davis. Natl. Butter and Cheese Jour. *36*, No. 10: 56. Oct., 1945.

The shade of butter color depends on the cow, her breed, feed, and period of lactation. Green feeds, cows of the Channel Island breeds, and milk pro-

duced in early stages of lactation, all produce more highly colored butterfat. Natural color ranges from deep yellow to canary. This color must be standardized to the high level for uniformity in packages. W.V.P.

65. Changes in Creamery Costs During the War. E. FRED KOLLER, University of Minnesota, St. Paul. Natl. Butter and Cheese Jour., *36*, No. 10: 37. Oct., 1945.

Costs of operating seventy-five identical Minnesota co-operative creameries in 1940 and 1944 are summarized.

Expense	Cents per pound of butter made*		Increase or decrease, per cent
	1940	1944	
Labor and management	0.808	1.193	+47.6
Manufacturing	1.288	1.511	+17.3
General and administrative	0.312	0.414	+32.7
Interest on loans	0.018	0.015	−16.7
Total	2.426	3.133	+29.1

* Pounds of butter made include the butter equivalent of fat sold in fluid cream.

W.V.P.

CHEESE

66. The Retention of Nutrients in Cheese Making. O. R. IRVINE, L. R. BRYANT AND W. H. SPROULE, Ont. Agr. Coll., Guelph, Ontario, and S. H. JACKSON, A. CROOK, AND W. M. JOHNSTONE, Hosp. for Sick Children, Toronto, Ontario. Sci. Agr., *25*, No. 12: 817; 833; 845. Aug., 1945.

I. The Retention of Calcium, Phosphorus, and Riboflavin in Cheddar Cheese Made from Raw Milk.

The efficiency of the cheddar cheese-making process with regard to the retention of these nutrients was studied in 12 trials. The effect of ripening the cheese at 40° and 58° F. upon the stability of riboflavin during 12 months was also studied.

About 61 per cent of the calcium and 53 per cent of the phosphorus originally present in the milk were retained in the cheese. These proportions were subject to small variations but did not appear to be related to minor variations in the method of cheese making nor to seasonal changes.

About 23 per cent of the riboflavin originally present in the milk was retained in the cheese although in this case the results were somewhat less consistent. Riboflavin values appeared to decline markedly during the first two months of ripening but later rose to the values found in the fresh cheese.

Mineral losses were almost entirely accounted for in the whey but there was some loss of riboflavin which could not be accounted for and which may have resulted from photochemical destruction during manufacture.

Samples of milk, whey and cheese secured from four factories representative of four soil types gave results similar to those in the controlled experiment. This was also true of cheese displaying defective flavor qualities.

II. The Effect of Pasteurization of the Milk upon the Retention of Calcium, Phosphorus and Riboflavin in Cheddar Cheese.

In each of six experiments approximately 1800 lb. of milk was divided into three lots, one of which was made into raw milk cheese while the second and third were made into cheese after the milk was pasteurized by the holder and high-short methods respectively. The efficiency of calcium retention was not affected by pasteurization, the average values being 61 to 63 per cent. Pasteurization of the milk resulted in a slightly improved retention of phosphorus, the three mean values being 53.1, 57.0 and 55.5 per cent, respectively. Neither the retention efficiency nor the stability of riboflavin during ripening was affected by pasteurizing the milk.

III. The Calcium, Phosphorus and Riboflavin Contents of Cream, Cottage, Brick and Blue Cheese.

Four lots of each of these varieties were manufactured under controlled conditions. Cream cheese of about 50 per cent total solids content contained 84.4 mg.% Ca, 86 mg.% P and 280 μg. riboflavin per 100 g. of cheese. Corresponding values of cottage cheese of about 20 per cent total solids content and 2.6 per cent fat were: 85 mg.% Ca, 146 mg.% P. and 288 μg. riboflavin.

Since whole milk was used in the manufacture of the brick and blue cheese, retention values were calculated on the basis of the original milk. In brick cheese 57.7 per cent of the calcium, 58.7 per cent of the phosphorus and 27.4 per cent of the riboflavin were retained. The corresponding values for blue cheese were 46.2, 43.3 and 30.1, respectively. Riboflavin was found to be stable in cream and cottage cheese when samples were stored at 40° F. for 7 and 14 days respectively. It also appeared to be quite stable during the ripening of brick and blue cheese. O.R.I.

CHEMISTRY

67. **The Purification and Crystallization of Rennin.** N. J. Berridge. Natl. Inst. Res. in Dairying, Univ. of Reading (Eng.). Biochem. Jour., *39*, No. 2: 179–186. 1945.

The author summarizes the experience gained in preliminary purification experiments and describes the preparation as well as some properties of the rennin crystals which were finally obtained.

"Rennin crystals are of very low solubility in water and can be dried without decomposition. Rennin is probably a protease, acting optimally on haemoglobin at pH 3.7." A.O.C.

68. Use of Enzyme in Riboflavin Determination. Free and Combined Riboflavin. L. ROSNER, E. LERNER AND H. J. CANNON, Lab. of Vitamin Technology, Chicago, Ill. Jour. Indus. Engin. Chem., Analyt. Ed., *17*, No. 5: 778–779. Dec., 1945.

In the fluorometric determination of riboflavin on many natural products by a method involving adsorption on Floristil without preliminary enzyme digestion, low results were obtained due to nonadsorption of a fraction of the riboflavin on Floristil. Evidence is presented that nonadsorption of part of the riboflavin is not due to physical factors alone but also to a difference in character between adsorbed and nonadsorbed riboflavin. The nonadsorbable or "combined" riboflavin is converted to the adsorbable form by enzyme. Results are given for determinations on various foods including dried skim milk and whey. B.H.W.

CONCENTRATED AND DRY MILK: BY-PRODUCTS

69. Condensed Milk By New Method. JOHN C. BURTNER, Ice Cream Field, *26*, No. 4: 26. Nov., 1945.

A brief review is given of a method of making condensed milk as developed by Dr. G. H. Wilster, professor of dairy manufacture at Oregon State College. In short, the method consists of heating milk continuously in a preheater, then circulating it through a Vacreator ("vacuum pasteurizer") until the desired concentration is reached. When the Vacreator is used for condensing, a relatively high preheating temperature is employed, from 200° to 205° F., in addition to the elimination of steam injection in the equipment when it is used as a condenser.

This equipment has successfully been used in pasteurizing cream for butter manufacture and according to the report, Wilster was the first to use it successfully to pasteurize ice cream mixes. He has also extended its use to the condensing of milk. Details of this research, it is stated, are to be published in a bulletin entitled "The dual use of the Vacreator for condensing milk and pasteurizing ice cream mix." W.C.C.

70. Ethyl Gallate and Abscorbic Acid as Antioxidants in Dried Whole Milk. J. D. FINDLAY AND J. C. D. WHITE. Biochem. Jour., *39*, No. 2: XXXIV. 1945.

"Milk powder was made from one batch of full-cream milk with and without the addition of very small amounts of ethyl gallate and ascorbic acid. Both these compounds lengthened the storage life of the powder very materially, ethyl gallate causing a greater extension of storage life than

ascorbic acid. During storage the concentration of ethyl gallate in the powder remained unchanged, but the ascorbic acid gradually decreased.''
A.O.C.

71. **Dried Milks—.** GEORGE E. HOLM, Division of Dairy Research Laboratories, Bureau of Dairy Industry, U. S. Dept. of Agriculture, Washington, D. C. Milk Plant Monthly, *34*, No. 8: 23, 52, 54, 65–67, 69. 1945.

Other than malted milk, the manufacture of dried milks is a relatively recent development in the dairy industry. Production of dried milk has increased markedly since 1934. Three principal methods are used in drying milk, namely, spray, atmospheric drum and vacuum drum processes. Dried milks made by the spray process are finely divided, very soluble and hygroscopic. The atmospheric drum process is used mainly in the drying of skim milk and buttermilk. Dried milks made by this method are practically nonhygroscopic. The vacuum drum process is essentially a roller process enclosed under partial vacuum during the drying operation. The products produced by this process resemble those made by the spray process in solubility, color, flavor and hygroscopicity. Inasmuch as the spray- and vacuum-dried milks have a great avidity for moisture, they must be packaged against absorption of moisture from the atmosphere. Dried whole milk deteriorates relatively rapidly when packaged in contact with air. In order to prevent spoilage through oxidation of the fat, this product is packaged in an atmosphere of inert gas, usually nitrogen. The principal types of off-flavors found in dried milks are cooked, which develops during manufacture; staleness, rancidity and tallowiness which develops during storage. Defects of discoloration, caking or fishiness may develop if the moisture content of the product exceeds 2 to 3%. Dried milk gas-packaged and stored at 75 degrees may be expected to remain in good condition for at least a year. Costs of drying milks by different methods and processes are not available, but estimates place the cost of drying skim milk at from 2 to 3 cents per pound of dried product. Data are presented showing the nutritive value of dried milk, as well as uses, definitions and standards. The author has included sources of information as well as listing some manufacturers of dried milks and milk driers. G.M.T.

DISEASE

72. **Comment on How to Handle the Mastitis Problem.** C. S. BRYAN, School of Veterinary Medicine, Michigan State College, East Lansing, Mich. Jour. Milk Technol., *8*, No. 3: 157–161. May–June. 1945.

The author classifies mastitis into acute, marked by swelling, pain and the production of abnormal milk, while acute systemic type is associated with

a sick cow and frequently is fatal. Again udder troubles may be divided into noninfectious, due to chilling, bruising and injury to the udder during the milking operation; infectious mastitis is usually associated with Streptococci, Staphylococci and *Escherichia coli.*

An attempt to determine the cause of mastitis should preclude any method of treatment. The following steps are summarized briefly:

1. The use of any test that will reveal the abnormal condition of the udder.
2. Prompt treatment before extensive changes take place in the udder.
3. Precautions should be used in treating cows with acute mastitis.
4. Better results are obtained in treating cows at the end of lactation or during the dry period.
5. Abnormal milk should never be used for human consumption.
6. Immunity is not conferred upon any cow as the result of treatment so that the animal becomes free from infectious agents. On the other hand, any program based on good practical sanitary practices to prevent re-exposure of the recovered case is desirable. H.H.W.

73. Can a Differential Germ Test with a Leucocyte Count Be Used in the Control of Mastitis? N. O. GUNDERSON, Commissioner of Health, AND C. W. ANDERSON, Director of Laboratories, Rockford, Ill. Jour. Milk Technol., *8,* No. 3: 147–152. May–June, 1945.

The authors suggest the following procedure in the control of mastitis: 1. Determine the type of organisms present in the milk; 2. Classification of milk into 4 classes based on the presence of streptococci and leucocytes by microscopic examination. (a) Leucocyte count 500,000 per ml.; (b) 500,000 to 1,000,000; (c) 1,000,000 to 7,500,000; and (d) over 7,500,000 per ml. Additional information may be useful in differentiating saprophytic streptococci from *Streptococcus agalactiae* by the inability of the former to produce ammonia in arginine broth. Polyvalent and type-specific antisera for identifying bovine streptococci may be useful. The following conclusions were made: 1. Leucocytes are directly related to stage of lactation, disease and age of the cow; 2. The "differential germ test" may be useful in the control of infectious mastitis; and 3. Good herd management and sanitary practices must be carried on concurrently under the laboratory examinations. H.H.W.

74. The Effect of Penicillin on Staphylococci and Streptococci Commonly Associated with Bovine Mastitis. E. G. FOLEY, S. W. LEE AND G. A. EPSTEIN, Wallace Laboratories, Inc., New Brunswick, N. J. Jour. Milk Technol., *8,* No. 3: 129–133. May–June, 1945.

Streptococcus agalactiae (Lancefield's group B), *Strep. dysagalactiae, Strep. zooepidemicus* (Lancefield's group C) and *Staphylococcus ameus* constitute the main group of microorganisms associated with bovine mastitis.

The authors concluded that penicillin shows considerable promise in the treatment of mastitis caused by groups B and C streptococci and staphylococci.

Approximately 100–200 Florey Units of penicillin per mg. and liquor filtrates of *Penicillium notatum* containing 25 to 80 Florey Units per ml. were diluted and used against the test organisms grown in defatted pasteurized milk.

Their susceptibility was compared by seeding 0.1 ml. of 1–10 dilution of 18-hour cultures in 5 ml. amounts of brain heart broth containing different dilutions of penicillin and then plated on proteose tryptone agar. The presence or absence of growth was noted after 23 hours incubation at 37° C.

Streptococcus agalactiae, Strep. dysagalactiae, Strep. zooepidemicus and *Staphylococcus ameus* were highly susceptible to small amounts (1–2 Florey Units) of penicillin. H.W.W.

FOOD VALUE OF DAIRY PRODUCTS

75. Changes on Storage in the Biological Value of the Proteins of Dried Skim Milk. K. M. Henry and S. K. Kon. Biochem. Jour., *39*, No. 2: XXVI. 1945.

While a certain amount of information is available on changes in the biological value of the proteins of various food products brought about by heat treatment, little is known about the effects of storage; nothing, as far as we are aware, regarding dried milk.

Since 1941 we have examined on several occasions by the method of Mitchell on groups of 12 rats the biological value of the proteins (nitrogen) of a sample of spray-dried skim milk manufactured in 1939, and since stored at room temperature. The results are given below.

Test No.	*Length of storage (months)*	*Biological value*	*True digestibility*
1	19	88.5	89.8
2	40	81.3	87.6
3	43	80.3	96.9
4	49	75.0	88.1
5	54	71.1	88.1

Normally, dried skim milk would not be stored for such prolonged periods but it is generally accepted as a product of great stability and our observations may have a practical bearing. They are in agreement with similar findings regarding the effects of storage on the proteins of maize and of soya bean. It should be noted that the true digestibility of the proteins of the milk remained unimpaired. Further work on the nature of the changes is in progress. A.O.C.

ICE CREAM

76. Lecithin in Chocolate Ice Cream. B. I. MASUROVSKY, Research Editor, Ice Cream Trade Jour., *41,* 10: 48. Oct., 1945.

Lecithin from soybeans is a well-known ingredient used in candy as a protective colloid to stabilize and insure uniformity in the finished product. Its use in ice cream has been limited to that found in egg yolk, buttermilk powder and cream, and that used in chocolate coatings for ice cream bars. Commercial lecithin is a material extract of soybeans, prepared in concentrated form and added to an oil in such quantities as to facilitate handling and application. Recently quick emulsifying lecithin has been developed which is miscible in water and is easy to handle in the preparation of an ice cream mix. About 0.15 per cent is the maximum amount used in ice cream. It is added to the mix by mixing with sugar and adding to the mix at 100° F. before pasteurization. The amount of lecithin for ices and sherbets is about 0.2 per cent.

When lecithin is used in combination with a stabilizer in a chocolate ice cream mix, it is advisable to reduce the amount of stabilizer about 0.1 per cent.

The lecithin when used in a chocolate mix acts as an emulsifying agent for the cocoa fat. It also helps to dissolve the cocoa particles by acting as a wetting agent. Chocolate ice cream containing 0.1 per cent lecithin and 0.4 per cent gelatin was found to have a smoother texture and smaller air cells in the foam from the melted ice cream than that which contained 0.5 per cent gelatin and no lecithin. W.H.M.

77. 1940 vs. 1945 Costs. Ice Cream Trade Jour., *41,* 11: 38. Nov., 1945.

Joseph Morrissey of the DeCoursey Creamery Co., Kansas City, Kansas, had made a study of the ice cream ingredient costs in his area in 1940 and 1945. The comparisons show that there has been an increase of 8 to 278 per cent in the cost of the various ingredients. Butter fat and other milk products have more than doubled in price. Other costs such as labor and taxes have also increased during the five-year period. W.H.M.

78. Ice Cream at the Fountain of Tomorrow. Ice Cream Trade Jour., *41,* 11: 30. Nov., 1945.

In order to meet the increased demand for ice cream equipment, manufacturers are designing larger soda fountains with improved facilities for handling larger volumes of ice cream. New features will include improved counter designs, better balanced and more comfortable stools, better leg room, greater accessibility of the various departments and improved appearance. Trained personnel will be needed to operate soda fountains. It is

estimated that from 100,000 to 500,000 new people will be needed to fill up the ranks now understaffed and to take care of expected increases in business. The Ice Cream Merchandising Institute is now working on a project which will help train fountain employees. W.H.M.

79. **The Influence of Soda Fountains on Ice Cream Sales.** Ice Cream Trade Jour., *41,* 11: 28. Nov., 1945.

The Ice Cream Trade Journal has tabulated the gallons of ice cream manufactured in each state in 1940 and the number of soda fountain installations and found that there is a very close relationship between the two. Of the ten leading states in ice cream production, nine of them were leaders in the number of soda fountains in operation. W.H.M.

80. **How the Food Chains Now Sell Ice Cream.** Ice Cream Trade Jour., *41,* 10: 54. Oct., 1945.

Seventeen per cent of the food chain stores which replied to the Ice Cream Trade Journal's survey indicated that they were now selling ice cream. At present the price ranges from 12 to 25 cents per pint and the volume per store ranges from 2,500 to 14,600 gallons per year. W.H.M.

81. **Forty Per Cent of the Food Chains Plan to Sell Ice Cream.** VINCENT M. RABUFFO, Editor. Ice Cream Trade Jour., *41,* 10: 50. Oct., 1945.

Replies to questionnaires sent to the leading food chain stores in 20 states by the Ice Cream Trade Journal indicate that 40 per cent of the reporting chains plan to sell ice cream; 17 per cent reported that they were already selling ice cream and 43 per cent professed no interest in the sale of ice cream.

A markup ranging from 10 to 30 per cent above the cost price was mentioned, with a majority of the chains, 67 per cent, indicating that they planned a markup of 20 to 25 per cent. This proposed markup is considerably below that used by present-day dealers, whose markups frequently range as high as 60 to 75 per cent.

Most chains favored the buying of ice cream from established manufacturers, rather than making their own. Fifty-eight per cent plan to use their own ice cream cabinets.

At present the pint- and quart-sized packages are most popular; however, other sizes including single gallons, or gallons broken into 8 pints or 4 quart units have been suggested.

Four of the leading food chain stores operate more than eleven thousand stores; should these stores and the thousands of others sell ice cream, they would provide an outlet for a large volume of ice cream. W.H.M.

MILK

82. A Time and Equipment Comparison Between the Methylene-blue and Direct Microscopic Tests. K. M. MASON, Division of Sanitation, Department of Health, Peoria, Ill. Jour. Milk Technol., *8:* No. 3, 145–146. May–June, 1945.

Milk sanitarians and dairy technologists are interested in methods that are applicable to their particular situation. Obviously, any method that will determine quickly and accurately the quality of the milk from a bacteriological standpoint is desirable. The cost of additional equipment, extra hours of labor and clerical services should in the opinion of the authors, determine the method to be used.

A comparison of the methylene-blue reductase test and direct microscopic method were made on 100 samples of milk serving a population area of 150,000. The additional cost of $85.00 for direct microscopic examination was estimated while the laboratory time increased from 4.5 to 10 hours and clerical services from 1 to 3 hours per 100 samples of milk examined.

H.H.W.

83. The Babcock Test on Homogenized Milk. L. M. LAMPERT AND J. H. BRANDON, Dairy Science Laboratory, Department of Agriculture, Sacramento, Calif. Jour. Milk Technol., *8:* No. 3, 140–144. May–June, 1945.

The comparison of the fat content of milk before and after homogenization at different pressures was made by using several modifications of the fat test. The regular Babcock test gave accurate results on homogenized milk as compared to untreated milk. Formaldehyde added to milk as a preservative gave a lower Babcock test than the unpreserved sample. Mercuric chloride enhanced a fat separation or "oiling of" which affects the fat test. The Pensylvania or Minnesota test are not satisfactory for testing homogenized milk.

H.H.W.

84. 14 Steps to Good Milk. H. C. JACKSON AND EVERT WALLENFELDT, Dairy Department, University of Wisconsin, Madison, Wisconsin. Milk Plant Monthly, *34,* No. 8: 25, 30, 32, 34, 38, 62, 68, 70. 1945.

The authors describe and illustrate the fourteen steps which they deem necessary to the production of high quality milk. These steps are: (1) healthy cows; (2) careful feeding; (3) clean barns; (4) insect control; (5) well-made utensils; (6) utensils bacteria-free; (7) clean cows; (8) good milking methods; (9) clean milking machines; (10) clean utensils; (11) proper straining; (12) good milk house; (13) proper cooling; (14) enclosed truck.

G.M.T.

85. The Acid Milks: Their Potential Hazard. F. L. WILSON AND F. W. TANNER, Department of Bacteriology, University of Illinois, Urbana, Ill. Jour. Milk Technol., *8:* No. 3, 127–128. May–June, 1945.

The milk sanitarians for many years have considered fermented milks safe from the public health standpoint. However, the U. S. Public Health Service has assembled sufficient evidence during the past few years in regard to disease outbreaks which have been traced to the consumption of fermented milks.

The authors made an extensive review of the literature and found many contradictory reports. A marked difference in the growth of acid-forming organisms and pathogens in milk acidified by the addition of acid as compared to milk fermented by normal acid-producing organisms is noted.

These investigators also studied the survival of the following test organisms: *Eberthella typhosa, Salmonella paratyphi, Sal. schottmulleri, Shigella dysenteriae* and *Shigella paradysenteriae,* (Flexner), when grown in sterile skim milk, acidified with lactic acid-producing bacteria and pathogens.

The following conclusions were drawn:

(1) The amount of acid varies in sterile skimmed milk produced by lactic acid-producing bacteria.

(2) The test organisms were destroyed more easily in acidified milk than in milk allowed to undergo natural fermentation.

(3) Larger numbers of pathogenic organisms survived in milk when the acidity increased gradually; perhaps the presence of acid-tolerant strains were present.

(4) The acidity of naturally fermented milks is not sufficient to destroy pathogenic organisms. Pathogens survived in milk with an acidity of 0.95 to 1.15 per cent (pH 3.9 to 4.2), an acidity of 0.50 to 0.86 per cent (pH 4.3 to 5.0) the organisms survived from two to nine weeks. H.H.W.

86. Butterfat Differentials. STEWART JOHNSON, Extension Economist AND A. J. MANN, Extension Dairyman, University of Connecticut, Storrs, Connecticut. Milk Plant Monthly, *34,* No. 1: 30, 81–86. 1945.

Butterfat differentials paid to producers and butterfat differentials paid by dealers are described fully. Three primary objectives are to be considered in determining the producer butterfat differential; namely, (1) to provide for an automatic adjustment of rates so that the profitableness of low test and high test milk of cows will remain reasonably constant; (2) to arrive at such a rate which will equitably pay for milk according to what it is worth; (3) to establish a rate which will encourage production of milk having a desired butterfat test for the market. A survey of butterfat

differentials in several markets show that there is a variation in the butterfat differential, but exceeding in most markets four cents a pound, which rate applies in Connecticut. The rate should vary with the difference in the net returns obtainable from the milk of different tests and should be the basic principle to follow in determining butterfat differentials on class 2 milk. The authors believe that a varying rate of the producers differential on Class 1 milk, as the price level fluctuates is preferable to a fixed rate. Certain advantages are given for the fluctuating rate of butterfat differential.

G.M.T.

87. **Factors to Consider Before Adopting High-Temperature Short-Time Pasteurization.** C. F. WEINREICH, Director of Research, Cherry-Burrell Corporation, at the Milk Pasteurization Conference, Michigan State College, May 22 and 23, 1945. Milk Plant Monthly, *34*, No. 11: 25–28, 38. 1945.

The factors to be considered before adopting short-time high-temperature pasteurization center around the following five questions: (1) What is the trend in pasteurization? (2) Will the raw milk supply lend itself to high-temperature pasteurization? (3) How large an operation should be had before considering high-temperature pasteurization? (4) How shall the size of the unit be determined? (5) How do special operations such as separating, homogenizing and clarifying fit into this system of pasteurization. Data and illustrations are presented showing in considerable detail the various items which must be considered before adopting high-temperature short-time pasteurization. The example of a planned operating schedule is presented. In general 10,000 to 12,000 pounds of milk is the minimum amount usually handled economically by high-temperature short-time pasteurization. The slogan of "get it big enough" which seems to fit well with other types of equipment does not fit in with short-time operation because a plate unit can be expanded at any time by merely adding more plates. Special operations such as clarification and homogenization fit in readily with short-time pasteurization.

G.M.T.

88. **Studies of Wartime Economies in Milk Delivery.** LELAND SPENCER, Professor of Marketing, Department of Agricultural Economics, New York State College of Agriculture, Ithaca, New York. Milk Plant Monthly, *34*, No. 11: 34, 46–47, 54–57, 84. 1945.

The prices paid for milk by consumers during the war increased much less than did the returns to producers. Despite increased price of milk to producers, an increase in wage rates of persons employed in milk processing and distribution, the spread between the price paid by the consumer and the amount received by the producer was reduced more than two cents a quart.

Two unusual developments made this possible: (1) payment of substantial subsidies by the federal government and (2) a remarkable lowering of milk distribution costs through economies brought about by certain restrictions of milk delivery service. The principle change in practice which made possible a saving of the cost of retail milk was the adoption of every-other-day service to retail consumers, which was put into effect by government order, primarily to conserve tires, gas and trucks during the war. Increasing the size of the route loads materially affected the delievery cost per quart of milk also. With the lifting of wartime restrictions on milk effective November 1, 1945, some questions receiving consideration by consumers, producers and distributors, and route men are as follows: (1) How many consumers prefer pre-war type of milk delivery service? (2) If wartime economies were abandoned, how much would the cost of delivery of milk to consumers be increased? (3) Would the resumption of pre-war delievery methods make the route man's job easier or more difficult, and how would it affect his earnings? (4) If the pre-war system is reinstated, how many more route jobs would be available? (5) Which system will yield the greater returns to producers? (6) If some of the economy practices are retained, what practical steps might be taken to insure their continuance? Indications are that if the pre-war type of delivery service is to be reinstated, that delivery of milk to retail consumers would be increased by 1.3 cents per quart and would reduce the earnings of route men about $3.00 a week. It would call for the operation of about ⅓ more retail routes. The attitude of the consumer will likely determine largely whether wartime practices will be retained or not. The retention of wartime milk delivery is of interest to the producer because it may have a significant effect on the volume of fluid sales and because of its effect on prices. The author believes that if more consumers on the retail milk routes have a strong preference for daily delivery and other services on the prewar pattern and are willing to pay the extra cost, more milk will be sold by reinstating that type of service. G.M.T.

MISCELLANEOUS

89. Tomorrow's Packages—an analysis. E. G. PENN, Riegel Paper Corp. Food Freezing, *I*, No. 1. Nov., 1945.

The first of a series of articles which will cover all of the materials that have been used and can now be used to do a protective job. When normal competition is once again fully under way in the food field, frozen foods will have to meet the "shelf life" of other processed foods. They must be able to stand up under months of storage without dehydration or deterioration. In evaluting a good frozen food package the protective qualities should be evaluated at 75 per cent, as against 25 per cent for sales appeal.

Sales-and-eye-appeal in packaging should be obtained through the advanced techniques of printing, design, display and advertising. The following requirements are becoming recognized as the ideal requisites of a protective material for frozen foods: 1. Moisture—vaporproofness. 2. Air-proofness and heat transfer. 3. Wet-strength. 4. Flexibility at low temperatures. 5. Closure strength. 6. Ease of filling and operational adaptability.

Glassine is presented as a packaging material possessing these attributes when it is manufactured in wet-strength quality obtained by treating the hydrated fibers with certain types of synthetic resins and applying a moisture-vapor proof lacquer or resin coating.

The author mentions that developmental work is underway to bring out a carton consisting of wet-strength glassine or greaseproof paper resin-laminated to carton-board stock, thus doing away with an outer wrap and an inner-liner or bag. Such a carton with foolproof locking ends would obviously effect considerable economy on the packaging line as well as meet the overall protective needs for frozen foods. L.M.D.

90. The Warehousing of Frozen Foods. PAUL B. CHRISTENSEN, Vice-Pres. and Chief Engineer, Merchants Refrigerating Co., N. Y. Food Freezing, *I*, No. 1. Nov., 1945.

The influence of the fast-developing frozen foods industry upon the cold storage warehousing industry has been to reverse the cooler and freezer space from 60 per cent and 40 per cent respectively to 60 per cent freezer and 40 per cent cooler space with prospect for even greater demand for freezer storage facilities. The refrigerated warehouse performs two very important and necessary functions in the flow of food commodities from the producer to the consumer. First, it absorbs production during harvest period and then gradually disperses it. Second, it serves as a consolidation and distribution point for these commodities. It is pointed out that even temperature at zero degree F. level is desired rather than fluctuating temperatures at below zero levels. The refrigerated warehouse can do its part by seeing to it that proper storage practices are followed, such as piling to permit air circulation, use of dunnage, and keeping packages from contact with outer walls. The ultimate goal is high quality of the food when it is placed on the table, as well as when it was packed. L.M.D.

91. Food Freezing, Vol. I, No. 1, Nov., 1945. Subscription rates: $4.00 per year; Canada, $4.50; Foreign, $5.00.

A new magazine makes its initial bow in the frozen foods industry. The publisher and editorial director is John T. Ogden. Food Freezing is dedicated to the task of promoting coordination of all of the frozen foods industry's specialized branches—processors, locker plant operators, distributors, warehouse men and transportation agencies—into one unified

team, each member of which will be fully acquainted with his own problem and the other fellows' problems. This calls for data, news, ideas. Everything that makes the industry tick must be probed, analyzed, disseminated. The editor emphasizes the fact that quality cannot be frozen into foods—it must be there in the first place—a fact that new-comers either in the processing or distributing fields of the industry must realize to the fullest extent. Quality control fundamentals becomes a matter of education for a very large proportion of the industry. L.M.D.

92. **Principles of Industrial Process Control.** DONALD P. ECKMAN, Engineering Department, The Brown Instrument Company. A division of Minneapolis-Honeywell Regulator Company. John Wiley & Sons, Inc., N. Y. 1945.

The author has brought together the many loose ends in the literature of automatic control in an attempt to provide a textbook for the student in chemical, metallurgical, mechanical or electrical engineering and as a reference for the industrial user of automatic control equipment. He had succeeded admirably in presenting in a logical manner the important laws of operation of industrial automatic control systems and their practical background of theory. The complete control system is divided into four elements: The measuring means, the controller mechanism, the final control element, and the process. It is emphasized that advancing technology in the industrial field is coming to depend more and more upon precision in processing, introducing standards which would have been thought of as impossible a few years ago. The elimination of manual control and the accompanying human element in processing has made for lessened expense, greater output, and a lowering of the inherent losses. Subjects treated are, The Art and Science of Control; Measuring Means; Modes of Automatic Control; Final Control Elements; Process Characteristics; Theory of Automatic Control; Quality of Automatic Control; Application Control Engineering; Automatic Control Systems; Maintenance of Exact Control. The text is illustrated with 178 figures key numbered by chapter number and sequence in the chapter. Many of the illustration figures are diagrams and the others are in the form of graphs. Numerous equations are keyed to the graphs by corresponding key numbers. The first chapter is preceded by a page of symbols, which are commonly used in the equations. A glossary of items peculiar to automatic control that is of great assistance in understanding the text follows the last chapter. Numerous references are included for each chapter. L.M.D.

93. **Transportation of Frozen Foods.** A. E. HUFF, Manager, Transportation, Warehousing, Birdseye-Snider, Inc. Food Freezing, *I*, No. 1. Nov., 1945.

A review of developments in transportation of frozen foods since 1929

and some recommendations for the future. The early distribution of frozen food was largely local and offered no great problem except suitable truck body insulation. In later years with greatly increased business and multiplicity of products the long haul has entered the picture, and as yet is not very satisfactorily functioning in the case of frozen food protection. Cross continental movement by truck meets obstacles of state motor truck law restrictions which holds down development along that line. Rail transportation has been slow to utilize special refrigerator cars provided with super insulation and refrigeration to hold car temperature at zero degree temperature. Water-ice plus salt used to greatest extent, along with some solid carbon dioxide and mechanical refrigeration applications. Greater need for building refrigerator cars for the frozen goods industry. Two newcomers in this field are the airlines and the steamship companies. L.M.D.

94. Insulation and Its Uses. Part II. P. EDWIN THOMAS, Sales Mechanical Engineer, Washington, D. C. Refrig. Engin., *50:* 5. Nov., 1945.

The author explains a few fundamentals of physics—conduction, convection and radiation—concerned with heat transmission. He emphasizes the fact that a good insulator for cold-storage application must possess a low conductivity factor, and for all practical purposes surface effects (convection and radiation) may be disregarded when estimating heat transfer where such insulators are concerned. A possible 10% error of underestimation may be introduced under such circumstances. The efficacy of metal insulating materials for cold-storage insulation is questioned. The author's contention being that environmental air temperature is established largely because of radiation and convection thereby setting up the temperature gradient against which efficient insulation (low conductivity factor) must be built up to offset the conduction heat flow.

The greatest problem in the low-temperature insulation field is the one great one of "water." Nature is contantly at work to establish moisture equilibrium employing the agencies of water, moisture, and water-vapor. Three powerful means are in use for the above purpose, (1) wind or air-current pressures; (2) air-pressure differential; (3) vapor-pressure differential. These more or less combine to drive moisture into insulation and to overcome the destructive result from deposition of moisture in insulation material. The warm-side vapor barrier is the modern safeguard. A plea is presented for the manufacturers and purveyors of the bulk of reliable cold-storage insulating materials to develop and launch a program looking to the discovery and dissemination of such additional information to users and potential users of insulating materials as will safeguard the buyer's interest and thus advance the interests of the insulating manufacturers themselves. L.M.D.

95. Technical Tips on Fish Freezing in the Locker Plant. J. M. LEMON, Chief of Technical Research, Fish and Wildlife Service, U. S. Dept. of the Interior. Food Freezing, 1, No.2: 48. Dec., 1945.

Fish is one of the most perishable of all commonly used food products, being subject to one or all of several types of deterioration when being frozen and stored in a freezer. The common causes of deterioration are (1) loss of flavor or color due to enzymatic or autolytic action within the tissue of the fish flesh; (2) action of bacteria; (3) oxidation of the fat; (4) "rusting" due to oxygen action on the flesh; (5) freezer burn or dehydration. It is recommended that fish be frozen as quickly as possible after being caught and pending preparation for freezing that they be kept packed in ice stored in a refrigerated room at 33°-38° F. This prevents loss of flavor due to melting ice. If a large quantity of fish is to be handled by a locker plant, a separate room for its preparation should be provided in order to protect other foods from fish odor. All forms in which fish are prepared, including fillets, steaks, sections or whole fish, must be very efficiently wrapped ill moisture-vapor-proof material and tightiy sealed against admission of oxygen. Low-temperature storage is most essential (-10° F.) for long-time storage of frozen fish, in fact a temperature much lower than that at which locker storage rooms are held.

Two tables are included, one being Chemical Composition of Common Varieties of Food Fish and the other; Estimate of the Probable Storage Life of Frozen Fish. The latter table gives the range in months of storage for fish "round or headed and gutted" and in packaged fillets. The storage life of all fish except those of rather oily nature is from two to four months greater in the fillet form thall in the round. L.M.D.

96. Refrigerated Trailers Move Frozen Foods, F. M. REID, Chief Engineer, Fruehauf Trailer Company. Food Freezing, 1, No.2: 46. Dec., 1945.

The ability of motor transport to make quick deliveries over long distances, and to any point, is a decided advantage in handling frozen foods. Details of operation of the new Trail-Aire Conditioner, manufactured by the Advance Mfg. Inc., are given. The unit is installed in the nose of the trailer and consists of a compressor powered by a 4-cylinder, V-type, air-cooled gasoline engine, equipped with a starter and generator, and an air-circulating blower of 1800 cu. ft. per min. capacity. This unit functions either for cooling the goods space or for heating it if desired. When cooling, the refrigerating system operates conventionally, the condenser being cooled by the circulated cold air. In order to operate as a heating system, the process is reversed, the evaporator functioning as a condenser and the condenser becoming an evaporator. The efficiency of the heating cycle is increased by supplementing it with the waste heat from the unit's gasoline engine.

Aside from a set of hand-operated change-over valves, the unit is automatically controlled from a thermostat for either the cooling or heating cycle.

L.M.D.

97. Correct Installation of New Refrigerating Equipment Can Mean Difference Between High–Low Maintenance Cost. E. I. ALTER, General Electric Co. Food Freezing, *I*, No. 1. Nov., 1945.

The author stresses the importance of layout of equipment in such manner that it may be accessible for easy and efficient servicing, thus cutting down maintenance expense. He then goes into details of installation of Freon systems. All copper tubing should be cleaned thoroughly with carbon tetrachloride or equivalent before it is assembled on the job. After copper tubing is brazed and the job is ready to run, insert auxiliary felt strainers in the suction line at the compressor to catch any foreign material which may have gotten into the piping during the assembling and brazing. After a short period of operating, the felt strainers must be removed.

The best way to obtain a dry system is to evacuate to a 29-inch vacuum or better, with all parts of the system kept above 70° F. for several hours, while the vacuum is being held. Alternative treatment is pulling the best vacuum possible on the system and remove remainder of moisture by operating with silica gel driers in the liquid lines. Change drier cartridges frequently until moisture has disappeared, then valve out the drier from the circuit.

Avoid oil and refrigerant trapping in the evaporator circuit piping. Whenever a compressor is started up after a period of shutdown, oil is usually pumped out of a compressor at a faster rate than it is returned. Trapping of oil in the low side may then prevent quick return of the oil to the compressor which may result in bearings failure. Especially avoid traps formed by a vertical drop from the evaporator followed by a long horizontal run with a short vertical rise to the suction service valve of the compressor. Liquid line solenoid valves in the refrigerant circuit are recommended to minimize drawing slugs of oil and refrigerant into the compressor when it starts up.

Heat interchangers are recommended where the refrigerant temperature in these systems is usually below zero degrees F. or lower. The heat interchanger increases the effective capacity of the system within the refrigerated space by cooling the incoming liquid refrigerant and warming the suction gas. This reduces the problem of frost on the suction line and makes possible less suction line insulation.

Defrosting by means of an automatic brine spray type evaporator is indicated where regular attention of an attendant is not possible.

When a system must be run the year around it is important to have at hand adequate replacement parts and where continuous duty is imperative,

provision should be made for standby equipment which can handle the load while major repairs, such as compressor or condenser replacements, are being made. L.M.D.

98. Tommorrow's Package . . . The story of Aluminum foil. T. M. HILL, Foil Division, Aluminum Company of America. Food Freezing, *1,* No. 2: 52. Dec., 1945.

The close of the war released aluminum foil once more for civilian use. Long used in the confectionery and processed cheese industries, aluminum foil offers many potentialities as a general food protective wrapper and particularly to the rapidly developing frozen foods industry. General characteristics of aluminum foil are: (1) Protection, (2) Odor Proofness, (3) Gas Proofness, (4) Light Proofness, (5) Glitter, (6) Dead Folding, (7) Dimensional Stability, (8) Aging Characteristics, (9) Insect Proofness. The four thicknesses typical of those used in the packaging industry are given together with the covering area in square inches per pound.

Thickness in inches	*Covering area in sq. in. per lb.*
0.001	10,250
0.0007	14,600
0.0005	20.500
0.00035	29,300

One defect appears in the thinner gages of foil which is that of pin holes which is said to be unavoidable. This permits some gas transfer.

Aluminum foil is very adaptable to being coated with synthetic resins, backed with paper or cloth, and to being coated with heat sealing material to provide nearly hermetic seals. As a liner for cartons it is bound to find great use in frozen food packaging. Large sheets of foil may be used for wrapping large units of either regular or irregular shapes. Because of the rather common use of aluminum cooking utensils, it is pointed out that foil-wrapped foods may be introduced into pot or pan for cooking without removing the wrapper. Also the use of foil wrappers should be satisfactory for pre-cooked frozen foods. L.M.D.

99. Women Want Informative Labels. DOROTHY B. MARSH, Food Editor, Good Housekeeping Institute. Food Freezing, *I,* No. 1. Nov., 1945.

Though frozen foods have been on the market for twenty years, many women still shy from using them. With an expanding market hoped for in the days to come, many new brands will come into competition with each other. The brands which will ultimately hold their own—such items as quality of product and efficiency of package protection being equal—are

those wihch convey adequate information to the housewife (the retail consumer) about proper cooking, number of servings per package (and not skimpy ones either), and number of cupsful. This latter for vegetables in both raw and cooked state because they may be used as recipe ingredients. If the product contains added sugar, state kind and amount so user can allow for it when using the product in a recipe. Also give quantity equivalent in terms of "as purchased" unprocessed market vegetables. In the case of meat, poultry and fish, point out that the product is ready for oven, pot or skillet with no waste. Directions for proper storage of frozen foods should be given also to cover various lengths of time before using. Above all, be sure that the contents of the package lives up to its label—the label being the window of the package. (All this will call for utilizing most of the six surfaces of a rectangular package for printed information and helpful instructions, but it will be good sales aid and bring repeat orders.)

L.M.D.

100. Oil Problems in Freon Refrigerating Systems. T. J. AMMEL, Sales Engineer, Nash-Kelvinator Corp., Detroit, Michigan. Refrig. Engin., *50:* 5. Nov., 1945.

Oil problems with self-contained equipment, principally in the smaller unit field are discussed. Because of the ease of miscibility of Freon with oil, the oils used should be of a somewhat higher viscosity generally than those used with ammonia or sulfur dioxide to overcome "thinning" action of the refrigerant. The oil must be heavy enough to provide a good body for lubricating purposes—yet it must remain fluid at temperatures which go down as low as – 40° F. in single stage systems and considerably lower in two and three-stage systems. Today most manufacturers specify an oil of 280 to 300 viscosity for domestic and commercial machines in the smaller sizes. Oils in this viscosity range have a flash point of 350° to 360° F. and a pour test of – 25° F. The pour point is further reduced by admixture of refrigerant.

The methods of compressor lubrication are used in the small compressors, splash system for the open type reciprocating units and forced feed system in the hermetic units.

Pumping of oil by compressors is kept to a minimum or eliminated entirely by the adoption of some or all of the following improvements: (1) Burnishing or superfinishing of cylinder walls and pistons to a clearance of from 0.0003 in. down to 0.0001 in. rendering piston rings unnecessary in fractional horsepower models; (2) Use of special close-grained metals for castings and cylinder walls rather than conventional cast iron; (3) The use of reed type valves, and ring-plate valves on larger compressors; (4) Streamlining of suction and discharge parts and passages; (5) Development of the balanced pressure seal; (6) Adoption of neophrene synthetic rubber compounds for gaskets and shaft seals.

To further facilitate the oil-handling problem, more attention has been paid to low side design to keep vapor velocity correlated with evaporator temperature, the lower the temperature the greater should be the terminal velocity of the vapor: 1000 ft. per min. for high operating temperatures and progressively increase to say 2000 ft. per min. at 0° F. or below. This prevents oil logging. The more oil in a Freon system the less efficient the refrigeration, thus 5% oil in Freon results in 4% reduction of evaporator capacity to 63%. Another accessory is the oil separator which returns oil from the discharge gas to the compressor crankcase through an oil return line but while it is necessary for the open type reciprocating machines, it is not needed with the hermetic systems. Lastly, low temperature applications on the order of – 100° F. have been made possible by the development by the refiners of lubricating oils that show no indication of wax separation over long periods of operation. L.M.D.

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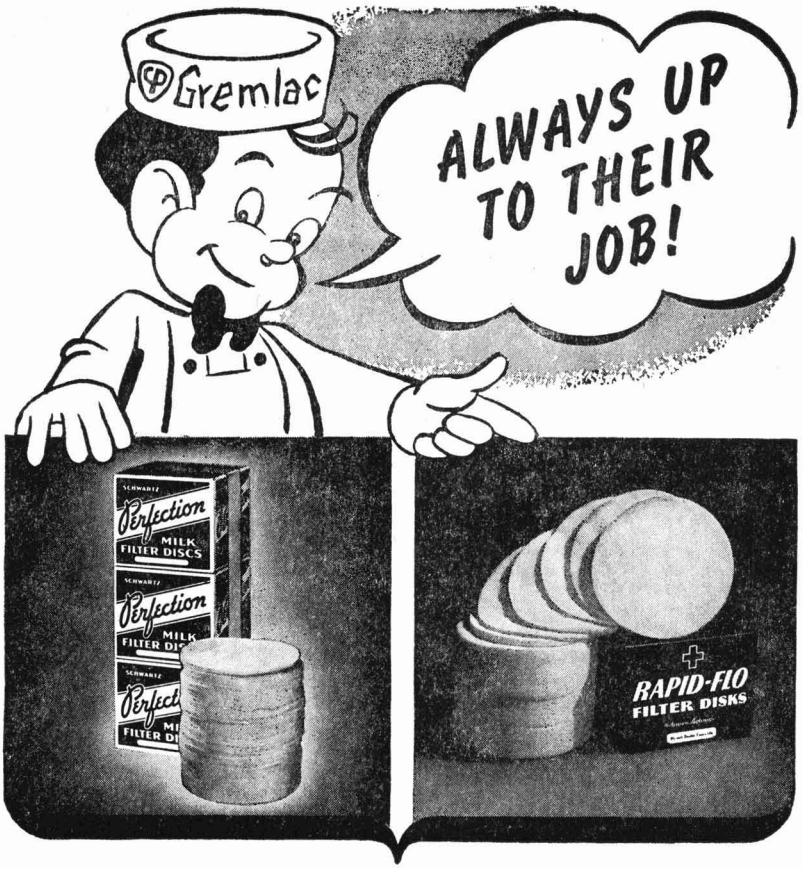

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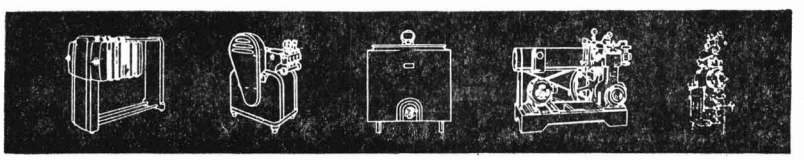

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