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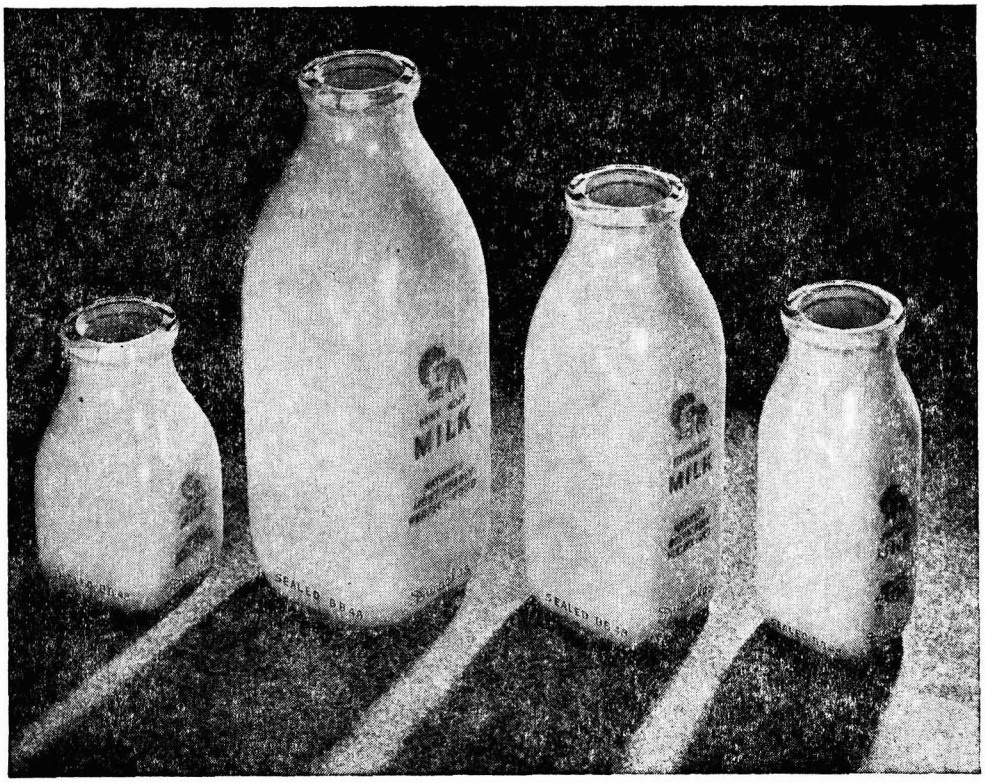

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JOURNAL OF DAIRY SCIENCE

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THE THIAMINE, RIBOFLAVIN, NICOTINIC ACID AND PANTOTHENIC ACID CONTENTS OF MARE'S COLOSTRUM AND MILK AND ASCORBIC ACID CONTENT OF THE MILK

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The importance of colostrum to the new-born animal has been emphasized by various investigators, and it is generally believed that new-born animals having access to colostrum do better than those that are fed only milk. The work of Lundquist and Phillips (8) suggests that some of the B vitamins play an important role in the prevention of certain diseases of the new-born calf. The work of Gamble, Earle, and Howe (4) emphasizes the importance of the proteins of colostrum for foals. While there is extensive literature on the vitamin content of milk of various species, information on the various B vitamins in colostrum has become available but recently and then only for colostrum of the human (2, 14, 15) and the cow and ewe (10). These studies show that colostrum differs from milk in respect to various members of the B vitamin group.

The present study was undertaken to provide information on the thiamine, riboflavin, nicotinic acid, and pantothenic acid contents of mare's colostrum as compared with mare's milk. Information on the B vitamins of various species is of interest for comparative purposes and possibly in the preparation of substitutes for feeding orphaned foals.

Information on the ascorbic acid content of mare's milk is very limited, and the two values found in the literature differ by about ten-fold. Holmes and associates (6) recently reported ascorbic acid values for mare's milk ranging from 0.6 to 2.3 mg. per 100 ml., while the ascorbic acid values reported by Cimmino (1) ranged from 8.7 to 19.7 mg. per 100 ml. of milk. The magnitude of the differences in the reported ascorbic acid content of mare's milk is too great to be accounted for on the basis of diet or breed differences. Therefore, it seemed desirable to obtain additional information on the ascorbic acid content of mare's milk.

EXPERIMENTAL

The mares used for this study represented various breeds of light horses. No attempt was made to control the dietary regimen of the mares. All were

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fed essentially the same except for the amount of green feed, which depended on season and availability of pasturage. Since riboflavin (12) and possibly other (13) of the B vitamins are known dietary essentials, diet may be a factor in the concentration in the colostrum and milk of some of the vitamins studied.

The colostrum was collected within 12 hours after foaling. All the milk samples were from mares that had been nursing foals for 30 days or longer. The samples were collected into brown bottles, and precautions were taken against photochemical destruction of any of the vitamins.

Thiamine was determined by the thiochrome method of Hennessy (5). Riboflavin was determined by the microbiological method (16) on the autoclaved sample following filtration at a pH of approximately 4.6 to remove the proteins and foreign growth stimulants. Nicotinic acid was determined by the microbiological method of Krehl, Strong, and Elvehjem (7), with the slight modification devised by Pearson and Leucke (11) which was found to be satisfactory for colostrum and milk. Pantothenic acid was determined by the method of Neal and Strong (9), following the enzymatic liberation of the vitamin by takadiastase and papain. The Evelyn photoelectric method (3) described for urine was adapted to the determination of the reduced ascorbic acid in milk by precipitating the proteins with an equal volume of 10 per cent trichloroacetic acid.

RESULTS AND DISCUSSION

Samples of colostrum were collected from eight mares and samples of milk from fifteen mares. Milk samples were collected from all of the animals from which colostrum was obtained except for mare number 1. The values for thiamine, riboflavin, nicotinic acid, and pantothenic acid expressed in micrograms per 100 ml. of colostrum are shown in table 1, and the values for milk in table 2. The values for reduced ascorbic acid per 100 ml. of milk are shown in table 3. Some of the milk samples for the ascorbic acid studies were obtained from animals not appearing in tables 1 or 2. The mares used for the ascorbic acid studies have, therefore, been designated by letter in order to avoid confusion with animals in the first two tables.

Thiamine. The average thiamine content of mare's colostrum was 38 μg. per 100 ml. as compared with 16 μg. per 100 ml. of milk. The fact that the thiamine content of the milk is lower than the value for colostrum is in accord with observations for the cow and ewe (10). The average thiamine content of cow's colostrum is 62 μg. per 100 ml., and of the ewe 108 μg. per ml. as compared with 38 μg. per 100 ml. for mare's colostrum. The corresponding average values for milk of the respective species are 38, 60, and 16 μg. per 100 ml. The average thiamine value for mare's milk reported in this paper is somewhat lower than the values reported for four animals by Holmes *et al* (6).

TABLE 1

Thiamine, riboflavin, nicotinic acid, and pantothenic acid content of mare's colostrum
(Values in μg. per 100 ml.)

Mare number	Thiamine	Riboflavin	Nicotinic acid	Pantothenic acid
1	65	162	155	700
2	40	135	167	750
3	37	112	114	800
4	21	125	150	900
5	34	125	185	425
6	34	120	178	400
7	38	165	200	950
8	40	160	134	1050
Average ...	38	138	160	747

Riboflavin. The average riboflavin content of mare's colostrum was 138 μg. per 100 ml. as compared with 40 μg. per 100 ml. for the milk. The fact that mare's colostrum is much richer than the milk in riboflavin is in accord with the observations on the cow and ewe (10), as cow's colostrum contains more than three times as much riboflavin as does the milk, while in the case of the ewe the difference is still greater. It is also of interest that the riboflavin contents of the colostrum and milk of the mare are much lower than the values for the cow and ewe. Mare's colostrum contains an average of 138 μg. per 100 ml. as compared with 610 μg. per 100 ml. of cow's colostrum and 2008 μg. per 100 ml. of ewe's colostrum; the corresponding values for the milk are 40, 177, and 436 μg. per 100 ml.

Nicotinic acid. The average nicotinic acid content of mare's colostrum was 160 μg. per 100 ml. as compared with 58 μg. per 100 ml. of milk. The nicotinic acid values reported here for mare's milk are slightly lower than values reported previously for four mares (6). The nicotinic acid value for mare's colostrum is higher than the value that has been reported (10) for cow's colostrum, but not as high as the value for ewe's colostrum.

TABLE 2

Thiamine, riboflavin, nicotinic acid, and pantothenic acid content of mare's milk
(Values in μg. per 100 ml.)

Mare number	Thiamine	Riboflavin	Nicotinic acid	Pantothenic acid
2	22	37	50	400
3	12	36	40	250
4	22	45	55	300
7	26	36	68	330
8	10	42	60	350
9	10	38	70	350
10	12	47	60	510
11	10	30	50	390
12	12	30	50	230
13	18	70	60	225
14	20	32	70	315
15	15	40	70	320
Average	16	40	58	331

Pantothenic acid. The pantothenic acid value of mare's colostrum is much higher than has been reported for the colostrum of other species. The average pantothenic acid content of mare's colostrum was 747 μg. per 100 ml. as compared with values of 224 and 262 μg. per 100 ml. for the colostrum of the cow and ewe, respectively. The average value of 331 μg. of pantothenic acid per 100 ml. of mare's milk is of the same order as values previously reported (6) for three animals. At present there is no physiological explanation for the high pantothenic acid level of mare's colostrum or for the fact that in this species the colostrum contains significantly more pantothenic acid than the milk, whereas cow's or ewe's milk contains more pantothenic acid than does the colostrum.

Ascorbic acid. The reduced ascorbic acid was determined on samples of milk collected from eight mares. These mares had been in milk for 2 or more months. From table 3 it will be seen that the values for reduced ascorbic acid ranged from 9.26 to 14.46 mg. per 100 ml. of milk, with an average of 11.83 mg. This figure is approximately ten times the value reported

TABLE 3

The reduced ascorbic acid content of mare's milk

Mare number	mg./100 ml.
A	13.62
B	9.26
C	11.95
D	14.46
E	12.45
F	12.95
G	9.96
H	9.96
Average	11.83

by Holmes and associates (6), but it agrees reasonably well with the values ranging from 8.7 to 19.7 mg. per 100 ml. of milk which were reported by Cimmino (1).

As a check on our analytical procedure we determined the reduced ascorbic acid in samples of milk from eight cows. The values for cow's milk ranged from 1.3 to 2.2 mg. per 100 ml. These figures agree well with numerous values reported for cow's milk. Thus mare's milk contains about five times as much ascorbic acid as cow's milk.

SUMMARY

Studies were made of the thiamine, riboflavin, nicotinic acid, and pantothenic acid contents of mare's colostrum and milk and of the reduced ascorbic acid content of mare's milk.

Mare's colostrum was found to contain an average of 38 μg. of thiamine, 138 μg. of riboflavin, 160 μg. of nicotinic acid and 747 μg. of pantothenic acid per 100 ml. The corresponding values for mare's milk are 16 μg. of thiamine, 40 μg. of riboflavin, 50 μg. of nicotinic acid, and 331 μg. of panto-

thenic acid per 100 ml. Mare's colostrum contains significantly less thiamine and riboflavin and more pantothenic acid than cow's colostrum. Cow's milk is richer in each of the four vitamins than mare's milk.

The average value for reduced ascorbic acid for mare's milk was 11.8 mg. per 100 ml. This is approximately five times greater than the ascorbic acid values found in this laboratory and reported in the literature for cow's milk.

Acknowledgment is made to Frances Panzer for assistance with some of the analytical work.

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A STUDY OF HEAT TOLERANCE IN JERSEY COWS

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In a previous article, the author (1) reported that there was a strong correlation between air temperature and body temperature of Jersey cows when the air temperatures were above 75° F., and that there was a wide variaton in the body reaction of different cows under the same conditions. Rhoad (4, 5) has found this to be true also for beef cattle and has proposed using the body temperature (converted to a heat-tolerance coefficient for convenience) under standardized conditions as one of the criteria for judging the suitability of cattle for areas having considerable periods of high air temperatures (2, 3). Seath and Miller (6) analyzed data on Jersey and Holstein cows in Louisiana and found that relative humidity plays a minor rôle in comparison to air temperature as a factor influencing body temperature, respiration rate, and pulse rate.

The author has not found, in the published data on the characteristics of the heat tolerance of individual animals, answers to the following questions: (1) Is the body temperature of the individual sufficiently stable from year to year to be a sound measure of the heat tolerance of the animal, or, in other words, is the heat-tolerance coefficient a fixed individual characteristic, such as fat percentage? (2) Do the age of the animal, the stage of lactation, and the stage of gestation affect the body reaction? (3) Are there real differences in reaction between individuals and groups of cows? These questions are of considerable importance to the livestock industry in the southern United States and in tropical countries, where the production of both beef and dairy products is low. This study was made in an attempt to answer them.

EXPERIMENTAL METHODS

The methods of gathering the data have been described in a previous report (1). For this study only the body temperatures in the afternoons for the 4-month period of June through September of each year were used. The report covers the five summer periods of 1941 through 1945. All body temperatures used in this report were obtained in the barn, and the cows were grazed on pastures in which shade was available during the test periods of each year.

The heat-tolerance coefficient for each cow was determined by first calculating the body temperature at 90° F. air temperature from linear regres-

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sion equations and then converting this body temperature to a heat-tolerance coefficient by use of the equation $HT = 100 - [14(BT - 101)]$. BT represents the calculated body temperature and HT the heat-tolerance coefficient. This equation is a modification of the one devised by Rhoad (2, 3) and is based on the assumption that a body temperature of 108°+ at 90° F. air temperature and under otherwise normal conditions would indicate complete loss of control in the regulation of body temperature, or zero per cent efficiency in eliminating surplus body heat. Conversely, a body temperature of 101° F. is considered as normal, and a cow that could maintain that body temperature at 90° F. air temperature would be considered 100 per cent efficient in eliminating surplus body heat. The heat-tolerance coefficient is used rather than the body temperature as it is a simpler figure to work with and gives a better expression of the degree of heat tolerance than does the body temperature.

An air temperature of 90° F. is used as a base for determining the body reaction as the maximum air temperature is 90° F. or higher on about 67 per cent of the 122 days in the June-through-September period at this station. Cattle, therefore, must be able to withstand 90° F. temperatures continuously if they are to be considered as well adapted to this area.

Since there is a known regression of body temperature on air temperature, it was considered that calculating the body temperature at 90° F. from regression formulae would be a more accurate method of determining the average body temperature for each animal than using the average body temperature within a specified air temperature range. This method also permits the use of all readings made during the test period and tends to eliminate differences of air temperature from year to year. The number of readings used in calculating the regression coefficient for each cow each year ranged from 10 to 18, with an average of 16.8 readings being used for determining each heat-tolerance coefficient.

One hundred and thirty-seven heat-tolerance coefficients were determined for 74 different cows during the 5-year period. Due to unavoidable circumstances, there was a rapid turnover in the herd during the period under study, and heat-tolerance coefficients were obtained on many of the cows for one year only and on only a few cows for more than 2 years.

EXPERIMENTAL RESULTS

Table 1 lists the number of cows included each year, the average heat-tolerance coefficient for the herd, the highest and lowest heat-tolerance coefficients for an individual in each year, and the range of air temperature encountered during the summer periods. An analysis of variance showed the differences in the yearly means of the heat tolerance to be not significant statistically. (The analyses of variance in this report were made by methods described by Snedecor (7). The term "significant" or "*"

TABLE 1

Heat-tolerance data of all cows, by years

Year	Number of cows	Heat-tolerance coefficients (%)*			Air temperatures (°F.)†		
		Average	Maximum	Minimum	Average	Maximum	Minimum
1941	21	77.8	90	62	86.6	94	78
1942	34	76.1	92	61	86.1	95	77
1943	20	81.2	92	65	88.4	96	80
1944	29	79.2	90	68	90.1	98	79
1945	33	77.6	89	64	85.9	93	77
Total or average	137	78.1	92	61	87.4	98	77

* The maximum is the highest for any individual cow; the minimum, the lowest for any individual cow; the average is that for all the cows.

† The figures given are the average for the four-summer-months periods of June through September and the highest and lowest temperatures encountered while taking the readings in the barn.

means that "*F*" values were between the 5 and 1 per cent points; and the term "highly significant" or "**" means that the "*F*" values were larger than those required at the 1 per cent level.)

Since there seemed to be little difference in the average heat tolerance of the herd from year to year, the data were grouped by age of the cow at the time of determining the coefficient, with the results shown in table 2.

There would seem to be a real difference between the average heat tolerance of the different age groups, since the "*F*" value is greater than that required for significance at the 1 per cent level. Apparently, there is a definite increase in heat tolerance as the cows increase in age from 2 to 3 years and probably some decrease again at ages beyond 8 years. An analysis of variance of the yearly means for each group was made, and the differences were found to be not significant from year to year except for the 3-year-old group. There was a wide variation from year to year in this 3-year-old group, and the "*F*" value for the between-year variance was greater than required for significance at the 1 per cent level. A possible explanation for this difference will be referred to under sire group analyses.

TABLE 2

Heat-tolerance data of all cows, by age groups

Age group*	Number of cows	Heat-tolerance coefficients		
		Average	Maximum	Minimum
6 years and over	27	75.8	92	61
5 years to 5 years 11 months	17	79.0	89	64
4 years to 4 years 11 months	28	79.5	92	65
3 years to 3 years 11 months	38	80.8	92	69
2 years to 2 years 11 months	27	74.7	90	61
Total or average	137	78.1	92	61

* Age of each cow was figured on August 1 of each year (center of test period).

TABLE 3

Correlation of heat-tolerance coefficients

Simple correlation (r) between heat-tolerance coefficients of cows determined at:	*r*	Number of cows
2 years of age and same cows at 3 years of age	+0.24	19
3 years of age and same cows at 4 years of age	−0.21	21
2 years of age and same cows at 4 years of age	+0.47	10
4 years of age and same cows at 5 years of age	+0.57*	11
5 years of age and same cows at 6 years of age	+0.96**	7
6 years of age or over and next consecutive year	+0.84*	5
4 years of age or over and next consecutive year	+0.66**	23

* Near to significance as determined from table 7.2 of Snedecor (7).
** Highly significant as determined from table 7.2 of Snedecor (7).

To measure the stability of the heat-tolerance coefficient for the individual cow from year to year, correlations were calculated, with the results shown in table 3.

It is obvious from these results that the heat-tolerance coefficient determined at 2 or 3 years of age would have little value in predicting the heat-tolerance coefficient of an animal at 4 years or more of age. Thus, while there is a definite increase in average heat tolerance from 2 to 3 years of age, as noted above, the increase is not at all uniform among the individuals studied. The heat-tolerance characteristic does appear to be more stable in the older cows. The coefficients of correlation between the heat-tolerance determinations made at 4 and 5 years of age, and between consecutive years at ages above 6 years, approach the 5 per cent level of significance, and the heat-tolerance determinations made at 5 and 6 years of age are almost perfectly correlated. The last group of table 3 is composed of all cows having heat-tolerance coefficients for two consecutive years, made at ages of 4 years or more. The correlation coefficient is higher than that required for statistical significance at the 1 per cent level, indicating that among the older cows there is a reasonable degree of stability in the heat-tolerance characteristic of the individual from one year to the next.

A considerable difference in heat tolerance of individual cows under similar conditions has been regularly noted in the studies here, and an analysis of variance was made to determine if these differences are great enough to be significant. Since the heat tolerance is unstable at the younger

TABLE 4

Analysis of variance of data on body temperatures of individual cows 4 years old and over

Source of variance	*df*	Sum of squares	Mean square
Total	1208	808.49	
Between-individual-cow means	71	242.01	3.409**
Within individual cow	1137	566.48	0.498

** Highly significant.

ages, only those cows were used which had determinations made at 4 years of age or older.

Analyses first were made for each of the five test periods, and the mean square of the between-cow variation was found to be highly significant in every year, the "*F*" values ranging from one and one-half to four times that required for significance at the 1 per cent level. The analysis of variance of the data for 5 years is given in table 4. There would seem to be no question but that there is a real difference in the body response of the individual cows to the climatic factors at this station.

To determine the effect of lactation and gestation on the heat-tolerance coefficient, the data from three groups of cows were studied. Group I cows were milking approximately one-half of a summer period and dry the balance of the same period and were pregnant 180 days or more at the start of the dry period. Group II cows were milking approximately one-half of

TABLE 5

Comparison of heat tolerance of cows when milking and dry

Group number*	Number of cows	Average heat tolerance		Average days pregnant—start of period	
		Milking	Dry	Milking	Dry
I	18	75.5	77.6	71.8	211.0
II	5	85.8	87.4	61.8	107.2
III	6	76.5	78.8	13.8	100.5

* Group I were in milk approximately half of a summer period and dry the balance of the period and were pregnant 180 days or more at start of the dry period.

Group II were in milk approximately half of a summer period and dry the balance of the period and were pregnant less than 180 days at the start of the dry period. Heat tolerance averages for the milking and dry periods for Groups I and II are, therefore, for the same cows in the same year.

Group III were milking all of one summer period and dry all of the previous or subsequent summer period. Heat tolerance averages for the milking and dry periods are, therefore, for the same cows in different years. Cows that were 4 years old or over in the first year included are the only ones included in this group.

a summer period and dry the balance of the same period but were pregnant less than 180 days at the start of the dry period. Group III cows were milking all of one summer period and dry all the previous or subsequent summer period. The averages are shown in table 5.

The differences between the average heat tolerance of the cows when milking and when dry are small in all three groups and cannot be considered as significant, since the mean square for within-group variance is larger than that for between milking and dry in each case. Apparently, there is little difference in body reaction regardless of the stage of lactation or gestation.

Since there was a definite difference in the reaction of individual cows, it would be desirable to know if this difference is inherited. A comparison of sire groups is given in tables 6 and 7. Sufficient data are not yet available to attempt to determine the influence of the dam.

TABLE 6

Comparison of heat-tolerance coefficients of groups of daughters of different sires

Sire*	Heat-tolerance coefficients of daughters determined at:					
	2 years of age		3 years of age		4 years or more of age	
	No. of daus.	Average *HT*	No. of daus.	Average *HT*	No. of daus.	Average *HT*
VGM	.....	.....	.....	.....	4	81.8
571	.....	.....	.....	.....	8	79.0
137	.....	.....	5	86.4	4	80.8
715	6	70.2	7	75.3	11	80.0
82	8	78.9	12	81.8	7	78.7
140	6	70.2	10	81.6	5	78.0
60	5	78.4	.....	.....	.....	.....

* Only those sires having four or more daughters with *HT* determinations are included.

The averages and the analyses of the sire groups are made on heat-tolerance coefficients determined at 2, 3, and 4 years of age and over, separately, since it was shown above that the heat-tolerance coefficients are not stable in the younger cows.

The difference between the mean heat tolerances of the sire groups appears to be fairly definite for the determinations made at 2 and 3 years of age, since the "*F*" values for these two mean squares fall between the 5 and 1 per cent points, but there is apparently no appreciable difference between the sire-group means where the determinations were made at 4 years or more of age. The influence of the sire on the heat tolerance of his daughters would, therefore, appear to be negligible, except at the younger ages.

In the analysis of the yearly means for various age groups (see table 2) it was noted that the means of the 3-year-old group varied significantly from year to year. This is believed due to the fact that in 1941 this group was made up entirely of daughters of 137, with a high average heat tolerance; and in 1942 of daughters of 715, with a low average heat tolerance (see

TABLE 7

Analysis of variance of data on heat-tolerance of sire groups

Group	Source of variance	*df*	Sum of squares	Mean square
I *HT* determined at 2 years of age	Total	24	1,406	.....
	Between sire groups	3	454	151.33*
	Within sire groups	21	952	45.33
II *HT* determined at 3 years of age	Total	33	1,299	.....
	Between sire groups	3	387	129.00*
	Within sire groups	30	912	30.40
III *HT* determined at 4 years or more of age	Total	38	1,586	.....
	Between sire groups	5	47	9.40
	Within sire groups	33	1,539	46.64

* Significant at 5% level.

table 6). In the other 3 years, the 3-year-old groups were made up of daughters of two or more sires, and the average heat tolerances were not much different from the 5-year average. This is believed to be the only place in this study where the sire influence would bias the results, as all of the other groups (except in tables 6 and 7) are composed of daughters of several different sires.

CONCLUSIONS

The following conclusions would appear to be warranted for Jersey cows under conditions prevailing at this station:

1. Not much change in the average heat tolerance of the herd occurs from year to year.

2. A definite difference in heat tolerance in the different age groups exists with the 2-year-olds showing the lowest average and the 3-year-olds the highest average.

3. The heat-tolerance coefficient is a reasonably stable individual characteristic at ages of 4 years and above, but not at 2 or 3 years of age.

4. There is a real difference in physiological response of different cows to the same environmental conditions, as measured by the body temperature.

5. The stage of lactation and gestation has little, if any, effect on the heat-tolerance coefficient.

6. There is some difference in the response of groups of daughters of various sires when measured at 2 and 3 years of age but little, if any, when measured at 4 years of age or more.

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SYNTHETIC RATIONS FOR THE DAIRY CALF[1]

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Information available up to 1942 on the nutrition of the calf has been adequately reviewed by Savage and McCay (9). Johnson, Loosli, and Maynard (4) used purified diets to study the growth requirements of dairy calves. They reported growth rates which were below normal when compared to Ragsdale's standards (7). They stated that poor food consumption, associated with periodic digestive upsets, seemed to be largely responsible for the slow growth. Madsen, McCay, and Maynard (6) were successful in rearing sheep on synthetic rations for a period of 480 days after weaning, but obtained less satisfactory results with goats, guinea pigs, and rabbits.

In this paper we report the development of a synthetic diet which is satisfactory for the nutrition of the young dairy calf.

EXPERIMENTAL

Male dairy calves 24 to 48 hours old which had been allowed to receive colostrum were used as experimental animals. They were housed in individual metal cages 5×6 feet in size and equipped with heavy wire mesh bottoms. When the animals were received, they were given a capsule containing 100,000 I.U. of vitamin A and an injection of anti-scour serum. All diets were compounded to simulate milk. For the first week the calves were fed from pails equipped with rubber nipples, and at the end of this time they were taught to drink from the bucket. The animals were fed at a level of one pound of synthetic milk for each ten pounds of body weight. They were fed twice a day and given half the daily intake at each feeding. All vitamin supplements were given at the morning feeding. The synthetic milk was always fed at a temperature of 37° C.

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The synthetic milk rations contained 13 per cent solids, similar to the solids content of cow's milk. The casein was dissolved according to the method of Bird *et al* (2). Sodium bicarbonate equal to 4.75 per cent of the weight of the casein was added to water at a temperature of 60° C. The casein was added slowly to the sodium bicarbonate solution and stirred with constant high speed (a "Lightnin" mixer was used[3]). When the casein

TABLE 1

Composition of synthetic milks

Components	Ration 1	Ration 2	Ration 3	Vitamins added[5]	Mg. per kg. liquid milk		
					Ration 1	Ration 2	Ration 3
	%	%	%				
Casein "Labco"	30.0	30.0	30.0	Thiamin	0.39	0.65	0.65
Soybean oil	12.0	.....	.....	Riboflavin	1.95	0.65	0.65
Lard	.....	26.6	26.3	Pyridoxine	0.65	0.65	0.65
Salts 11	6.0	6.0	.....	Calcium panto-thenate	1.95	1.30	1.30
Salts 22	.....	.....	4.0	Nicotinic acid	.....	2.60	2.60
Cerelose	47.0	37.4	39.4	Ascorbic acid	.....	13.0	.....
Wheat germ oil	.....	.....	0.3[4]	α-Tocopherol	.....	1.0[6]	.....
Liver[3]	5.0	.....	.....	2-Methyl-1,4-naphtho-quinone	.....	0.26[6]	0.26[6]
				Inositol	.....	.....	26.0
				Choline	.....	.....	260.0
				p-Aminobenzoic acid	.....	.....	2.60
				Pteroyl-glutamic acid (folic acid)	.....	.....	0.052
				Biotin	.....	.....	0.01
				Vitamin A	5,000 I.U. per day		
				Vitamin D	500 I.U. per day		

[1] Salts 446 used in this laboratory, unpublished.

[2] Salt mixture of Phillips, P. H., and Hart, E. B., Jour. Biol. Chem., **109**: 657 (1935), and modified by addition of cobalt chloride and increasing the manganese content. These salts were preferred because they dissolved more readily in the liquid rations.

[3] A defatted pork liver prepared and donated by the VioBin Corporation, Monticello, Illinois, through the courtesy of Mr. Ezra Levin.

[4] The 2-methyl-1,4-naphthoquinone, dissolved in the wheat germ oil, and the lard were homogenized into the solution of casein, salts, and cerelose.

[5] The water-soluble vitamins were made up in 25 per cent alcohol.

[6] The α-tocopherol and 2-methyl-1,4-naphthoquinone were dissolved in 95 per cent alcohol.

was in solution, cerelose was added. The salt mixture was dissolved in boiling water and then added to the casein-cerelose solution. After the entire mixture had been stirred for approximately one hour, the fat was homogenized into the mixture under a pressure of approximately 3,000 lbs. The synthetic milk was then pasteurized and stored in a refrigerator at a temperature of 5° C. until used. The synthetic milk thus prepared had a

[3] Manufactured by Mixing Equipment Co., Rochester, New York.

pH of 6.5 to 6.8. The compositions of the liquid rations used are given in table 1.

A capsule containing 5,000 I.U. vitamin A, 500 I.U. vitamin D, 50 mg. nicotinic acid, and 250 mg. ascorbic acid was given each animal daily.

Two animals, placed on ration 1, appeared to be doing well at the end of one week. During the second week both animals began to scour and appeared to be excreting a considerable amount of fatty material. The scours became progressively worse, and the animals refused to eat, lost weight, and presented a very unthrifty appearance. An attempt was made to save the animals by substituting a diet of cow's milk and treating scours by adminis-

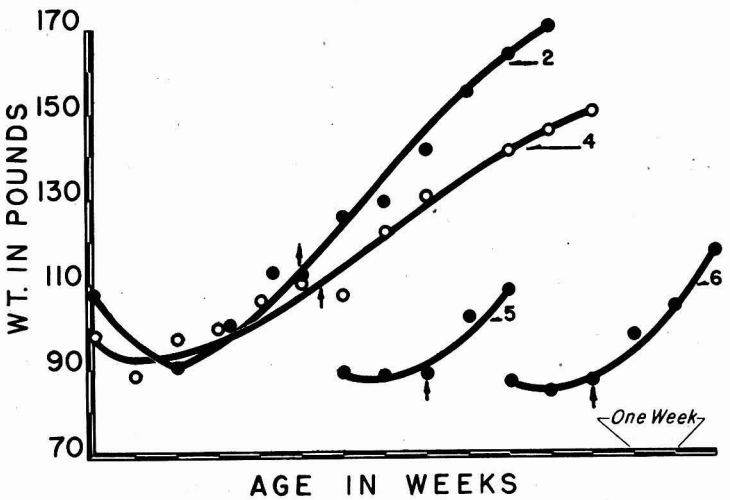

FIG. 1. Growth of calves on soybean oil–skim milk and lard–skim milk rations. Upward-pointing arrow indicates change from soybean oil–skim milk ration to lard–skim milk ration.

tration of sulfathalidine. Calf no. 1 became worse and died. Post-mortem examination showed the cause of death to be infectious scours. The condition of calf no. 2 improved on the diet of cow's milk and the animal finally recovered.

Gullickson, Fountaine, and Fitch (3) have reported that calves fed a diet of soybean oil homogenized into skim milk grew poorly, scoured, and appeared emaciated and unthrifty. Since soybean oil was included in ration 1, an attempt was made to determine whether this oil could be used satisfactorily in calf rations. Calves nos. 2, 3, 4, 5, and 6 were placed on a diet of skim milk into which soybean oil was homogenized at a level of 4 per cent on the liquid basis. After several days on this diet the animals started to scour, became very unthrifty in appearance and grew poorly. The volume of fecal material was large and appeared to contain large quantities

of undigested matter. The feces contained up to 30 per cent ether extract on the dry basis.

On the soybean oil–skim milk diet, calf no. 3 had severe scours, lost weight and became very weak. The animal, changed to a diet of whole cow's milk, still did not improve and was taken off the experiment. Autopsy showed the animal had gastro-enteritis.

Since the other animals (calves nos. 2, 4, 5, 6) were not doing well on this diet, it was decided to try some other fat. Lard was selected because the work of Gullickson *et al.* (3) had shown that calves fed a diet of lard homogenized into skim milk made good gains in weight, remained in a healthy and thrifty condition, and exhibited only occasional scours. The animals were changed to a diet of skim milk into which lard was homogenized at a

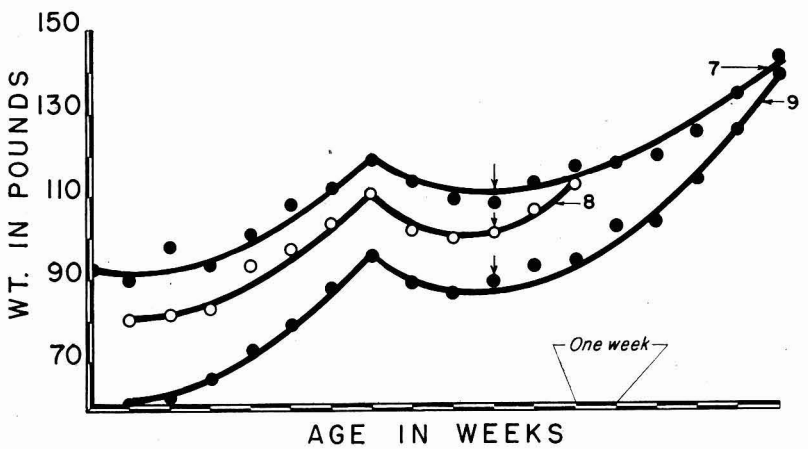

FIG. 2. Growth of calves on rations 2, 4, and 5. Break in curve at 7 weeks occurred with change to ration 4. Downward-pointing arrow indicates change to ration 5.

level of 4 per cent on the liquid basis. After several days on this diet the animals stopped scouring, became healthy and thrifty in appearance, and made gains in weight. The growth data are summarized in figure 1.

From these results it was apparent that the type of fat used in the diet of the dairy calf is of importance. Ration 2 was prepared and homogenized with water, as previously described.

Three animals, calves nos. 7, 8, and 9, were placed on ration 2. They made good gains in weight, appeared healthy and thrifty, and scoured infrequently. The growth data are given in figure 2.

After 6 weeks on the liquid diet, a change to a solid diet was attempted. The animals would not eat the dry ration except when fed as a slurry. The composition of ration 4 is given in table 2. On this ration the animals scoured and lost weight. Decreasing the lard content to 4 per cent, chang-

ing the salt mixture, or adding roughage (wood flock) did not prevent scours. Even the addition of *p*-aminobenzoic acid, inositol, choline, pteroylglutamic acid ("folic acid") and biotin did not improve the condition of the animals. Only after the substitution of starch for some of the cerelose did the animals stop scouring and gain weight. The composition of ration 5, on which the calves showed good growth, appeared healthy and thrifty, and did not scour, is given in table 2.

Rations 1 and 2, previously described, did not give completely satisfactory results for rearing young calves. The vitamin supplement was modified to contain all the pure crystalline compounds that have been re-

TABLE 2

Composition of dry rations

Components	Ration 4	Ration 5	Vitamins added	Mg. per kg.	
				Ration 4	Ration 5
	%	%			
Casein "Labco"	20.0	20.0	Thiamin	5.0	5.0
Lard	8.0	4.0	Riboflavin	5.0	5.0
Salts 1	6.0	.....	Nicotinic acid	20.0	20.0
Salts 2	.....	4.0	Pyridoxine	5.0	5.0
Magnesium carbonate	0.7	.....	Calcium pantothenate	10.0	10.0
Cerelose	65.3	20.0	Ascorbic acid	100.0	.....
Methionine	.....	0.3	*p*-Aminobenzoic acid	.....	20.0
Wheat germ oil	.....	0.3	Inositol	.....	200.0
Wood flock	.....	10.0	Choline	.....	2,000.0
Starch	.....	41.4	Pteroyl-glutamic acid (folic acid)	.....	0.4
			Biotin	.....	0.1
			2-Methyl-1,4-naphthoquinone	.....	2.0
			Vitamin A	5,000 I.U. per day	
			Vitamin D	500 I.U. per day	

ported to be members of the vitamin B complex. Two animals have been raised on ration 3 for a period of 12 weeks. The growth of the calves was normal as compared to Ragsdale's standards (7), and they were healthy and thrifty in appearance. The scours occurring on two or three occasions were cured by administration of sulfathalidine. The growth data are given in figure 3.

Ascorbic acid was not included in the vitamin supplement of ration 3 as it was found unnecessary for the young calf. Several calves have been raised without vitamin C in the diet and showed normal growth, appeared healthy and thrifty, and did not scour. In addition, they did not develop navel ill, which Lundquist and Phillips (5) reported to be caused by a vitamin C deficiency. Blood ascorbic acid levels have been determined by the method of Roe and Keuther (8) and are given in table 3. The values are normal by comparison to those reported by Lundquist and Phillips (5), who found the ascorbic acid content of calf blood varied between 0.1 and 0.8 mg. per 100 cc. of whole blood.

TABLE 3

Ascorbic acid levels of calves' whole blood

Calves on diet containing ascorbic acid						Calves on ascorbic acid–free diet											
Calf 7		Calf 8		Calf 9		Calf 10		Calf 11		Calf 12		Calf 13		Calf 14		Calf 15	
Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.	Age in days	Mg./ 100 cc.
45	0.25	30	0.42	30	0.82	7	0.75	2	0.81	2	0.60	2	0.94	2	1.04	2	0.72
52	0.50	37	0.94	37	0.66	14	0.77	9	0.29	9	0.47	8	0.80	8	0.63		
59	0.51	44	0.83	44	0.70	21	0.90	16	0.53	16	0.55	23	0.39	23	0.38		
73	0.46			79	0.59	28	0.93	23	0.58	23	0.76						
								30	0.77	30	0.47						
								37	0.49	37	0.51						
								44	0.66	44	0.84						
										51	0.57						

Ascorbic acid was fed to calf no. 7 until 70 days of age and to calves nos. 8 and 9 until 56 days of age. After this time these animals received an ascorbic acid–free diet. Calves nos. 10, 11, 12, 13, 14, and 15 did not receive any ascorbic acid during the course of the experiment. The data in table 3 show that the blood level of ascorbic acid does not decrease to any great extent when the animal is fed an ascorbic acid–free diet. This indicates that the calf can synthesize vitamin C in its body tissues and does not need it in the diet.

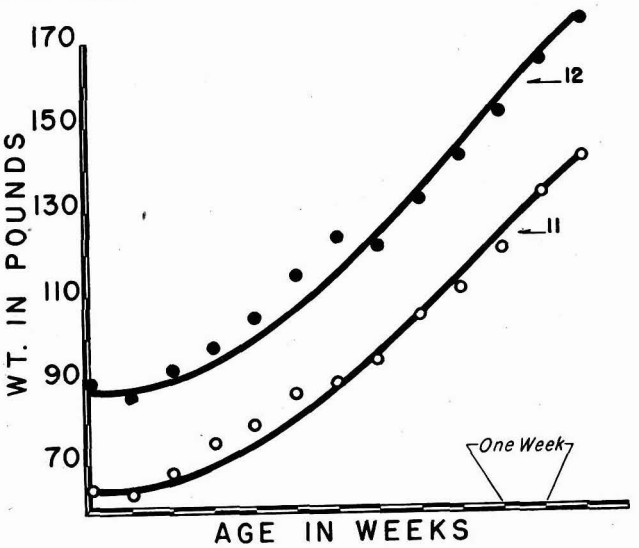

FIG. 3. Growth of calves on ration 3.

DISCUSSION

A synthetic milk diet (ration 3) has been developed for studies of the nutrition of the young dairy calf. Day-old calves have been raised on this ration for a period of 12 weeks. They have shown good growth, were healthy and thrifty in appearance, and seldom scoured.

When the ration was fed in the dry form, less satisfactory results were obtained. It may be that the physical characteristics of this diet or the method of feeding (as a slurry) caused the unsatisfactory results. Bate, Espe, and Cannon (1) have reported that dairy calves did poorly on a diet of skim milk and unhomogenized fat. Calves fed the same diet but with the fat homogenized into the skim milk did better. Since rations 4 and 5 were fed as slurries, the fat was unhomogenized. This may have been the cause of the poor results obtained.

The data presented in table 3 on the blood levels of ascorbic acid indicate that the young dairy calf does not require ascorbic acid. Lundquist and Phillips (5) have reported that the young dairy calf requires ascorbic acid

only if the animal is receiving an insufficient amount of vitamin A. The animals in the experiments reported in this paper all received 5,000 I.U. of vitamin A per day. This may account for the fact that the results obtained do not show a great decrease in the blood level of ascorbic acid.

SUMMARY

1. A synthetic milk has been developed for the young dairy calf. This ration will support good growth over a period of 12 weeks from birth. The animals raised on this diet were healthy and thrifty in appearance.

2. On rations containing liberal amounts of vitamin A, the young dairy calf does not require vitamin C.

3. Calves that received soybean oil in the diet grew poorly, scoured, and appeared unthrifty, whereas the animals that received the rations prepared with lard showed good gains in weight, did not scour, and appeared normal and healthy.

4. The calves did much better in all respects when fed the synthetic milk diet than when solid diets fed as a slurry were used.

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A SUGGESTED MODIFIED BABCOCK PROCEDURE FOR TESTING HOMOGENIZED MILK[1]

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With increasing consumer acceptance of homogenized milk, considerable interest has been shown in the testing of such milk for fat either by the standard Babcock method or by a modification. In general, early work and statements conflicted relative to the accuracy of the Babcock test for homogenized milk. However, there was general agreement that the homogenized milk tested within the 0.1 per cent tolerance of the Babcock procedure. Some accepted the theory that the fat globules, being reduced in size by the process, could not be centrifuged sufficiently to give a test comparable to that of nonhomogenized milk; consequently, the Babcock fat test of homogenized milk could be expected to be not more than 0.1 per cent lower than that of nonhomogenized milk.

If a slightly lower test value were the only factor involved in making a Babcock fat test of homogenized milk, likely the regular procedure would be accepted and used in routine work. However, workers soon recognized that char formation was greater in applying the test to homogenized than to nonhomogenized milk. This char often gave the appearance of a burned test. If less acid were used, the test often appeared curdy. This char or curd usually appeared as a thin disc or plug at the base of the fat column. When the char was reduced to a minimum, its presence did not affect appreciably the reading of the fat column. In routine testing, however, the presence and appearance of this char in greater or lesser amounts, intermixed with or at the base of the fat column, often led one to question the accuracy of the test. Consequently, many modifications of the Babcock procedure, in part with the aim of preventing char formation and thus increasing the accuracy of the test, have been recommended for testing homogenized milk.

The literature on this subject has been reviewed, in part, in a previous paper (9), which showed that at least 12 modifications of the standard Babcock procedure have been recommended for homogenized milk. Variants involved in the different modifications included: (a) strength of the sulphuric acid used, (b) amount of acid used, (c) temperature of the acid, (d) addition of acid ranging from three to five portions, (e) temperature of the milk, (f) prolonged mixing of acid and milk, (g) remixing acid-water-serum mixture after centrifuging, and (h) prolonged centrifuging.

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EXPERIMENTAL METHODS

In comparing the various modifications recommended, it became evident that the procedures involving prolonged action of the sulphuric acid at a relatively high concentration without burning the test offered the best solution to the problem. This, in effect, entailed the tempering of the milk and acid to 70° F., the use of a relatively large portion of the acid (1.83 sp. gr. sulphuric acid) at the first addition, thorough mixing of the acid and milk after each addition, and prolonged agitation of the milk-acid mixture after all the acid was added. As a result of these observations and after comparing the numerous modifications of the test, the following suggested modified Babcock procedure for testing homogenized milk was adopted:

(a) Temper the acid and milk to 70° F.
(b) Use sulphuric acid of 1.83 to 1.835 sp. gr.
(c) Use the full amount of sulphuric acid (17.5 ml.).
(d) Add the acid in three portions, 8, 5, and 4.5 ml., respectively.
(e) Mix the acid and milk by rotary motion after each addition and continue agitation for at least 15 seconds before adding the second and third increments of sulphuric acid.
(f) Shake the tests in a mechanical shaker for at least 2 minutes before centrifuging.
(g) Centrifuge and add hot water in accordance with the regular Babcock procedure. Substitution of a water-alcohol (ratio 1.4:1 by weight) solution for the hot water to bring the fat up into the neck of the bottle for reading is optional.

This procedure was followed carefully in testing in duplicate a series of 36 milk samples, both nonhomogenized and homogenized. These samples also were tested in duplicate by the Mojonnier method, which was used as a standard for accuracy. However, instead of using a volumetrically measured approximately 10-gram portion, the samples previously tempered to 70° F. were weighed carefully on a chemical balance directly into fat-extraction flasks.

The nonhomogenized samples were taken from the vat after pasteurization prior to homogenization. The milk had been kept thoroughly mixed during pasteurization and homogenization in order to insure uniform fat distribution. The homogenized samples were taken from the cooled, bottled product after homogenization was well under way.

Homogenization was accomplished by means of a 500-gallon-per-hour viscolizer at 2500 pounds pressure at 130° F. following pasteurization. All the 17.5-ml. portions of milk were pipetted into the calibrated test bottles at one time to assure correct sampling after the milk had been tempered at 70° F. for two hours.

In studying the accuracy of the suggested modified Babcock procedure, the procedure was tried on the same milk unhomogenized and homogenized.

TABLE 1

Percentages of fat in nonhomogenized and homogenized milk as determined by the Mojonnier method

Trial no.	Date	Mojonnier fat test on milk which was						Variation of average fat test of homogenized milk from that of nonhomog. milk
		Not homogenized			Homogenized			
		Duplicates	Difference between duplicates	Average test	Duplicates	Difference between duplicates	Average test	
		%		%	%		%	
1	12–13–44	3.735 3.698	0.037	3.713	3.705 3.722	0.017	3.714	+0.001
2	12–14–44	3.928 3.933	0.005	3.930	3.962 3.943	0.019	3.952	+0.022
3	12–15–44	4.024 4.047	0.023	4.035	4.058 4.073	0.015	4.064	+0.029
4	12–18–44	3.973 3.957	0.016	3.965	3.976 3.976	0.000	3.976	+0.011
5	12–19–44	3.918 3.867	0.051	3.892	3.888 3.903	0.015	3.895	+0.003
6	12–20–44	3.984 4.033	0.049	4.008	4.064	.....	4.064	+0.056
7	12–21–44	4.068	.....	4.068	3.994 3.948	0.046	3.971	−0.097
8	1–15–45	3.966. 3.906	0.060	3.936	3.931 3.888	0.043	3.910	−0.026
9	1–16–45	3.702	.....	3.702	3.706	.....	3.706	+0.004
10	1–17–45	3.898 3.899	0.001	3.898	3.876 3.887	0.011	3.881	−0.017
11	1–18–45	3.848 3.849	0.005	3.848	3.847 3.868	0.021	3.857	+0.009
12	1–19–45	3.980 3.973	0.007	3.977	3.982 3.996	0.014	3.989	+0.012
13	1–22–45	5.012 5.038	0.026	5.025	5.049 5.040	0.009	5.044	+0.019
14	1–23–45	4.956 4.973	0.017	4.964	4.936 4.934	0.002	4.935	−0.029
15	1–24–45	4.575 4.628	0.053	4.601	4.653 4.634	0.019	4.643	+0.042
16	1–25–45	5.124 5.082	0.042	5.103	5.047 5.082	0.035	5.064	−0.039
17	1–26–45	4.470 4.476	0.006	4.473	4.493 4.503	0.010	4.498	+0.025
18	1–29–45	4.591 4.589	0.002	4.590	4.580 4.600	0.020	4.590	0.000
19	1–30–45	4.763 4.761	0.002	4.762	4.759 4.768	0.009	4.763	+0.001
20	1–31–45	4.619 4.606	0.013	4.612	4.608 4.606	0.002	4.607	−0.005
21	2– 1–45	4.532 4.537	0.005	4.534	4.543 4.552	0.009	4.547	+0.013
22	2– 2–45	4.585 4.575	0.010	4.580	4.560 4.570	0.010	4.565	−0.015
23	2– 5–45	4.375 4.409	0.034	4.392	4.407 4.404	0.003	4.405	+0.013
24	2– 6–45	4.606 4.627	0.021	4.616	4.641 4.644	0.003	4.642	+0.026
25	2– 7–45	4.591 4.596	0.005	4.593	4.597 4.586	0.011	4.591	−0.002
26	2– 8–45	4.786 4.789	0.003	4.789	4.785 4.777	0.008	4.781	−0.006
27	2– 9–45	4.556 4.592	0.036	4.574	4.594 4.593	0.001	4.593	+0.019
28	2–19–45	3.831 3.804	0.027	3.818	3.804 3.815	0.011	3.810	−0.008
29	2–20–45	3.708 3.699	0.009	3.704	3.701 3.694	0.007	3.698	−0.006
30	2–22–45	3.651 3.650	0.001	3.650	3.672 3.671	0.001	3.671	+0.021
31	2–23–45	3.897 3.926	0.029	3.912	3.918 3.903	0.015	3.911	−0.001
32	2–26–45	3.723 3.716	0.007	3.720	3.724 3.738	0.014	3.731	+0.011
33	2–27–45	3.695 3.716	0.021	3.706	3.712 3.695	0.017	3.704	−0.002
34	2–28–45	3.850 3.864	0.014	3.857	3.835 3.832	0.003	3.834	−0.023
35	3– 1–45	3.814 3.801	0.013	3.807	3.826 3.817	0.009	3.821	+0.014
36	3– 2–45	3.916 3.886	0.030	3.901	3.898 3.882	0.016	3.890	−0.011
Averages		(Arithmetic) ...	0.0189	4.2015	....	0.0124	4.2032	0.0177
		(Algebraic)	.....	.....	....	.....	.....	+0.0017

Thus, comparisons are made on homogenized milk tested under the same conditions as the nonhomogenized samples. In other words, the regular Bab-

TABLE 2

Comparison of modified Babcock and Mojonnier tests on homogenized milk

Trial no.	Date	Modified Babcock test of milk			Variation of modified Babcock test from Mojonnier test	
		Not homogenized	Homogenized	Difference	Not homogenized	Homogenized
		Average of duplicates	Average of duplicates			
		%	%			
1	12–13–44	3.725	3.70	−0.025	+0.008	−0.014
2	12–14–44	4.00	4.00	0.00	+0.070	+0.048
3	12–15–44	4.10	4.10	0.00	+0.065	+0.036
4	12–18–44	4.10	4.10	0.00	+0.135	+0.124
5	12–19–44	3.95	3.95	0.00	+0.058	+0.055
6	12–20–44	4.10	4.05	−0.05	+0.092	+0.014
7	12–21–44	4.05	4.025	−0.025	−0.018	+0.054
8	1–15–45	4.00	4.00	0.00	+0.064	+0.090
9	1–16–45	3.80	3.775	−0.025	+0.098	+0.069
10	1–17–45	3.925	3.90	−0.025	+0.027	+0.019
11	1–18–45	3.90	3.90	0.00	+0.052	+0.043
12	1–19–45	4.025	4.00	−0.025	+0.048	+0.011
13	1–22–45	5.075	5.125	+0.05	+0.050	+0.081
14	1–23–45	5.00	4.95	−0.05	+0.036	+0.015
15	1–24–45	4.675	4.65	−0.025	+0.074	+0.013
16	1–25–45	5.175	5.15	−0.025	+0.072	+0.086
17	1–26–45	4.525	4.525	0.00	+0.052	+0.027
18	1–29–45	4.65	4.625	−0.025	+0.060	+0.035
19	1–30–45	4.80	4.80	0.00	+0.038	+0.037
20	1–31–45	4.70	4.70	0.00	+0.088	+0.093
21	2– 1–45	4.575	4.575	0.00	+0.041	+0.028
22	2– 2–45	4.625	4.625	0.00	+0.045	+0.060
23	2– 5–45	4.475	4.475	0.00	+0.033	+0.070
24	2– 6–45	4.675	4.70	+0.025	+0.059	+0.058
25	2– 7–45	4.625	4.625	0.00	+0.032	+0.034
26	2– 8–45	4.80	4.80	0.00	+0.013	+0.019
27	2– 9–45	4.675	4.60	−0.075	+0.101	+0.007
28	2–19–45	3.85	3.85	0.00	+0.032	+0.040
29	2–20–45	3.725	3.70	−0.025	+0.021	+0.002
30	2–22–45	3.725	3.70	−0.025	+0.075	+0.089
31	2–23–45	3.95	3.925	−0.025	+0.038	+0.014
32	2–26–45	3.775	3.775	0.00	+0.055	+0.044
33	2–27–45	3.775	3.75	−0.025	+0.069	+0.046
34	2–28–45	3.90	3.875	−0.025	+0.043	+0.041
35	3– 1–45	3.90	3.875	−0.025	+0.093	+0.054
36	3– 2–45	3.975	3.925	−0.05	+0.074	+0.035
Averages	(Arithmetic)	4.258	4.244	0.018	0.058	0.045
	(Algebraic)	.....	.....	−0.014	+0.057	+0.044

cock procedure was not used as a standard for the nonhomogenized milk. It was believed that no modification of the Babcock procedure would improve the accuracy of the regular Babcock procedure on nonhomogenized

milk. Consequently, the modified Babcock technique was used on the nonhomogenized milk also, and the results accepted as though they were obtained by the regular procedure. A few trials run on nonhomogenized milk by the regular and modified procedures showed the tests to be comparable in every respect.

RESULTS

The data are presented in tables 1 and 2. The average tests of the 36 nonhomogenized and homogenized samples, as determined by the Mojonnier method, were practically identical; the homogenized milk averaged 0.0017 per cent higher than the same milk not homogenized. A study of the duplicate Mojonnier tests showed less variation, on the average, between the tests of homogenized milk than between those of the nonhomogenized milk, although there were several exceptions.

The modified Babcock method yielded tests on homogenized milk on the average within 0.018 per cent of that of the same milk not homogenized. Of the 36 tests, 16 (or 44 per cent) checked with those of the nonhomogenized milk; 15 (or 41 per cent) were 0.025 per cent lower; one was 0.025 per cent higher; two were 0.05 per cent lower; one was 0.05 per cent higher; and one was 0.075 per cent lower. The average algebraic difference was −0.014 per cent lower than that of the nonhomogenized milk.

DISCUSSION

In presenting the suggested modified Babcock procedure for testing homogenized milk, no claim is made for originality. The suggested technique resulted from observations made while testing homogenized milk by the many recommended procedures, results of which already have been published (9). Particular use was made of the principles involved in some of the methods (1, 5, 6, 7, 8, 10). During this earlier study (9) it appeared necessary to prolong action of the sulphur acid on the milk at a concentration to give maximum digestion without burning. Also, continued agitation of the acid-milk mixture following final addition of the acid seemed to facilitate more complete digestion of the caseous matter. These modifications, while involving more time than the regular Babcock method, did not require as much time as did some of the suggested methods. Considerable importance is associated with the correct temperature, both of the acid and of the milk. The procedure used was based on temperatures of 70° F. With this temperature a relatively large volume of sulphuric acid could be introduced into the milk at the first addition without harmful results. Maintaining maximum chemical reaction through further additions of acid and prolonged agitation before centrifuging seem imperative.

Also, importance is associated with the addition of the full volume (17.5 ml.) of sulphuric acid rather than reducing the total volume. This seems to be in accordance with the work of Bailey (3), who showed in his extensive

studies on the Babcock test that casein was digested with more difficulty when fat was homogenized into the solution. Data indicated that, as the volume of acid was increased, a lesser percentage of insoluble organic material remained in the mixture.

The feature of remixing the acid-milk mixture after either the first or second centrifugings, and before or after the addition of all or a part of the water (1, 5, 6, 7, 10), was not incorporated into the suggested technique. Such remixing would seem to indicate that the caseous matter was not wholly digested at the time of centrifuging. Apparently if the original mixing and agitation under the best conditions of temperature and concentration of acid were insufficient to digest all the adsorbed casein, then lower temperatures, which naturally follow during the carrying out of the procedure, and a diluted acid, due to the addition of water, would not facilitate further digestion. Furthermore, by remixing the centrifuged fat with the acid-serum-water-liquid, a partial loss of the benefits of the preceding centrifuging would seem to occur. Retention of the caseous matter in its digested form through the addition of hot water (140° F. or above) or other liquids (2, 3) in bringing the liberated fat up into the neck of the bottle for reading seems important. Beautifully clear fat columns were obtained when a hot sulphuric acid–water mixture (7 : 10) was added instead of water after the centrifugings to bring the fat up for reading (2). However, one lot of 12 tests made using this variant averaged 0.18 per cent lower on the homogenized milk than on the nonhomogenized milk; in another series of 15 samples, the difference was 0.12 per cent lower. Hence, the introduction of an acid-water mixture instead of hot water to raise the fat offered no possibilities.

Brueckner's (4)* recommendation of adding a water-alcohol mixture (ratio 1.4 : 1 by weight) to the tests of homogenized milk to bring the fat up into the column before final centrifuging appears to have considerable merit. Despite any char formation, the tendency of which seems to be reduced, the fat column is clear, is supported by a clear solution, and has well-defined menisci. However, the results of a few trials indicate that the fat-test reading is slightly higher when the water-alcohol solution is used to support the fat column of homogenized milk than when water alone was used. This slightly increased reading may offset, in part, the slightly lower test generally reported on Babcock tests of homogenized milk. Several factors, such as the slight solubility of alcohol in fat and *vice versa,* may contribute to the slightly higher reading of the fat column of homogenized milk when using the water-alcohol mixture to force up the fat, but the appearance of the fat column with its relatively deep menisci supported by a perfectly clear liquid would indicate that such fat columns were in the best condition for reading. The menisci were well defined, probably due to the drying and cleaning action of the alcohol on the glass, thereby enhancing the capillarity of the fat. Thus, the seemingly increased depth of menisci might

be sufficient to account for the slightly higher reading. Reports of use of the water-alcohol solution to bring up the fat column on Babcock tests of homogenized milk in routine testing in a commercial laboratory indicate much satisfaction over its use.

In view of the many modifications of the Babcock method for testing homogenized milk, the authors are extremely reluctant to suggest another technique. However, in the interest of clarifying and unifying the procedure with a minimum of time involved, the apparently most satisfactory features of the various methods were incorporated into one method. It is hoped that this procedure will simplify and lend greater accuracy to the Babcock testing of homogenized milk, rather than add to the confusion.

SUMMARY

A modified Babcock fat test for homogenized milk, employing the best features of the many modifications now recommended, has been suggested. The technique involves tempering the milk and acid to 70° F.; using at least 17.5 ml. of sulphuric acid with sp. gr. of 1.83 to 1.835; adding the acid in three portions, the first consisting of approximately one half of the acid; and prolonging the agitation of the milk-acid mixture prior to centrifuging. The addition of a water-alcohol mixture (ratio 1.4:1 by weight) to the test instead of water alone before final centrifuging adds to the clarity of the fat column without appreciably affecting the reading.

Employing the suggested technique, the arithmetic-average fat test of 36 samples of homogenized milk was 0.018 per cent lower than that of the same test applied to similar milk not homogenized. The arithmetic-average variations of the 36 tests from the Mojonnier tests were +0.058 and +0.045 per cent for nonhomogenized and homogenized milk, respectively.

Credit is due Mr. Robert Frantz for the making of the tests reported herein.

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METHODS OF PRESERVING GRASS SILAGE AND VITAMIN A POTENCY OF MILK PRODUCED THEREFROM[1]

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In previous publications a number of methods for the preservation of grass forages have been reported (3, 7). The investigation has been continued with several forages to which were added various materials to aid in preservation. In addition to chemical analysis of the forages and silages, short-time feeding tests have been made on all the silages to determine their palatability, and longer feeding trials have been made on the most important lots in order to obtain data regarding milk production and the vitamin A potency of the milk produced by cows fed these silages. The work has been extended to several farms which were part of an experimental grass silage program sponsored by the College of Agriculture.

EXPERIMENTAL

Silages. In preliminary experiments, forages treated in different ways were ensiled in layers in silos 8 or 10 feet in diameter. Each layer contained one to 5 tons of forage. The preservative was added to the forage as it was passed through the silage cutter in order to obtain uniform distribution. When the silo was opened, the silages were analyzed and fed, and the readiness with which the cows consumed each lot was recorded. The methods of preservation which had been most successful in the layer trials were further tested on a larger scale. Quantities of fresh forage ranging from 5 to 20 tons were ensiled and the resulting silages were used for feeding experiments. Chemical analyses of the forage and silage were made. Dry matter was obtained by drying in an electric oven at 105° C., and the pH of the silage was determined on the expressed juice by means of a glass electrode. The carotene content was determined by the method of Hegsted, Porter, and Peterson (2), except that a photoelectric colorimeter and a calibration curve of β-carotene in Skelly solve were used instead of a spectrophotometer. Light absorption by the carotene solution was measured with a 440-μ filter.

Milks. The silages used in the feeding trials were fed to lots of from five to nine cows each. The animals composing each lot were selected so that lactation, weight, and milk and butterfat production were approximately equal at the time the feeding trials were begun. Representative samples of morning and evening milkings were obtained from each lot of animals and

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analyzed for their butterfat, carotene, and vitamin A content. The carotene and vitamin A contents of these milks were determined by the methods of Olson, Hegsted, and Peterson (4) and Berl and Peterson (1). The method used for the extraction and saponification of the butterfat in the milk was that of Olson *et al.* The procedures used for drying the ethereal extract, analysis for β-carotene in Skelly solve and vitamin A in chloroform were those of Berl and Peterson (1).

RESULTS

Layer silages. Table 1 summarizes the data for the layer silage experiments. In silo I, 9 different materials or treatments were tested to determine their usefulness as a means of preservation. Acidity, which is usually a good index of quality, ranged from pH 4.2 to 5.2. The best layers from the standpoint of palatability were those approximating 4.5 or less. Silages which have a pH above 4.5 often contain butyric acid, ammonia, and other fermentation products having an objectionable odor. The layers of alfalfa preserved with Silogerm (a commercial bacterial culture for the preservation of silage) and salt (I–2), and salt alone (I–4) had undergone a butyric type of fermentation and were of poor quality. Carotene preservation in these two silages was reasonably good, however. A butyric fermentation and carotene preservation not uncommonly go together. Butyric fermentation occurs under anaerobic conditions, and exclusion of air favors carotene preservation. The wilted alfalfa and the alfalfa ensiled without a preservative were well preserved and palatable, showing that at times good silage may be obtained without any additions. However, these layers were far down in the silo, where there was considerable pressure from above, and this condition may have favored preservation. The most palatable silages were produced by addition of corn meal, molasses, or concentrated soured whey to the forage. Concentrated soured whey was produced from whey which had been inoculated with a 1 per cent inoculum of *Lactobacillus bulgaricus* and incubated under anaerobic conditions at 110° F. for 5 days. The soured whey was concentrated in vacuo to one-seventh of the original volume and applied to the forage at a rate of 70 pounds per ton. The layers preserved with concentrated soured whey and whey alone were very soggy. There was no correlation between carotene and pH or between carotene and palatability.

The differences between the dry-matter content of the forage and the corresponding silage noted in tables 1 and 2 may be due, in part, to variations in sampling, but in some cases are due to additions either of liquid (*e.g.*, whey) or of dry material (*e.g.*, dry sorghum fodder) to the forage at the time of ensiling. There also would be a tendency for the moisture content of the layers to become equal because of the movement of liquid or water vapor from one layer to the next.

In 1941, the unavailability of molasses led to further experiments (layers II–1 to II–9) in search of a suitable method for preserving grass silage by

TABLE 1

Composition of layer silages

Silo and layer[a]	Year	Forage	Addition or treatment	Preservative	Dry matter		pH	Carotene (dry basis)		Palatability[c]
					Fresh forage	Silage		Fresh forage	Silage	
				lbs./ton	*%*	*%*		*μg./gm.*	*μg./gm.*	
I–1	1940	Clover-timothy	Corn meal	150	36.2	36.5	4.3	130	86	Good
I–2	1940	Alfalfa	Silogerm and salt	[b]	28.1	22.1	5.2	192	118	Poor
I–3	1940	Alfalfa	Dry sorghum fodder	250	27.3	26.0	4.5	164	65	Good
I–4	1940	Alfalfa	Salt	10	27.3	23.5	5.2	164	142	Poor
I–5	1940	Alfalfa	None	None	27.3	25.4	4.6	164	83	Good
I–6	1940	Alfalfa	Wilted, 37% D.M.	None	48.6	35.3	4.8	92	70	Good
I–7	1940	Alfalfa	Wilted, 37% D.M., molasses	60	37.8	35.9	4.3	145	81	Excellent
I–8	1940	Alfalfa	Conc. soured whey	70	26.9	25.0	4.3	146	73	Good
I–9	1940	Alfalfa	Wilted, whey	600	42.2	32.5	4.2	100	80	Fair
II–1	1941	Sweet clover (3)–corn (1)	None	None	29.3	30.5	4.1	91	86	Good
II–2	1941	Sweet clover (1)–corn (1)	None	None	28.0	24.5	3.8	83	70	Good
II–3	1941	Alfalfa	None	None	22.9	22.8	4.7	172	5	Poor
II–4	1941	Alfalfa	Silogerm and salt	[b]	22.9	23.0	5.2	172	34	Poor
II–5	1941	Alfalfa	Vacatone	30	21.9	22.1	5.1	172	28	Good
II–6	1941	Alfalfa	Vacatone	60	21.9	24.6	5.0	172	47	Good
II–7	1941	Alfalfa	Wilted, 40% D.M.	None	43.3	25.6	4.9	72	87	Fair
II–8	1941	Alfalfa	Ground barley	200	31.8	31.7	4.4	172	117	Fair
II–9	1941	Alfalfa	Corn and cob meal	250	31.8	30.2	4.0	172	151	Excellent
III–1	1942	Alfalfa	Ground shelled corn	200	41.0	31.9	4.8	75	31	Good
III–2	1942	Alfalfa	Whole shelled corn	200	41.0	30.2	4.5	75	46	Good
III–3	1942	Alfalfa	Ground wood shavings	200	.....	33.7	4.6	.....	39	Poor
III–4	1942	Alfalfa	Oat straw	200	34.5	38.0	4.7	133	30	Poor
III–5	1942	Alfalfa	Dry sorghum fodder	200	29.9	43.7	4.5	140	29	Poor
III–6	1942	Alfalfa	Wilted, 60% D.M.	None	60.0	57.2	4.5	.....	12	Fair

[a] The first number refers to the silo and the second to the layer. The layers are in the order in which they were removed from the silo.

[b] A mixture of 10 lbs. salt, 36.4 gm. Silogerm, 9.05 gm. lactose, and water to make 120 lbs. was applied at the rate of 30 lbs. per ton as recommended by the manufacturer of Silogerm.

[c] Palatability was judged by odor, appearance and consumption.

use of other adjuvants. As judged by pH, odor, carotene content and palatability, alfalfa ensiled with corn and cob meal, and sweet clover in combination with green corn in the ratios of 1:1 and 3:1 gave good silages. A fair silage was obtained from wilted alfalfa. Poor silages were obtained from alfalfa ensiled with Silogerm and salt and with Vacatone (residual solids from the industrial fermentation of molasses). The untreated alfalfa was very poor. More extensive chemical analyses were performed on the alfalfa preserved with Silogerm and salt. The ammonia nitrogen in this silage amounted to 0.70 per cent, the acetic acid to 3.32 per cent, and the butyric acid to 4.98 per cent, all calculated on the basis of dry-matter. The volatile acids and the ammonia content of this silage were similar to the values for poor quality silage reported in previous experiments (5).

In 1942 other materials were used as preservatives (layers III–1 to III–6). The object in these experiments was to raise the dry-matter content of the ensiled material to 30 or 35 per cent. The fresh forage was in the late stages of maturity when ensiled. The alfalfa layers preserved with ground or whole corn and by wilting produced fair to good silages. The wilted forage had been rained on twice and had been wilted for 3 days, resulting in a very low carotene content. The alfalfa layers treated with oat straw and ground wood shavings were not palatable and had characteristic straw-like and woody odors. Dry sorghum fodder did not preserve the alfalfa, for the silage was moldy and dry, and the carotene content was low, even though the acidity was equal to that found in good silages.

Composition of silages used in longer feeding trials. Of the many preservatives used in the palatability tests, several were tested further on a larger scale in order to include more complete feeding trials. In 1940, three different silos were filled with the following forages: oat-and-pea mixture sown in a ratio of 4 to 1, Sudan and soybean combination in a seeding ratio of 2 to 1, and alfalfa. Table 2 gives the kind and the amount of preservative used, as well as the analytical data on the fresh forage and the corresponding silage. All three silages were very palatable. However, the carotene contents of lots 3a, 3b, and 3c were low regardless of the kind and amount of preservative used. There was no apparent explanation for the high carotene loss.

In the following year, 1941, the soybean-sorghum silage, in ratios of 1:1, 2:1, and 4:1, was of good quality, although the loss of carotene during ensiling was high in two of the lots. Lots 5a, 5b, and 5c, which were preserved with whey powder, were rated as good silages in spite of the poor carotene preservation. Lots 6a, 6b, and 6c, which consisted of one layer containing no preservative and two others containing different amounts of corn and cob meal, were very good silages as judged by odor and color. However, the carotene preservation was not the same for all layers. The layer which contained 250 pounds of corn and cob meal had very little caro-

TABLE 2

Composition of silages used in feeding trials

Lot	Year	Material	Treatment	Preservative	Dry matter		pH	Carotene (dry basis)		Carotene loss
					Fresh forage	Silage		Fresh forage	Silage	
				lbs./ton	%	%		*μg./gm.*	*μg./gm.*	%
1a	1940	Oats-peas	None	.....	27.8	28.7	4.1	131	99	24
1b	1940	"	Phosphoric acid	15	29.1	27.4	4.0	144	130	10
1c	1940	"	"	8	27.4	25.8	3.9	149	138	7
1d	1940	"	Molasses	40	25.3	25.3	3.9	165	130	21
2a	1940	Sudan (2)– soybeans (1)	None	.....	20.7	19.9	3.9	204	106	48
2b	1940	"	Phosphoric acid	12	20.4	17.4	4.5	266	128	52
2c	1940	"	Molasses	40	20.8	19.6	4.1	220	196	11
3a	1940	Alfalfa	Molasses	60	29.7	27.5	4.4	126	76	40
3b	1940	"	Corn and cob meal	150	30.2	33.8	4.3	160	32	80
3c	1940	"	"	200	28.8	33.5	4.3	188	90	52
4a	1941	Soybeans (1)– sorghum (1)	None	.....	29.7	31.6	3.7	143	84	41
4b	1941	Soybeans (2)– sorghum (1)	None	.....	32.2	30.7	4.0	143	74	48
4c	1941	Soybeans (4)– sorghum (1)	None	.....	34.9	30.1	4.3	98	85	13
5a	1941	Alfalfa	Whey powder	10	27.4	30.6	4.5	135	56	59
5b	1941	"	"	20	28.6	28.0	4.4	135	32	76
5c	1941	"	"	30	34.3	32.7	4.3	135	68	50
6a	1941	"	None	.....	34.6	36.2	4.5	113	7	94
6b	1941	"	Corn and cob meal	200	29.5	29.6	4.3	113	17	85
6c	1941	"	"	250	29.5	28.0	4.3	113	89	21
7	1942	"	Wilted, 40% D.M.	.....	41.7	39.9	4.9	116	64	45
8	1942	"	Corn and cob meal	200	29.5	30.8	4.5	125	70	44
9	1943	Corn	None	.....	22.4	21.7	3.8	107	72	33
10	1943	Alfalfa	Corn and cob meal	200	24.0	23.6	4.4	202	241	0

tene loss; 200 pounds of corn and cob meal gave very low carotene preservation; and the layer which was untreated had lost most of the original carotene. The difference in carotene preservation obtained with a variation of 50 pounds in corn and cob meal was unexpected. The alfalfa used in these experiments was ensiled in the late blossoming stage in order to raise the dry-matter content. In consequence of this more mature condition, it was low in carotene and in most lots the loss was heavy. Corn and cob meal is slow in promoting the development of lactic acid–producing bacteria, which are important in bringing about anaerobic conditions and consequent retardation of carotene oxidation. Also, a high dry-matter content is less favorable for good packing and exclusion of air from the ensiled material. With several factors involved, it is possible that in a given case irregular results may be obtained. Even with molasses, which is a much better preservative than corn and cob meal, poor preservation is encountered occasionally. In our judgment, good preservation of carotene should not entail a loss of more than 25 per cent of the carotene of the forage.

In 1942, two silos were filled with alfalfa preserved by wilting to 40 per cent dry matter (lot 7) and by adding 200 pounds of corn and cob meal per ton (lot 8). Chemical analyses of these two silages (table 2) show that good silages were obtained. The carotene loss was approximately 50 per cent. The alfalfa silage containing corn and cob meal was more readily consumed by the animals than the untreated alfalfa.

In 1943, the experiments were set up to determine the comparative value of corn and alfalfa silages for maintaining the carotene and the vitamin A content of milk. To obtain silages high in carotene content, material in the early stages of maturity was ensiled. In one silo, succulent alfalfa was preserved with 200 pounds corn and cob meal and, in another, corn in the early-dough stage was ensiled. Excellent silages (lots 9 and 10) were obtained. The data show that in order to obtain good silage, the material ensiled must be of good quality.

Milk production and change in body weight. Table 3 summarizes the data on feed consumption, milk production, and changes in body weight of animals fed the silages listed in table 2. In the 1940, 1941, and 1943 feeding experiments, each lot consisted of five cows, while in the 1942 feeding trials the lots were made up of nine cows each. The alfalfa hay used for these experiments contained from 15 to 25 micrograms of carotene per gram of dry matter. The rations for all lots, except 10 and 11, contained equivalent amounts of protein as the result of adding linseed meal to the grain mixtures of lots 1, 2, 4, and 9. From the data in table 3 it appears that the silages were of approximately equal nutritive values, as judged by milk production and body weight.

In 1942 feeding trials showed that apparently all of the corn and cob meal used as preservative for the alfalfa was available to the animal. The

TABLE 3

Feed consumption, milk production and change in body weight per cow per day

Lot	Silage fed	Silage	Alfalfa hay	Grain mixture*	Av. daily 4% F.C. milk	Weight change	Av. decline 4% F.C. milk
		lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1940	*17 weeks feeding period*						
1	Oats-peas	42.4	9.2	11.3	27.97	+0.31	0.101
2	Sudan-soybeans	43.6	9.7	11.2	28.56	−0.06	0.088
3	Alfalfa–corn and cob meal	42.8	9.5	10.9	28.03	+0.56	0.102
1941	*16 weeks*						
4	Sorghum-soybeans	48.8	6.4	8.3	26.85	+0.029	0.105
5	Alfalfa–whey powder	47.4	6.2	8.3	25.02	−0.33	0.139
6	Alfalfa–corn and cob meal	49.1	6.4	8.3	26.88	−0.06	0.139
1942	*7 weeks*						
7	Alfalfa–wilted	31.4	5.6	10.4	30.09	−0.42	0.066
8	Alfalfa–corn and cob meal	50.1	5.5	6.1	30.16	−0.07	0.038
1943	*13 weeks*						
9	Corn	40.3	14.0	8.5	25.67	+0.80	0.065
10	Alfalfa–corn and cob meal	40.8	14.0	8.7	24.41	+0.91	0.080
11	Corn, ½; alfalfa–corn and cob meal, ½	40.4	14.0	8.7	25.02	+0.86	0.088

* Ingredients	Lots 1, 2 and 4	Lots 3, 5 and 6	Lot 7	Lot 8	Lots 9, 10 and 11
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Ground corn	64.4	69.4	48.5	19.0	38
Ground oats	24.8	27.7	48.5	76.2	30
Bran	.....	.....	.....	.....	20
Linseed meal	9.9	.....	.....	.....	10
Bone meal	.....	1.9	2.0	2.9	.....
Iodized salt	1.0	1.0	1.0	1.9	1.0
Calcium flour	.....	.....	.....	.....	1.0
Irradiated yeast	.....	.....	.....	.....	0.025

grain mixture fed lot 8 was adjusted to allow for the corn and cob meal used in the preservation of the alfalfa. There were no differences between the two lots, one receiving wilted alfalfa silage (lot 7) and the other silage preserved with corn and cob meal (lot 8).

Lots 9, 10, and 11, which were based on an ordinary farm ration, showed that good corn silage is equivalent to good alfalfa silage for milk production.

Carotene and vitamin A content of milks. The data for the carotene and vitamin A intake of each lot of cows on the feeding trials as well as the vitamin A potency of the milks produced are given in table 4. The milks from the cows in lots 1, 2, and 3 had a high carotene and vitamin A content as compared to the milks produced in the 1941, 1942, and 1943 trials. Milk from lots 4, 5, and 6 had only about 50 per cent of the vitamin A potency (carotene and vitamin A together) of the 1940 milks. The silages fed were low in carotene, and the carotene and vitamin A contents of the corresponding milks were below the average for winter milk. The feeding trials in 1942 showed no differences in the vitamin A potency of the milks produced by animals fed wilted alfalfa silage and those fed alfalfa preserved with corn and cob meal. Waugh *et al* (6), in comparing two groups of cows, one fed corn silage and the other alfalfa–brome grass silage, found no differences in milk production or change in body weight. However, the cows fed corn silage containing 50 micrograms of carotene per gram of dry matter produced milk exceedingly low in vitamin A potency (approximately 9 I.U. per gram of butterfat). The animals fed alfalfa–brome grass silage produced milk of vitamin A potency above the average for winter feeding.

The 1943 experiments indicated that corn silage of high carotene content was almost equivalent to excellent alfalfa silage.[3] Although the cows in lot 10 ingested approximately three times as much carotene as those in lot 9, the vitamin A potency of the milk was only 20 per cent higher than from lot 9 and no higher than that from cows ingesting about two-thirds as much carotene (lot 11). The carotene and vitamin A content of milk from lot 10 accounted for less than one per cent of the carotene intake. In lot 9, 2 per cent of the ingested carotene was accounted for in the milk. As may be seen, the amount of carotene ingested did not correlate with the vitamin A potency of the milk produced. Other undetermined factors appear to have operated. The vitamin A level of the milk for each lot remained constant for the 13 weeks of the 1943 feeding trial.

Survey of experimental farm milks. These data were obtained as part of a grass silage harvester program under farm conditions which was sponsored

[3] Another short experiment, in which cows fed a low-carotene corn silage (26 μg. per gram dry matter) were switched to a high-carotene corn silage, showed that the vitamin A potency of the milk followed the increase in carotene intake very closely. At the beginning of the experiment the vitamin A potency of the milk was 14 I.U. per gram of butterfat and, after feeding high carotene silage for 3 weeks, it rose to 30 I.U. per gram of butterfat.

TABLE 4

Carotene and vitamin A content of milks produced in feeding trials

Lot	Year	Silage	Butterfat	Carotene intake*	Carotene	Vitamin A	Vitamin A potency, I.U.	
			%	*mg./day*	*μg./gm. butterfat*	*μg./gm. butterfat*	*per gm. butterfat*	*per 100 ml. milk*
1	1940	Oats-peas	3.5	722	9.3–10.2 9.8†	8.3–8.6 8.5†	50	183
2	1940	Sudan-soybean	3.5	641	8.5–8.9 8.7	7.1–8.3 7.7	45	166
3	1940	Alfalfa–corn and cob meal	3.9	491	6.0–7.5 7.3	8.2–8.6 8.4	46	185
4	1941	Soybean-sorghum	3.9	611	2.1–3.4 2.9	2.9–5.2 3.9	20	84
5	1941	Alfalfa–whey powder	3.5	396	3.3–3.7 3.5	4.2–4.6 4.4	23	83
6	1941	Alfalfa–corn and cob meal	3.8	323	1.5–3.0 2.5	2.3–4.9 3.6	19	74
7	1942	Alfalfa–wilted, 40% D.M.	3.55	415	2.9–3.2 3.0	6.1–6.6 6.4	31	113
8	1942	Alfalfa–corn and cob meal	3.85	540	5.2–5.6 5.4	5.9–6.0 6.0	33	131
9	1943	Corn	4.0	414	4.1–5.8 4.6	5.2–7.4 5.6	30	124
10	1943	Alfalfa–corn and cob meal	3.6	1164	4.2–7.0 5.7	6.0–7.9 6.9	37	137
11	1943	Corn (1 part); alfalfa and cob meal (1 part)	4.2	784	3.8–5.9 5.4	5.2–6.5 5.9	33	143

* Includes carotene supplied by hay; 20 μg. per gram of dry matter was used as an average value.
† The third figure is the average of the preceding two figures.

TABLE 5

Data on experimental farm silages and milks

Silage*	Silage analysis			Milk analysis			Vitamin A potency, I.U.	
	pH	Dry matter	Carotene	Butterfat	Carotene	Vitamin A		
		%	μg./gm. *dry matter*	%	μg./gm. *butterfat*	μg./gm. *butterfat*	*per gm. butterfat*	*per 100 ml. milk*
Alfalfa	4.2	29.5	250	3.5	4.7	10.6	50	180
Sweet clover	3.9	29.5	75	3.7	3.4	7.0	34	130
Alfalfa	4.1	26.3	154	3.9	3.8	5.9	30	120
Alfalfa	4.2	29.3	156	4.8	4.8	5.6	30	148
Alfalfa	4.4	30.5	30	3.2	2.1	5.7	26	86
Timothy	4.1	29.3	74	3.6	1.6	5.3	24	89
Corn	.....	.....	.....	5.0	8.8	3.0	27	139
Alfalfa	.....	25.6	118	4.7	10.0	3.4	30	145

l grass silages were preserved with 200 lbs. corn and cob meal with the exception of that from farm no. 4 which was preserved
asses.

by the College of Agriculture. The analyses (table 5) show that four of the alfalfa silages were unusually high in carotene. These were ensiled during the early stages of maturity. Farm no. 1 produced milk which had a vitamin A potency equal to that of summer milk. This herd had been fed high carotene silage for 3 months previous to the time the sample was taken. It will be noted that the feeding of low-carotene silage (*e.g.*, farm no. 5) resulted in milk low in vitamin A potency.

An experiment was conducted at the La Crosse, Wisconsin, Soil Conservation Experiment Station (farm no. 7) to note the effect of replacing corn silage in an ordinary farm ration with alfalfa silage. During the last month (February) on corn silage, the vitamin A potency decreased from 32 to 27 I.U. per gram of butterfat. The cows were then switched to alfalfa silage which contained 118 micrograms of carotene per gram of dry matter. The decline stopped, and after 3 weeks the vitamin A potency reached 30 I.U. per gram of butterfat and remained at this level for a month, when the experiment was terminated.

SUMMARY

In a study of various methods of ensiling grasses and legumes, preservation by the addition of 200 pounds corn and cob meal per ton gave a very palatable silage, although carotene preservation was not as good as with some other methods, *e.g.*, molasses.

No significant differences were found in milk production and change in body weight when the lots for any one feeding period were compared.

A comparison of good corn and alfalfa silages indicated that both silages had apparently equivalent feed value on the basis of milk production and change in body weight. The vitamin A potency of the milk produced from these two silages varied by only 20 per cent. Alfalfa silage high in carotene generally increased and maintained the carotene and vitamin A level in winter milk.

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THE EFFECT OF SUPPLEMENTARY VITAMINS ON BLOOD COMPOSITION, LIVER STORAGE, AND INCIDENCE OF SCOURS IN CALVES

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Following the reports by Wisconsin workers (4, 8) that supplementary vitamin feeding is beneficial in preventing calf scours, much interest has developed regarding the possibilities in vitamin supplementation for calves. Most previous work has been done with calves maintained on skim milk or calves from dams known to be on a low level of vitamin A intake. We, therefore, undertook to determine the effect of two systems of vitamin supplementation on the blood picture, liver storage, and scour incidence of calves maintained under normal herd conditions.

In these experiments each calf was allowed to nurse before the dam was milked out. The calves remained on their dams for at least 3 days and were then pail-fed on whole milk. Hay and grain were fed beginning at 2 weeks of age. Calves of both the Jersey and Holstein breeds were included in this experiment and the blood and liver data of both breeds are combined in the results.

Blood plasma vitamin A and carotene were determined by the method of Kimble (2). Liver vitamin A and carotene were determined by using the extraction procedure of Guilbert and Hart (1). Blood plasma ascorbic acid was determined by the macromethod of Mindlin and Butler (6). All colorimetric readings were made using an Evelyn photoelectric colorimeter.

EXPERIMENT 1

The first experiment was carried out during the late winter and early spring months of 1945, before the pasture season. Alternate calves were placed in Group I (control) and Group II (experimental). Group I (fifteen calves) received a placebo capsule[1] containing a biologically inactive oil. Group II (fifteen calves) received one multivitamin capsule daily for the first 20 days. These capsules contained 10,000 USP units of vitamin A, 300 USP units of vitamin D, 50 mg. of niacin, and 250 mg. of ascorbic acid.

Blood samples were drawn for analysis of plasma vitamin A, carotene, and ascorbic acid on the same day each week from all calves under 31 days of age. In averaging the results, all determinations made on the first, second, and third days were averaged separately. All determinations made between the fourth and eleventh days were grouped together and considered as the seventh

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[1] All vitamin capsules were supplied by The Gelatin Products Company, Detroit, Michigan, to whom grateful acknowledgment is herewith extended.

day. Similar groupings of the data were made centering on the fourteenth, twenty-first, and twenty-eighth days. Total vitamin A liver storage was determined on four male calves in Group I and on five male calves in Group II at 21 days of age.

The average results of the blood and liver analyses are presented in figure 1. The vitamin A liver storage indicated is due to vitamin A alone. A small carotene storage was found which amounted to an average of 813 USP units per liver in the nine calves. Plasma vitamin A reached a peak on the

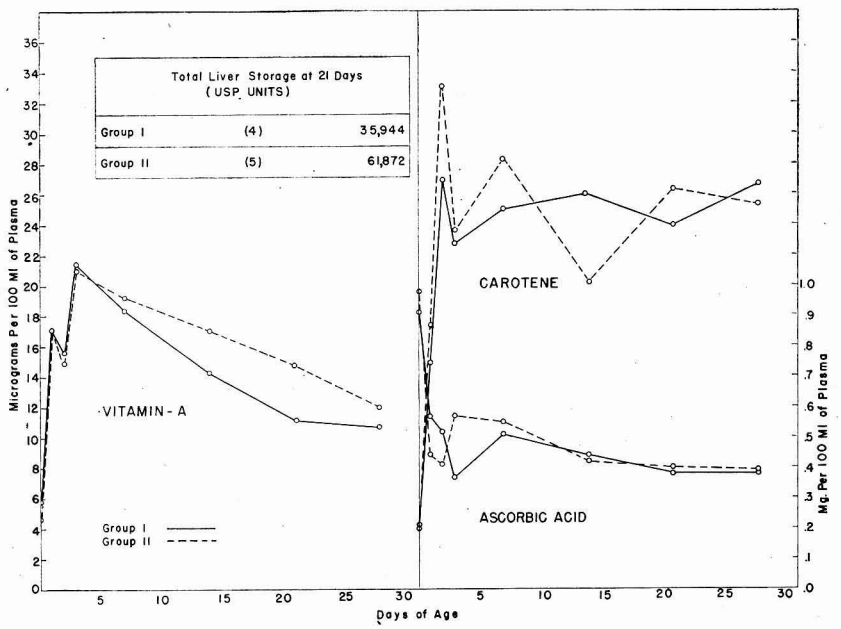

FIG. 1. The effect of daily supplementary vitamin feeding on the blood plasma vitamin A, carotene, and ascorbic acid, and on vitamin A liver storage in calves.

third day and then declined rapidly. No difference in the groups was observed until after the third day, when it was shown that Group II (experimental) did not decline in blood vitamin A as rapidly as did Group I (control). There was a decline in blood vitamin A regardless of supplementary feeding. Liver storage at 21 days in Group II was found to be nearly double that of Group I, indicating marked liver storage due to the supplemental vitamin A. Greater individual variations were found in the plasma carotene levels; however, no marked difference between the two groups is indicated.

Plasma ascorbic acid was found to be extremely high immediately after birth. The initial high level rapidly dropped so that normal levels were usually found within 24 hours. No beneficial effect of feeding ascorbic acid

was observed except that Group II showed a slight increase over Group I between the third and seventh days.

Although a considerable number of calves had scours, no difference was noted in the incidence between Group I and Group II.

EXPERIMENT 2

To determine the effects of feeding massive doses of vitamin A at less-frequent intervals, the following experiment was carried out from February through April, 1946. Holstein and Jersey calves born in the Experiment Station herds were assigned to one of three groups. Group I (ten calves)

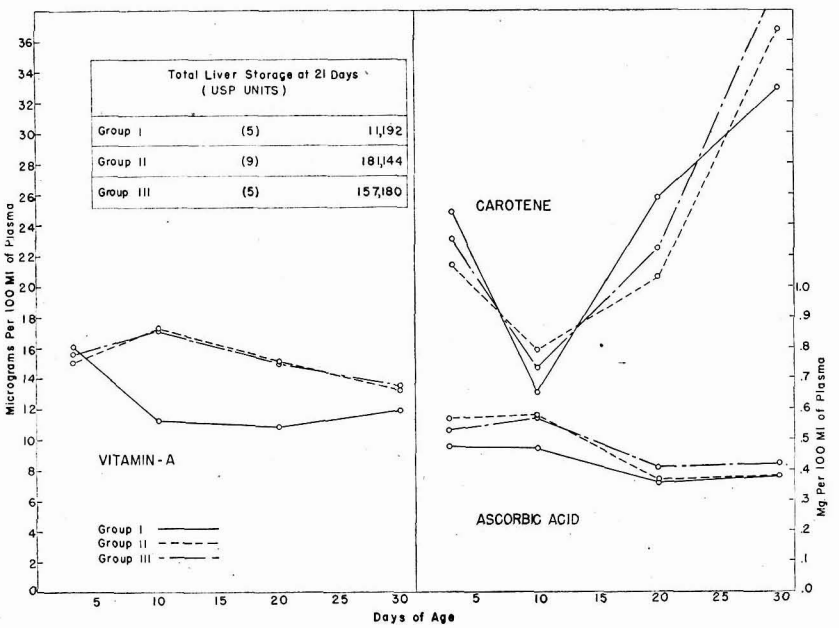

FIG. 2. The effect of feeding 250,000 USP units of vitamin A on the third and tenth days, plus 50 milligrams of niacin daily for 20 days, on the blood plasma vitamin A, carotene, and ascorbic acid, and on liver storage in calves.

served as a control group. Group II (thirteen calves) received a capsule containing 250,000 USP units of vitamin A on the third and tenth days after birth. Group III (twelve calves) received the same vitamin A supplement and, in addition, were given 50 mg. of niacin in a gelatin capsule daily for the first 20 days. Blood samples were drawn for analysis for plasma vitamin A, carotene, and ascorbic acid on the third, tenth, and twentieth days for all calves and also on the thirtieth day for the females. The male calves in each group were sacrificed on the twenty-first day and the total vitamin A liver storage determined. The average results of the blood and liver storage data are shown in figure 2.

It is evident that the supplemental vitamin A feeding resulted in the maintenance of a higher blood level in Groups II and III. However, the most marked effect of vitamin A feeding showed up in the amounts stored in the liver. Nearly ten times as much vitamin A was stored in the livers of the experimental group as in the control group. No difference was noted between Groups II and III in the blood level of vitamin A or in liver storage. Thus, the addition of niacin did not raise the blood level of vitamin A or increase liver storage at this level of vitamin A intake. The average liver carotene value of the nineteen male calves in the three groups was 633 USP units per liver.

Although the blood carotene followed a somewhat different pattern in experiment 2 than in experiment 1, no difference among the three groups is detectable. No differences were noted among the groups regarding the average ascorbic acid level. The incidence of scours was the same in all three groups.

DISCUSSION

In these experiments, no lowering of scours incidence was noted which could be attributed to supplemental vitamin feeding. This is in general agreement with the work of Norton *et al.* (7).

The incidence of scours was much higher in the Jersey calves than in the Holsteins. The average plasma vitamin A of the Jersey calves was lower than that of the Holsteins. Possibly this is due to the higher incidence of scours in the Jersey calves. The average carotene level of Holstein plasma was lower than that of the Jerseys. This observation is in agreement with the results reported by Moore (5). Plasma vitamin A and carotene, as well as vitamin A liver storage, were reduced in calves that had severe scours.

These data show that the decrease in plasma vitamin A of calves during the first few weeks can be offset to a considerable extent by feeding supplemental vitamin A according to either of these two systems. It is of interest that Sutton and Kaeser (9) have shown that, when colostrum feeding was extended for 7 days, the blood vitamin A level at 21 days was nearly identical with that of calves that received 10,000 units of vitamin A daily for 21 days.

No linear correlation between plasma vitamin A and liver storage was observed when liver storage was high. At low liver storage levels the plasma vitamin A values were a good index of liver storage. In general, data reported by Lewis and Wilson (3) confirm these observations. However, the experimental procedures are not sufficiently comparable for direct comparison of the data.

It is questionable how much benefit to the health of the calf is derived from excessively high liver storage or increases in blood vitamin A over the normal levels, when a normal ration is fed. In large-scale field trials conducted in Ohio and Michigan, the results of which are to be published else-

where, no lowering of scour incidence could be attributed to the feeding of supplemental vitamin A. It is reasonable to believe, however, that calves with a high vitamin A storage would be able to withstand periods of low vitamin A intake or impaired absorption much better than calves raised without supplementary vitamin A. Since both the plasma vitamin A content and liver storage of calves that had severe scours were extremely low, the administration of supplementary vitamin A to such calves would seem to be indicated in order to counteract the subnormal levels. Calves with severe scours often had plasma vitamin A levels as low as 4.5 micrograms per 100 ml. In Group III one calf, which had severe scours for 8 days, had a vitamin A liver storage value of 54,420 USP units at 21 days, whereas the average value for the group was 157,180 USP units. This calf had a vitamin A blood plasma level of 4.4 micrograms per 100 ml. at 20 days of age. The average blood vitamin A level for the group at this age was 13.9 micrograms per 100 ml.

SUMMARY AND CONCLUSIONS

1. Calves fed extra vitamin A, either 10,000 USP units daily for 20 days or 250,000 USP units on the third and tenth days, maintained a higher blood plasma vitamin A level after the third day than did their controls.

2. Liver vitamin A storage was increased with increased vitamin A intake. Plasma vitamin A and liver storage were not closely correlated except at low levels of liver storage.

3. The daily addition of 50 mg. of niacin when 250,000 USP units of vitamin A were fed on the third and tenth days had no effect on blood plasma or liver storage vitamin A values.

4. Except for a slight increase between the third and seventh days, no effect was observed on the plasma ascorbic acid content when 250 mg. of ascorbic acid were fed daily for 20 days.

5. No significant effect on lowering the incidence or severity of scours could be detected when supplementary vitamins were added to the normal ration according to the procedures described.

It is concluded that routine supplementary feeding of vitamin A, ascorbic acid, and niacin to calves during the first few weeks following birth is of doubtful value in preventing scours. The feeding of supplementary vitamin A at the rate of 10,000 USP units daily for 20 days or 250,000 USP units on the third and tenth days will help overcome any deficiency of vitamin A intake resulting from inadequate feeding of colostrum and whole milk, from impaired absorption, or from subsequent feeding of poor-quality hay.

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COPPER AND IRON IN THE BLOOD SERUM OF DAIRY COWS[1, 2, 3]

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The usefulness of blood or blood serum levels of copper, iron, hemoglobin, and cell volume as indications of nutritional deficiencies of cattle grazing in areas deficient in certain micronutrient elements has been shown by the work of various investigators (1, 2, 3, 5, 13). The utility of this blood picture tool, however, is dependent on a knowledge of the normal levels and variabilities of these blood characteristics. A review of the literature reveals no general agreement in the results reported for blood serum copper and iron levels for dairy cows. In view of this, the work reported here was undertaken as preliminary to a project designed to study certain deficiencies of micronutrient elements in some coastal areas of North Carolina. Hemoglobin and cell volume were run concurrently with iron and copper and also are reported.

Most of the published copper values on bovine blood are reported on whole blood rather than on blood serum. Tompsett (16), however, presented data showing that the copper of the blood was distributed evenly between the plasma and the corpuscles of the blood for man, sheep, ox, pig, and horse. The data of Kehoe *et al* (9) also show the copper content of the corpuscles and plasma of blood to be of the same order. In this laboratory, no significant difference was found in copper content between blood serum badly contaminated with red cells and serum with little or no red-cell contamination. The copper content for apparently normal bovine blood or blood serum, as determined by various workers, is shown in table 1. Blood serum iron values for dairy cows are meager.

MATERIALS AND METHODS

The principal difficulty in determining iron in blood serum is to obtain a preparation completely free from hemoglobin and other forms of organic iron. This problem has been discussed by Kitzes *et al* (10), and a method is presented which appears to give satisfactory results. In our work, the method of Kitzes was used to prepare the blood serum filtrate for the iron

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determination. Instead of a,a′-bipyridine, however, *o*-phenanthroline was used for the color reagent, as outlined by Parks, *et al* (14).

In some preliminary work, it was found that wet-ashed serum gave higher copper values than blood serum filtrate prepared according to Kitzes. Typical values obtained were: wet-ashed serum, 103 μg. of copper per 100 ml. of serum; and blood serum filtrate, 68 μg. of copper per 100 ml. of serum. These values are an average of twelve samples in duplicate. In view of these results, a wet-ash method was adopted. The blood serum was wet-ashed with concentrated nitric and perchloric acid. Essentially the method outlined by Parks *et al* (14) was used for the determination of copper. The method of Shenk *et al* (15) was used for the hemoglobin determination, and the Sanford Magath hematocrit tube for cell volume.

The experiment was designed to study the influence of breed, age, and time on the levels of the blood constituents under study. Blood was obtained

TABLE 1

Normal bovine blood or blood serum values obtained by various workers

Author	Animal	Type of blood	Copper
			μg./100 ml.
McHargue (12)	Ox	Whole blood	140
Guillemet (6)	Cow	Serum	58–82
Tompsett (16)	Ox	Whole blood and serum	192–223
Bennetts *et al* (3)	Cow	Whole blood	30–100
Beck (2)	Cow	Whole blood	70–170
Cunningham (5)	Cow	Whole blood	Mean of 100

from Ayrshire, Holstein, Guernsey, and Jersey cows in the college herds. The animals were subdivided into four age classifications: 4 to 6 months, 12 to 18 months, 2 to 2.5 years, and 4 to 7 years, with one animal from each breed in each age class. Blood from each animal was analyzed at four different times: January 2, February 14, March 6 and March 20. The four different dates will be referred to as Periods I, II, III, and IV, respectively. The cows were barn-fed for all periods except Period IV, when they were on pasture. Throughout the experimental period, all the animals received hay and a 17 per cent protein concentrate mixture. In addition, the animals in the age groups 2 to 2.5 years and 4 to 7 years received corn silage. The calves, 4 to 6 months of age, received a supplement of milk during most of the first two periods and a supplement of calf manna during the remainder of the experiment.

EXPERIMENTAL DATA

The means for iron, copper, hemoglobin, and cell volume, classified according to the ages of the animals, together with their standard errors, are presented in table 2.

TABLE 2

Effect of age on the blood level of indicated characteristic

Blood characteristics	Age				Standard error of a mean $S_{\bar{x}}$	Significance of age effect*
	4–6 months	12–18 months	2–2½ years	4–7 years		
Serum iron, μg./100 ml.	171.2	155.0	157.3	162.4	± 12.0	o
Serum copper, μg./100 ml.	94.5	85.0	109.9	113.8	± 6.2	hs
Hemoglobin, gm./100 ml.	9.08	9.72	10.06	10.64	± 0.26	hs
Cell volume, % of total	29.37	30.92	32.40	34.53	± 1.27	o

* o = not significant ($P > 0.05$).
s = significant ($P \leq 0.05$).
hs = highly significant ($P \leq 0.01$).

As indicated in the table, no evidence was obtained that serum iron changes with age. Copper and hemoglobin, however, changed significantly with age, the higher values being observed with advancing age. Although cell volume increased with advancing age, this effect was not statistically significant. On the other hand, there was a positive and significant correlation ($r = +0.9986$) between hemoglobin and cell volume from age group to age group. It might be concluded, therefore, that perhaps both hemoglobin and cell volume increase with advancing age.

The influence of breed on the blood levels of the characteristics studied is summarized in table 3.

No evidence was obtained that the blood characteristics differ among breeds. In this connection Tompsett (16), in his copper studies of various species, reports "the copper contents of sheep, ox, pig, horse, and guinea pig are of the same order as that of human blood." McCay (11) and Brooks *et al* (4), working with the four breeds used in this study, also found no difference in hemoglobin levels among breeds.

The effect of period on the blood levels of the characteristics is presented in table 4.

TABLE 3

Effect of breed on the blood level of the indicated characteristic

Blood characteristics	Breed				Standard error of a mean ($S_{\bar{x}}$)	Significance of breed effect*
	Ayrshire	Holstein	Guernsey	Jersey		
Serum iron, μg./100 ml.	130.8	168.3	163.7	183.1	± 12.0	o
Serum copper, μg./100 ml.	93.6	92.5	99.1	115.6	± 6.2	o
Hemoglobin, gm./100 ml.	10.39	9.50	9.94	9.67	± 0.26	o
Cell volume, % of total	32.14	29.78	34.45	30.85	± 1.27	o

* o = not significant ($P > 0.05$).

TABLE 4

Effect of period on the blood level of the indicated characteristics

Blood characteristics	Period				Standard error of a mean ($S_{\bar{x}}$)	Significance of period effect*
	I 1/2/46	II 2/14/46	III 3/6/46	IV 3/20/46		
Serum iron, μg./100 ml.	130.3	169.2	162.6	183.9	± 6.8	hs
Serum copper, μg./100 ml.	87.8	101.2	116.3	95.2	± 4.6	hs
Hemoglobin, gm./100 ml.	10.07	9.93	10.06	9.44	± 0.17	s
Cell volume, % of total	.....	30.94	31.54	32.94	± 0.75	o

* o = not significant ($P > 0.05$).
s = significant ($P \leq 0.05$).
hs = highly significant ($P \leq 0.01$).

As illustrated by table 4, period had a pronounced effect on all measures except cell volume. Possibly, if cell volume had been measured in Period I, it also would have shown a significant period variation. This experiment was not designed to sort out and find the causes of this period variation. Presumably, however, such factors as nutritional status of the animal, season of the year, and post-absorptive state of the animal are contributing to period variations. For example, Hemmeler (8) reports that in humans the serum iron is highest in the morning, averaging 127 μg. per 100 ml., and lowest in the evening, averaging 82 μg. per 100 ml. Hazleton (7) administered single doses of iron salts to rats and found the maximal level of serum iron to occur two to three hours after administration. Bennetts *et al* (3) made monthly analyses of blood copper of healthy cows from April through December and reported a low of 30 to 50 μg. in April and a high of 60 to 100 μg. per 100 ml. in September.

In table 5 are presented the over-all means and their coefficients of variation. It may be pointed out that the observations which make up the general or over-all means are subject to both the controlled variation or experimental error due to technique, age, breed, and period, as well as uncontrolled variation. The coefficients of variation presented in table 5 are measures of total variation; they include unbiased estimates of both controlled and uncontrolled variation for dairy cows under the conditions of the experiment.

The error due to technique, such as sampling, manipulation, reading, etc.,

TABLE 5

Grand means of the indicated blood characteristics and their coefficients of variation

Blood characteristic	Grand mean	Coefficient of variation
		%
Serum iron, μg./100 ml.	161.5	26.75
Serum copper, μg./100 ml.	100.1	23.93
Hemoglobin, gm./100 ml.	9.87	10.20
Cell volume, % of total	31.8	13.07

was less than 5 per cent for serum iron and copper and less than 2 per cent for hemoglobin.

No evidence was obtained that iron and copper are correlated in any way. On the other hand, hemoglobin and cell volume, in general, were correlated positively. The only deviation from this observation was the negative correlation which existed among periods (−0.8812). This negative correlation was not significant, but suggested that the factors causing the blood picture to change from period to period affect cell volume and hemoglobin in opposite manners.

SUMMARY

1. The means for serum iron, serum copper, hemoglobin, and cell volume in sixteen dairy animals were 100 μg. per 100 ml., 162 μg. per 100 ml., 9.9 gm. per 100 ml., and 32 per cent of total volume, respectively. The errors of estimate are given.

2. No evidence was obtained that serum iron changed with age. Serum copper and hemoglobin changed significantly with advancing age. The copper values ranged from about 90 μg. per 100 ml. in calves to 114 μg. in 4- to 7-year-old cows, and the hemoglobin increased from 9.08 to 10.64 gm. per 100 ml. of blood in these age classes.

3. There was no significant difference among breeds with respect to any of the measurements.

4. For serum iron, serum copper, and hemoglobin, there were pronounced variations from period to period. These variations were irregular with ranges as follows: serum iron, 130.3 to 183.9 μg. per 100 ml.; serum copper, 87.3 to 116.3 μg. per 100 ml.; and hemoglobin, 9.44 to 10.07 gm. per 100 ml.

5. No evidence was obtained that serum iron and serum copper are correlated in any way. Hemoglobin and cell volume, in general, were correlated positively.

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ASSOCIATION ANNOUNCEMENT

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ABSTRACTS OF LITERATURE

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ABSTRACTS OF LITERATURE

BACTERIOLOGY

18. The Origin and Control of Thermoduric Organisms. Some Fundamental Phases. DAVID LEVOWITZ, New Jersey Dairy Lab., New Brunswick, N. J. N. Y. State Assoc. Milk Sanit., Ann. Rpt., *19:* 219. 1945.

Thermoduric bacteria are present in milk freshly drawn from normal, healthy cattle. Research has not established whether poor health of cows raises their numbers. The cow does not affect the thermoduric content of milk enough to affect municipal milk standards. Bedding, manure, and feed dusts are sources of thermoduric bacteria. The sediment test would begin to mean something if straining of milk on the farm were eliminated. Contamination of milking machines with thermoduric bacteria may become important when machines are not handled properly.

Although thermoduric bacteria are not pathogens, they are associated with unclean equipment surfaces and should be held at minimum numbers. It is difficult to sterilize film-coated surfaces. High-temperature, short-time pasteurization cannot yield thermoduric counts as low as the holder method.

A.C.D.

19. Significance of Thermoduric and Thermophilic Bacteria in Milk and Their Control. F. W. FABIAN, Division of Public Health, Michigan State College, East Lansing, Mich. Jour. Milk Technol., *9,* 5: 273–278. Sept.–Oct., 1946.

Thermophilic bacteria are more resistant than thermoduric organisms. They are distributed widely in feeds, grain, soil, cow hairs, manure, and improperly cleaned utensils. These organisms may contaminate the dairy plant from producers' milk and be propagated in the pasteurizing equipment, if it is not properly cleaned. These groups of organisms are not pathogenic. Their presence in appreciable numbers in milk indicates unsanitary practices both on the farm and in the milk plant. H.H.W.

20. Heat Resistant Bacteria from an Unclean Milking Machine Invade the Udder of the Cow. C. S. BRYAN, H. S. BRYAN, AND KARL MASON, Michigan Agricultural Experiment Station, East Lansing, Mich. Milk Plant Monthly, *35,* 8: 30–32. 1946.

The properly pasteurized milk from a small dairy increased during a 4-month period from its normal level of 15,000 to as high as 2,500,000 on some days. Despite careful plant cleaning and sanitizing, the high count continued. The source of the high count of heat-resistant bacteria was

found to be the milk of one of the seven producers. An unclean milking machine contributed heat-resistant bacteria to the milk, both directly during the milking process and indirectly by inoculating the cows' udders with these bacteria. The cows were free of the heat-resistant bacteria in periods varying from 1 to 4 months after the milk equipment was properly cleaned and sanitized. During this same period, the standard plate count of the properly pasteurized milk of this dairy decreased to its previous level of 10,000 to 25,000. G.M.T.

21. **Thermal Death Range of Bacteria in Milk. A New Electric Sampling Device.** F. W. GILCREAS AND J. E. O'BRIEN, New York State Dept. of Health, Albany, N. Y. N. Y. State Assoc. Milk Sanit., Ann. Rpt., *19:* 237. 1945.

Study of the destruction of pathogenic bacteria by temperatures higher than now employed in the dairy industry is needed. Recently the Trumbull Electric Co. of Plainville, Conn., constructed a mechanism, based upon ideas of C. W. Weber, which makes possible laboratory pasteurization with accurate one-second holding intervals. The equipment is electrically activated and adds culture and withdraws samples by syringes. Tests were made on one ordinary *Escherichia coli* culture and two heat-resistant strains from the U. S. Public Health Service. It was concluded that the thermal death point for *E. coli* is not constant, and "therefore only a thermal death range based on results of repeated tests with many cultures can be determined." A.C.D.

22. **The Survival of Staphylococci Food Poisoning Strain in the Gut and Excreta of the House Fly.** SARAH MOOREHEAD AND HARRY WEISER, Dept. of Bacteriology, Ohio State University, Columbus, Ohio. Jour. Milk Technol., *9*, 5: 253–259. Sept.–Oct., 1946.

A food-poisoning strain of staphylococcus, *Staphylococcus aureus* 611, suspended in a dilute sucrose solution, was fed to 900 "cultured" houseflies, *Musca domestica*. The test organism was recovered from the digestive tract in some of the flies periodically through 8 days.

Staphylococci not of a food-poisoning strain were isolated from the digestive tract of 10 of the 50 wild-caught flies examined. This indicates that staphylococci may be commonly carried by flies.

Musca domestica may serve as a reservoir host for *Staphylococcus aureus* 611, and under suitable conditions the fly may initiate or augment a food-poisoning outbreak by spreading staphylococci from infected handlers or dirty equipment to food and from contaminated supplies to good foodstuffs which are favorable for enterotoxin production. The organism may survive in the digestive tract of the housefly several days after contamination and be deposited on food even after the carrier source has been removed or after the fly has sought a new feeding location. H.H.W.

23. The Influence of Surface Active Cationic Germicides on the Bacterial Population of Milk. ADRIEN S. DUBOIS AND DIANA D. DIBBLEE, Onyx Oil and Chemical Co., Jersey City, N. J. Jour. Milk Technol., *9*, 5: 260–268. Sept.–Oct., 1946.

Alkyldimethylbenzylammonium chloride did not influence the bacterial counts of raw or pasteurized milk at concentrations ranging from 1: 500 to 1: 25,000. The higher concentrations had an inhibitory effect on the growth of Gram-positive acid-producing organisms but did not affect the Gram-negative bacteria. When this compound was used in lower concentrations, no such effect was noted. A chemical method for the estimation of surface-active cationic germicides in milk and a qualitative test for their detection in solutions are described. H.H.W.

BUTTER

24. Experiments on the Packing and Storage of Butter. Part V. The Effect of the Temperature-Level of Storage on the Keeping Quality. C. R. BARNICOAT, Dairy Res. Inst., Palmerston North, New Zealand. New Zeal. Jour. Sci. and Technol., *27*A, 4: 343–348. Dec., 1945.

At storage temperatures between 14° and 60° F., the average rate of deterioration of well-made sweet cream butter, as measured by decrease in the score for flavor, was related directly to both time and temperature. The average rate of loss in score increased by about 0.15 point per week for each 10° F. rise in temperature above 14° F.

The slight advantage obtained by storage at – 5° F. instead of 14° F. was not warranted by the extra cost. W.C.F.

25. Some Experiments on the Use of Parchfoil and Pliofilm for the Wrapping of Butter in *Pinus radiata* Boxes. F. H. MCDOWALL, Dairy Res. Inst., Palmerston North, New Zealand. New Zeal. Jour. Sci. and Technol., *27*A, 4: 303–308. Dec., 1945.

A strong wood flavor developed within 10 days in butter wrapped in parchment and packed in boxes made of *Pinus radiata*. Wrapping in parchfoil (aluminum foil between parchment sheets) prevented the development of primrose color on the surface and wood taint in the butter up to 2 years, except where the wrappers joined. Pliofilm wrapping prevented the color defect but permitted the absorption of the flavor within 6 months. The treatment of the box with pliowax did not prevent the taint. Tensilized pliofilm was not satisfactory. Little trouble with mold growth was encountered, but under commercial conditions molds might appear under the pliofilm. W.C.F.

26. **Measurement of the Gas Content of Concentrated Butter and Other Fat Products.** G. L. HILLS AND J. CONOCHIE (Div. Indust. Chem.). Austral. Council Sci. & Indus. Res. Jour., *18*, 4: 366–372. Nov., 1945.

A modification of the method of Rahn and Mohr is described. W.C.F.

27. **The Manufacture of Dry Butterfat and of "Butter Concentrated Hardened."** W. J. WILEY AND G. W. COOMBS (Dairy Research Section). Austral. Council Sci. & Indus. Res. Jour., *19*, 1: 140–146. Feb., 1946.

Methods for large-scale production are described. W.C.F.

28. **Experiments on the Manufacture and Storage of Ghee.** C. R. BARNICOAT, Dairy Res. Inst., Palmerston North, New Zealand. New Zeal. Jour. Sci. and Technol., *27*A, 4: 309–319. Dec., 1945.

Attempts to produce ghee from cow butterfat yielded a product resembling Indian ghee but not entirely characteristic. Dry New Zealand butterfat was found to be acceptable to the Indian trade. These products when canned kept fairly well over 9 years of storage at 40° F. W.C.F.

CHEESE

29. **The Effect of Hydraulic Pressing on Cheese Texture.** H. R. WHITEHEAD, Dairy Res. Inst., Palmerston North, and L. J. JONES, Dairy Div., Dept. of Agr., Wellington, New Zealand. New Zeal. Jour. Sci. and Technol., *27*A, 5: 406–410. Feb., 1946.

When pressing cheddar cheese by hand-screw presses was compared with pressing by hydraulic presses, use of the latter almost eliminated "mechanical" openness in normal cheese of good quality but did not influence "slit" openness which may develop later. W.C.F.

CHEMISTRY

30. **Surface Chemistry in Chemical Cleaners.** GEORGE J. LEHN, Turco Products, Inc. Milk Plant Monthly, *35*, 7: 50–53. 1946.

Much time is spent in eliminating soil, such as film, scale, rust, and casein accumulations, from surfaces of dairy equipment. New knowledge of cleaners points more toward surface chemistry, which involves destroying the bond holding the soil to the surface. Wetting action brings cleaning solutions into close contact with oily, fatty, adhesive films, in order that soil may be dislodged more easily. Better wetting is made possible by the

control of surface and interfacial tensions. Cleaning a surface involves wetting, emulsifying, saponification, and solvent action. Carefully formulated cleaners are buffered so that their cleaning energy will be retained. Also, properly formulated cleaners condition and control the precipitation of minerals in hard water, thus assuring free and complete rinsing. Applications of surface chemistry to cleaners should save enormous amounts of production time and costs in dairy sanitation. G.M.T.

31. The New Non-Chlorine Disinfectants. D. H. JACOBSON. Ice Cream Field, *48*, 4: 70. Oct., 1946.

Quaternary compounds are compared with chlorine compounds as germicides. The following advantages of quaternary compounds in dairy plants are listed: (a) non-corrosive on common metals, (b) non-toxic, (c) stable under heat and over long periods of time in common dilutions, (d) non-irritating to the skin, (e) colorless and odorless in common dilutions, (f) rapid wetting and penetrating action, (g) relatively non-selective towards various types of bacteria, (h) surfaces may be rendered bacteriostatic for some time after treatment, (i) not affected by hard water salts.

The organization of the "National Sanitation Foundation" in 1945 in the School of Public Health at the University of Michigan is mentioned. This organization is supported by the industry, and expectations are that the information required for developing the use of the products in dairy plants will be supplied. Brief mention is made of some experimental results already published by other workers. W.C.C.

32. The Use of Quaternary Ammonium Compounds in the Dairy Industry. C. A. LAWRENCE, Winthrop Chemical Co., Rensselaer, N. Y. N. Y. State Assoc. Milk Sanit., Ann. Rpt., *19:* 177. 1945.

The quaternary ammonium compounds are surface-active agents consisting of two parts, a hydrophilic group and a lipophilic group. Since the lipophilic group is charged positively, these compounds also are known as cationic sterilizers. The wetting action, degree of detergency, and lowering of surface tension do not in themselves determine sterilizing action. The cationic sterilizers are effective for both Gram-positive and Gram-negative bacteria. These are most effective in alkaline solutions.

The cationic sterilizers are non-corrosive, non-toxic, odorless and non-irritating to the skin. They have high phenol coefficients. High concentrations of organic matter reduce their efficiencies. Soap and other anionic detergents also reduce their efficiency. These cationic compounds (alkyldimethylbenzylammonium chloride known as Zephirol, Zephiran, and Roccal was given as an example) have been found to be effective in sterilizing dairy equipment. A.C.D.

33. Higher Fatty Acid Derivatives of Proteins. W. G. GORDON, A. E. BROWN, AND R. W. JACKSON. Eastern Regional Res. Lab., U. S. Dept. of Agr., Philadelphia 18, Pa. Indus. and Engin. Chem., Indus. Ed., *38*, 12: 1239–1242. Dec., 1946.

Casein and other proteins were modified by preparing a series of novel fatty-acid derivatives by the reaction of acid chlorides with the proteins dissolved in aqueous alkali. The procedure developed gave derivatives of casein which were acylated to the extent of approximately 20% by substituent groups ranging from caprylyl to steoroyl. The physical and chemical properties of palmitoyl casein are discussed. The acylated products show reduced affinity for water and altered solubilities. B.H.W.

34. Plastic Properties of Higher Fatty Acid Derivatives of Proteins. W. G. GORDON, A. E. BROWN, C. M. MCGRORY, AND E. C. GALL, Eastern Regional Res. Lab., U. S. Dept. of Agr., Philadelphia 18, Pa. Indus. and Engin. Chem., Indus. Ed., *38*, 12: 1243–1245. Dec., 1946.

Data on the water absorption and tensile and flexural strengths of molded test specimens of the higher fatty-acid derivatives of casein and other proteins are compared with similar data for casein hardened with formaldehyde. The acylated casein molding powders flow well in small positive type molds, and the molded pieces do not require further treatment with formaldehyde to yield finished articles. The molded specimens were light to dark yellow and translucent, with many almost transparent. B.H.W.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

35. Keeping Qualities of Whole Milk Powder and Oatgum Mixes. H. A. BENDIXEN, Division of Dairy Husbandry, Washington State College, Pullman, Wash. Ice Cream Field, *48*, 4: 68. Oct., 1946.

Comparisons of oatgum and sodium alginate as stabilizers for ice cream are reported. Whipping ability, flavor, and texture were similar when 0.5% of the former and 0.22% of the latter were used. A gravimetric method of determining solubility of milk powder, developed at the Washington Experimental Station, is mentioned. W.C.C.

36. The Keeping Quality of Australian Milk Powders. C. C. THIEL AND E. G. PONT (Dairy Research Section). Austral. Council Sci. & Indus. Res., *18*, 4: 373–390. Nov., 1945.

Gas packing did not improve materially the storage life of skim milk powders but greatly increased that of whole milk powders. Because of leakage of cans, the results of gas packing on a commercial scale often were

nullified. The influence of different storage temperatures tried, 15, 30, and 37° C., was not marked. No correlation was observed between bacterial counts and the initial or final quality of the powder. Working fresh butterfat into stored skim milk powder gave a product no better than the stored, gas-packed, whole milk powder. W.C.F.

37. **Studies on Compressed Whole Milk Powder.** C. C. THIEL (Dairy Research Section). Austral. Council Sci. & Indus. Res., *18,* 4: 391–406. Nov., 1945.

The compression of spray-dried whole milk powder to a density of 1.15 to 1.2 reduced the interstitial oxygen as effectively as did the usual gas packing in cans, but neither cellophane nor waxed paper wrapping prevented the uptake of atmospheric oxygen or moisture. Blocks made of the milk powder containing 20% of cane sugar remained more friable and kept better than blocks made up of milk powder alone. Added vanillin improved the keeping quality of the milk powder in blocks. W.C.F.

38. **Cultured Dairy Products, Production and Quality Control, Part I . . . . Buttermilk.** S. M. MANN, General Biochemicals, Inc., Chagrin Falls, Ohio. Milk Plant Monthly, *35,* 8: 26–29. 1946.

A brief review of literature on the development of dairy cultures and on some of the salient facts pertaining to the development of a high-quality cultured buttermilk is given. The cardinal principles to observe in the handling of milk cultures are: 1. Use best-quality milk; 2. Work cleanly and carefully in clean, draft-free surroundings; 3. Use clean utensils, preferably those which have been sterilized or rinsed in chlorine (20–30 p.p.m.) solutions; 4. Strictly observe sterilization, pasteurization, incubation, and cooling temperatures.

The production of high-quality cultured buttermilk involves: (a) pasteurizing milk at 185 to 190° F. for 30 minutes; (b) cooling and setting to 70° F.; (c) adding 4 gal. of 20% cream to 100 gal. skim milk; (d) adding 1 to 2% starter; (e) setting for 16 hours at 70°; (f) salting at the rate of 0.5 oz. per 10 gal., and adding highly colored butter granules if desired, after which the cultured milk is churned at high speed 5 to 10 minutes; (g) drawing off the churned cultured buttermilk into a coil vat and cooling to below 40° F. G.M.T.

DISEASES

39. **Mastitis Prevention.** I. E. PARKIN, Pennsylvania State College, State College, Pa. N. Y. State Assoc. Milk Sanit., Ann. Rpt., *19:* 187. 1945.

Mastitis can be eliminated almost entirely from our dairy herds, even though research at Pennsylvania State College has shown that mastitis-pro-

ducing bacteria are present in the udder of practically every cow. The problem is primarily one of best herd-management practices.

Factors of major importance are good barns, well-bedded stalls of ample size, feeds of high vitamin A potency, prepartum milking of cows whose udders are inflamed, and the new managed-milking program. One of the greatest preventatives of mastitis is the use of managed-milking practices, which are described briefly. Several instances of marked improvement of mastitis by the managed-milking program were cited. A.C.D.

HERD MANAGEMENT

40. The Effect of the Level of Stimulus Applied by the Pulsator on the Rate of Machine Milking. W. G. WHITTLESTON, Animal Res. Sta., Dept. of Agr., Ruakura, New Zealand. New Zeal. Jour. Sci. and Technol., *27*A, 5: 445–450. Feb., 1946.

Under otherwise normal conditions of machine milking, the application of a greatly reduced pulsator stimulus had no effect on the milking rate. Once the milk flow starts with the pulsator operating, it will continue if the pulsator is stopped. Normal milk letdown is not obtained, however, if an attempt is made to milk without the pulsator when the teat-cups are applied. W.C.F.

ICE CREAM

41. How Golden State Cuts-Wraps Slices. GEO. D. AMERDING, Mojonnier Bros. Co. Ice Cream Field, *48*, 4: 76. Oct., 1946.

The cut-wrap slice machine is claimed to give the best and most popular individual serving of ice cream. The machine will produce 5,000 slices per hour, which is equal to 200 gallons of ice cream if cut seven slices to the quart. With waxed paper costing $0.13 per lb., waxed liners for cartons will cost $0.241 per M. Using the cut-wrap slice machine, labor costs for slicing one gallon of ice cream would be about 2.5 cents. The cost of the individual slice of ice cream is lower than any other individual package so far introduced. W.C.C.

42. Manufacture of Dry Ice Cream Mix. S. T. COULTER, Dairy Division, University of Minnesota, St. Paul, Minn. Milk Plant Monthly, *35*, 7: 84–85. 1946. Also Ice Cream Field, *48*, 4: 56. Oct., 1946.

Dry ice cream mix developed during the war has some advantages over liquid mix for ice cream manufacturers who buy mix. Transportation costs are lower, refrigeration unnecessary, and the mix is less perishable. Dry ice cream mix often is subject to oxidation during storage, the rate of oxidation depending upon such factors as freshness of dairy products used, degree of

preheating of the milk, the presence of metallic catalysts, and temperature of storage. The moisture level of the dry mix seems to be a persistent factor influencing staling. Keeping quality of the dry mix may be improved by reducing the moisture level as low as 1%, and avoiding storage at unduly high temperatures. Composition of dry ice cream mixes and steps in processing the dry ice cream mix are given. G.M.T.

43. **Analysis of Stabilizers.** C. D. DAHLE, Pennsylvania State College, State College, Pa. Ice Cream Field, *48*, 4: 62. Oct., 1946.

Gelatin, sodium alginate, locust bean (carob gum), Irish moss, sodium carboxymethyl cellulose, oatgum, pectin, Karaya, and Psyllium seed husks (ground) as stabilizers in ice cream are discussed. Because of the shortage of certain stabilizers during the war, several "mixed" stabilizers were placed on the market. These often contain various sugars which aid in dispersing the stabilizing agent and also may contain one or more of the following: sodium bicarbonate, sodium citrate, whey powder, milk solids dextrines, and, possibly, emulsifying agents. Emulsifying agents such as glycerol monostearate, sodium mono-palmitate, and sorbitan monostearate are mentioned briefly as aids to the whipping ability of ice cream mixes. W.C.C.

44. **Flavors and Fruits from Brazil.** H. A. CARDINELL, Horticultural Section, AND P. S. LUCAS, Dairy Section, Michigan State College. Ice Cream Field, *48*, 4: 58. Oct., 1946.

Results of experiments in which certain Brazilian fruits were tried as flavors in ice cream are given. The juice of the passion flower fruit, known in Brazil as "maracuja," has a sour taste somewhat similar to orange juice; it was better suited for ices or sherbets than for ice cream. Juice of the cashew plant gave a pleasing, nut-like flavor which blended well with ice cream containing nut meats. The authors stress the desirability of using certain of these foreign fruits in ice cream. W.C.C.

45. **Nuts for Your Winter Ice Cream.** W. J. CAULFIELD AND C. A. IVERSON, Department of Dairy Industry, Iowa State College, Ames, Iowa. Ice Cream Field, *48*, 4: 84. Oct., 1946.

The use of nuts in ice cream enhances the nutritive value of ice cream, since nuts are good sources of fat, protein, vitamins (A, B, and G), and minerals (calcium, phosphorus, iron, and copper). Selection of nuts with good flavor, prevention of deterioration, and development of crispness as a result of proper roasting are important considerations, but the question of bacterial contamination of ice cream through the use of nut meats deserves more consideration than it has received in the past. Small manufacturers can use prepared nuts to advantage, whereas the large manufacturers ordinarily find it advantageous to roast the nuts in their own plants.

Directions are given for preparing the following nuts for use in ice cream: almonds, cashews, hazel nuts, peanuts, pecans, pinions or pignolias, pistachios, black walnuts and English walnuts. Roasting procedures cannot be used according to time and temperature charts. Frequent examination during roasting is necessary to assure that the nuts will be light brown in color throughout as well as brittle and crisp when finished. The nuts should be chopped after roasting and 6 to 8 lbs. of nuts and 1 oz. of salt mixed with 1 lb. of butter previously heated to 330° F. (160° C.). They may be used immediately or stored in a closed container in the hardening room. Use 3 to 5 lbs. of buttered nuts per 10 gal. of ice cream. W.C.C.

46. Some New Facts on Ice Cream in Super-Markets. R. W. MUELLER, Associate Editor of Progressive Grocer. Ice Cream Field, *48*, 4: 32. Oct., 1946. (Reprinted from Progressive Grocer.)

A recent survey of super-markets in the Los Angeles area shows that ice cream occupies only 0.88% of store display facilities but represents 2.02% of total store volume and brings 4.7% of total dollar margin. This same survey shows that the rest of the frozen food line occupies 1.96% of total display space, represents 4.56% of total store volume and 7.14% of the total dollar margin. Ice cream represents 30% of the total frozen food department and equals 40% of the department's gross.

Ice cream sales now are mostly in pints and quarts. With larger frozen food storage compartments in household refrigerators, food merchants anticipate the sale of larger packages, such as half-gallon and gallon sizes. W.C.C.

47. What to Do About Ice Cream Cabinets. EDWARD L. KOEPENICK, Ex-Secretary, National Conference of Ice Cream Industries. Ice Cream Field, *48*, 4: 112. Oct., 1946.

Certain unfair trade practices in connection with credits, repairs, advertising, etc., often used in the ice cream industry as a means of distributing ice cream cabinets and controlling ice cream sales, are discussed. Mention is made of the California Agricultural Code which prohibits these unfair trade practices. The author advocates Federal legislation designed to abolish such evils. W.C.C.

48. Layout of Market to Feature Ice Cream and Frozen Foods. BEMAN FAST, Store Planning and Market Fixture Division, Weber Showcase and Fixture Co., Inc., Los Angeles, Calif. Ice Cream Field, *48*, 4: 34. Oct., 1946.

The recently modernized Hollywood Ranch Market is described and the subsequent increase in sales noted. Self-service, glass-topped cabinets which

replaced blind storage cabinets have resulted in a 60% increase in ice cream sales and have doubled sales in some departments. W.C.C.

49. Sale of Ice Cream by Weight. ANONYMOUS. Ice Cream Trade Jour., *42*, 8: 32, 83. Aug., 1946.

The International Association of Ice Cream Manufacturers is opposed to the sale of ice cream by weight. Reasons for this stand are:

(1) The most expensive ingredient in ice cream, namely butterfat, is the lightest in weight.

(2) Although, proportionately, ice cream contains very much less air than does angel food cake, air in the proper quantities is just as important, and there is no more reason to sell ice cream by weight than there is to sell angel food cake by weight.

(3) In the proposed Food and Drug Administration standard for ice cream, the product must be agitated during freezing to avoid formation of a solid brick similar to a block of ice. The air in ice cream gives an insulating effect and makes ice cream melt more easily in the mouth.

(4) The most expensive ingredient of ice cream, butterfat, is lightest (7.76 lbs. per gal.), while its cheapest ingredient, invert sugar sirup, is heaviest (10 lbs. per gal.).

(5) A high-grade rich ice cream which would weigh not more than 4.6 lbs. or 4.7 lbs. per gal. may be made. A very cheap grade of ice cream, one poorer in almost all of the qualities that make a good ice cream, may be made to weigh 5.5 or 6 lbs. to the gallon.

(6) Most of the almost 200 different flavors which have been recorded for ice cream would have a different weight.

(7) More ice cream is sold at the soda fountain, in restaurants as individual servings or in ice cream cones than is sold to be taken home. It is entirely impractical to make sales of this kind by weight, even if it seemed desirable to do so. W.H.M.

MILK

50. Post War Milk Bottle. V. L. HALL, Glass Container Manufacturers Institute, New York, N. Y. Jour. Milk Technol., *9*, 6: 336–338. Nov.–Dec., 1946.

The square milk bottle gradually is being introduced into the dairy industry. In the dairy plant, the washing and handling of the square bottle is just as satisfactory as for the round bottle. A case of round bottles occupies 47.5% greater area than the square bottles; a 6-ft. household refrigerator will hold 12 square bottles in the area formerly occupied by 8 round bottles. Moreover, the square container permits the retail grocer to do a better job of packing groceries in bags and in shopping carts. H.H.W.

51. Strainer Pad Control of Milk Quality. C. B. A. BRYANT, Johnson and Johnson Co., Chicago, Ill. N. Y. State Assoc. Milk Sanit., Ann. Rpt., *19:* 199. 1945.

Observations on sources of sediment were made during field demonstrations on farms all over the United States. A clean cow and a clean milk can are essential. Milk-can covers are often in dusty place when not in use. About 40% of all water on the farm contains considerable sediment. Half of the farmers do not put the cotton disk in the strainer correctly. Cotton pads commonly distort during use. Single gauze-faced disks should be placed in the strainer with the cotton side up. Strainers are often jammed and disks loosen. The strainer should be rinsed with water before a new disk is inserted. Milking machine teat cups frequently draw up bedding.

New York State experiences have shown several things. Dairies use 8-inch cotton disks when 5.5- or 6-inch disks would do, and cost about half as much. Some 85% of the strainers were not good. A fluid milk plant was selected for demonstration. Each farmer demonstrated correctly how to put the 6-inch disk into the strainer. Good strainers were installed. Emphasis was placed upon sanitary methods rather than *cleaning milk.* Excellent farm cooperation was obtained. Original strainers and used cotton disks were obtained for exhibition. After proper farm instruction had been given and correct equipment used, results showed definite improvement in sanitary procedures and milk quality. A.C.D.

52. Laboratory Tests in the Control of Milk Supplies. EDITORIAL. Amer. Jour. Pub. Health, *36,* 11: 1309–1310. 1946.

This editorial concerns the review article by Dr. A. H. Robertson in the same number of the American Journal of Public Health. In part, the editorial states: "Dr. Robertson's specific recommendations with regard to Plan B (the Connecticut State Department of Health milk program) deal with legal and administrative problems which are of purely local interest to the State of Connecticut and involve no changes in laboratory procedure. With respect to Plan A (the U. S. Public Health Service Ordinance and Code), on the other hand, he makes three important recommendations with regard to testing technique: the routine testing of all samples of allegedly pasteurized milk by the use of the phosphatase test and the coliform test; the routine examination of all samples of pasteurized milk by the microscopic count; and use of the microscopic count for samples of raw milk from sources which fail to comply, especially when field inspectional methods fail to disclose the cause for high counts or short reduction times.

This is not a matter to be settled by any one expert, as Dr. Robertson would admit; but he has marshalled evidence which makes an impressive case against sole reliance on the laboratory tests included in Plan A. There is a clear challenge here to the experts in this field—and particularly to the

experts of the U. S. Public Health Service—to seek some common ground of agreement which can harmonize or combine the values of both Plan A and Plan B. We would urge that the procedure employed by water bacteriologists in their field be applied in this related area. This procedure involves the setting up of cooperative studies in which workers in various laboratories employ several alternative standardized procedures and compare results, with regard to the significance of results obtained in the examination of a considerable series of actual field samples and the time involved in each procedure. . . . Only by such a cooperative study, in which advocates of both Plan A and Plan B participate, can the solution be found of a difference of opinion which may otherwise place serious obstacles in the way of an effective system of milk control." M.W.Y.

53. Laboratory Procedures in Sanitary Milk Control. A. H. ROBERTSON, Director of State Food Laboratory, Department of Agriculture and Markets, Albany, N. Y. Amer. Jour. Pub. Health, *36,* 11: 1245–1259. 1946.

The author prepared this special review at the request of the Editorial Board. He concludes "Under either the U. S. Public Health Service Ordinance and Code (Plan A) or under the Connecticut State Department of Health Program (Plan B), the fundamental objectives of maintaining the highest possible assurance of safety and continuous conformance to the standards for low count milk have not been as fully achieved as might be expected.

"Plan A would be improved by:

"1. Requiring the routine testing of all samples of allegedly pasteurized milk using the phosphatase test and the coliform test.

"2. Requiring a microscopic examination of all raw samples which fail to comply, especially when field inspectional methods fail to disclose the cause for high counts or short reduction times.

"3. Requiring routinely a microscopic examination of all pasteurized samples to determine whether or not high-count samples escape detection by the plate method.

"4. Permitting the use, where determinations have been checked periodically and found satisfactory, of routine plant reports on inspections and analyses of samples by licensed purchasing agencies in lieu of official inspections and analyses.

"Plan B would be improved by:

"1. Securing proper legislation fixing, or allowing the Dairy and Food Commissioner to fix by official order, standards for bacterial density in terms of results by methods which are to be used officially for the determination of compliance with the statute.

"2. Providing for more frequent routine inspections and examinations of samples, with prompt repeat inspections and repeat examinations of samples in cases of non-compliance until continuous conformance can be reasonably assured." M.W.Y.

54. What the Dairy Industry Expects of the Sanitarian. C. C. HADLEY, Indiana Dairy Products Assn., Inc. Milk Plant Monthly, *35*, 8: 24–25, 56. 1946.

A good milk sanitarian should be a teacher, diplomat, and administrator, thus exhibiting common sense, sound judgment, diplomacy and practicability, and radiating a pleasing personality through good health, energy, unquestioned integrity and enthusiasm for his work. A health sanitarian is expected to be an ambassador of good will for sanitation programs; to make proper contact with the manager's office prior to inspection; to use gentlemanly procedures in calling the management's attention to existing conditions; to be consistent month after month, not overlooking recommendations made on the previous visit; to use judgment on big versus little things; to refrain from peddling information from plant to plant concerning conditions; to be loyal to his superior; and to be well-trained for his job. Attention is called to a report appearing in the JOURNAL OF DAIRY SCIENCE, August, 1944, concerning courses which should aid in the training of a dairy sanitarian. G.M.T

MISCELLANEOUS

55. Dairy Waste Saving and Disposal. WILLIAM A. DEAN, JR., Bowman Dairy Co., Chicago; Chairman, Task Committee on Dairy Waste Disposal. Milk Indus. Found. Assoc. Bul., *39*, 2: 30–42. Dec., 1946.

The problem of waste is serious because litigation and punitive expense frequently result from overloading existing sewage disposal facilities. Systems of undue size may be required because of excessive quantities of waste. Without change in equipment, one plant reduced daily waste from a B.O.D. (biological oxygen demand) of 260.5 lbs. or a population equivalent of 1,580 to a B.O.D. of 73.4 lbs. or a population equivalent of only 450. Many causes of waste are listed. The following recommendations are made: drip savers; pre-rinses; electronic level controls on tanks and troughs subject to overflow; improved maintenance of pumps, fittings, valves, etc.; elimination of foam in separation; adequate storage tanks for whey, buttermilk, and skim milk; standby pumps where needed to handle these products if regular pumps fail; special entrainment separators and other controls on vacuum pans. Special emphasis is placed upon preventing dilution of wash waters and necessary wastes with condenser and clear waters.

Every plant seemingly in need of additional waste treatment facilities should make sure that losses are reduced to a minimum. Use of continuous proportionate sampling device and determinations of turbidity and B.O.D. are recommended. E.F.G.

56. The Effect of Dairy Factory Drainage Upon the Quality of Streams in Taranaki. P. O. VEALE, Taranaki Service Laboratories, New Zealand. New Zeal. Jour. Sci. and Technol., *27*B, 4: 282–301. Jan., 1946.

With reasonable dilution available, the discharge of dairy plant wastes into a well-oxygenated stream had only a temporary effect upon the quality of the water. The greater the dilution, the shorter was the distance downstream to where effects were no longer evident. W.C.F.

57. The Oregon Program of Licensing Cheese-Makers, Butter-Makers and Pasteurizer Operators. G. H. WILSTER, Oregon State College, Corvallis, Oregon. Jour. Milk Technol., *9,* 6: 317–321, 328. Nov.–Dec., 1946.

The licensing of cheese-makers, butter-makers, and pasteurizer operators is an important step in Oregon's dairy products quality-improvement program. The compulsory milk and cream grading law enacted in 1937 provides for the grading of these products when received at factories and creameries, licensing of persons who are doing the grading, and payment for the milk and cream in accordance with quality. Inferior quality of milk and cream must be denatured by adding red coloring matter and must be tagged, and returned to place of origin. In 1939, an amendment requiring the issuance of licenses upon passing of an examination for butter- and cheese-makers made the act much more effective.

A new law, passed in 1945, governs the pasteurization of milk and milk products and licensing of pasteurizer operators. The ultimate goal of these standards is: To raise the general standard of proficiency of the Oregon butter-makers and cheese-makers, to manufacture the highest-quality cheese and butter of correct composition, to increase the demand for Oregon cheese and butter in out-of-state markets, and to increase the return to the Oregon dairy farmers. H.H.W.

58. Insect Control in Dairy Plants. GEORGE E. GOULD, Purdue University. Milk Plant Monthly, *35,* 7: 38, 54–55. 1946.

Control of dairy farm and dairy plant insects is essential to the manufacture of quality dairy products. Insect control is linked closely with plant sanitation and is actually a part of that program. Insects are attracted to dairy plants because of milk and milk products, although some insects are

attracted because of lights. The first and most important step in fly control is sanitation. Thorough daily cleaning of all equipment used is imperative. Daily burning and disposal of refuse is essential. Sixteen-mesh screening will check entry of flies, mosquitoes, gnats, and other small insects into the plant. The use of DDT should not be considered as the only necessary control measure, but as supplementary to sanitation. Specific directions are given for applying DDT. Descriptions are given of the various roaches infesting dairy plants. Sodium fluoride alone, or diluted with 25% pyrethrum powder, is a standard roach powder. Sprays have never been entirely successful in roach control. Sanitation is an important part of roach control. G.M.T.

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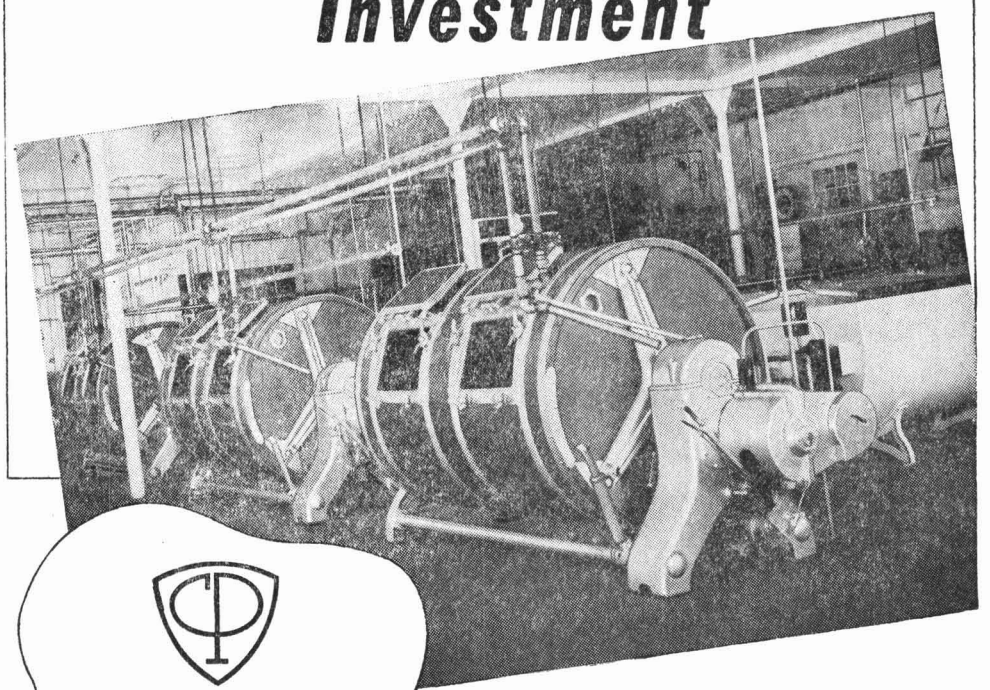

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