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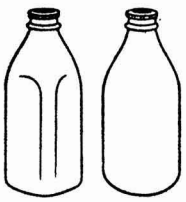

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STALE FLAVOR COMPONENTS IN DRIED WHOLE MILK. I. THE DISTRIBUTION OF STALE FLAVOR BETWEEN FRACTIONS OF RECONSTITUTED STALE WHOLE MILK POWDER

R. McL. WHITNEY AND P. H. TRACY

Department of Food Technology, University of Illinois, Urbana, Illinois

During storage a stale flavor often develops in dried whole milk which is very objectionable and reduces the consumer's acceptance of the product. Considerable research has been done to prevent or retard the development of this stale flavor by means of variations in the method of manufacture (6) and also to correlate the occurrence of this off-flavor with certain chemical changes observed in the powder (1).

However, neither the exact chemical compound responsible for the stale flavor nor its mechanism of formation are known. As a step toward the isolation and identification of the stale-flavor component, its distribution between fractions of reconstituted stale whole milk powder was investigated.

EXPERIMENTAL

Manufacture and storage of dried whole milk. Whole milk was condensed, dried in a pilot-size experimental spray drier and stored under varying conditions in order to have a continuous supply of stale dried whole milk for this study. All lots of powder were manufactured from milk without previous homogenization and at low spray pressures (450–700 p.s.i.) to facilitate the subsequent fractionation of the reconstituted stale whole milk.

Method for determining the relative concentrations of the stale-flavor component in the fractions. The relative concentration of the stale-flavor component in each of the fractions was determined by establishing *the threshold concentration of the stale fraction* when blended with an appropriate non-stale product to the approximate composition of the original whole milk. Since this judging technic has not been reported before for flavors in milk, it is described in detail as follows with stale cream as an example:

1. A reconstituted milk of approximately the same composition as the original milk with respect to fat and total solids was prepared from the stale cream and non-stale skim milk in a malted-milk mixer at 43° C. by agitating for 1 minute.

2. Two series of five samples each, of overlapping concentrations with respect to the percentage of stale cream in each of the samples, were prepared by diluting this reconstituted milk with non-stale whole milk of the same composi-

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tion. For example, the five samples in the first series might contain 3, 5, 7, 10 and 16 per cent stale cream, while the second series might contain 1, 4, 6, 8 and 14 per cent stale cream.

3. The samples were tempered at 24° C. in a water bath (approximately 10 minutes).

4. A panel of experienced judges tasted the samples, arranged at random in each series, and recorded those in which they could detect the stale flavor.

5. The judgments of each judge on each series and on the combined series were arranged in the order of the concentrations of stale cream, and the lowest consistent concentration in each series at which the stale flavor was detected was selected as the threshold value. If a judge recorded one sample inconsistently, the lowest consistent positive judgment was selected as his threshold value for the series. If he recorded two samples inconsistently, his judgment was rejected on that series. Table 1 illustrates this procedure.

TABLE 1

A sample determination of the threshold values of three judges

Sample no.	Stale cream	Judgments		
		1st judge	2nd judge	3rd judge
	(%)			
1–2	16	+	+	−
1–4	10	+	+	+
1–5	7	+	−	−
1–3	5	−	−	+
1–1	3	−	+	−
Threshold value of stale cream (%)		7	10	rejected

6. From all the judgments of all the judges, the mean threshold value and the standard deviations were calculated. This mean threshold value bears a reciprocal relationship to the concentration of the stale-flavor component in the stale cream.

The effect of separation of whole milk upon the distribution of stale-flavor component. Upon the development of sufficient stale flavor in the dried whole milk, the powder was reconstituted with distilled water to the composition of the original whole milk in a 10-gallon pilot-size pasteurizer constructed with a conical base. Agitation for 1 to 4 minutes at 43° C. with a motor-driven stirrer at 1,550 r.p.m. effected complete reconstitution. The milk then was separated into cream and skim milk with a motor-driven De Laval separator, model no. 18, at temperatures ranging from 12 to 64° C. and at rates of flow ranging from 2.3 to 6.2 quarts per minute, in order to determine both the optimum conditions for efficient separation of this product and the effect of these variables upon the distribution of the stale-flavor component between the cream and skim milk. The fractions then were cooled in an ice bath to approximately 10° C. and stored at this temperature until scored. Analyses of the fat content of the reconstituted whole milk, cream and skim milk were performed in duplicate by

TABLE 2

The effect of temperature and rate of flow during separation of reconstituted whole milk upon the distribution of stale-flavor component

Expt. no.	Separation temp.	Rate of flow	Fat tests			Threshold values for stale products[a]			Fat from stale products at threshold value		
			Milk	Cream	Skim milk	Milk	Cream	Skim milk	Milk	Cream	Skim milk
	(°C.)	(*qt./min.*)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	64	5.7	4.1	40.8	1.6	(2) not stale (6) 60 ± 10	(4) not stale (2) 6.0 ± 0.0	(2) not stale (2) 90 ± 0	not stale 2.5 ± 0.4	not stale 2.4 ± 0.0	not stale 1.4 ± 0.0
2	63	5.8	4.2	42.0	1.2	.....	(8) 4.4 ± 1.5	(8) 42 ± 10	.....	1.8 ± 0.6	0.50 ± 0.12
3	43	6.2	4.3	40.0	2.35	(5) 60 ± 19	(5) 8.0 ± 1.0	(4) 60 ± 0	2.6 ± 0.8	3.2 ± 0.4	1.4 ± 0.0
4	43	5.9	4.1	38.0	2.3	(8) 67 ± 11	(8) 6.5 ± 1.3	(8) 48 ± 19	2.8 ± 0.5	2.5 ± 0.5	1.1 ± 0.5
5	43	5.9	4.0	40.0	1.8	(8) 52 ± 19	(6) 5.0 ± 0.4	(6) 47 ± 21	2.1 ± 0.8	2.0 ± 0.2	0.85 ± 0.32
6	43	5.7	4.2	37.5	1.6	.....	(8) 5.2 ± 1.0	(8) 38 ± 20	.....	2.0 ± 0.4	0.61 ± 0.32
7	43	5.4	4.3	40.5	2.0	(6) 50 ± 18	(4) 5.4 ± 0.3	(2) not stale	2.2 ± 0.8	2.2 ± 0.1	not stale
8	43	2.3	4.4	31.5[b]	2.65	(8) 55 ± 9	(6) 8.3 ± 1.4	(8) 70 ± 17	2.4 ± 0.4	2.6 ± 0.4	1.9 ± 0.5
9	32	5.7	4.3	38.5	1.9	(6) 37 ± 3	(2) not stale (4) 3.4 ± 2.2	(6) 35 ± 16	1.6 ± 0.6	1.3 ± 0.8	0.66 ± 0.33
10	32	5.6	4.2	38.5	2.0	.....	(6) 4.0 ± 0.0	(8) 46 ± 15	.....	1.5 ± 0.0	0.92 ± 0.30
11	21[c]	6.3	4.2	40.0	2.45	(10) 36 ± 9	(5) 4.0 ± 0.9	(5) 27 ± 3	1.5 ± 0.4	1.6 ± 0.4	0.66 ± 0.07
12	12	5.3	4.2	38.5	2.7	.....	(8) 4.8 ± 2.0	(8) 30 ± 13	.....	1.8 ± 0.8	0.81 ± 0.35

[a] The numbers in parentheses indicate the number of judgments. Rejected judgments are not included.
[b] No cream was obtained from cream spout during separation. This cream was obtained from the bowl after separator had stopped.
[c] The reconstituted milk was held for 2 hr. at 4° C. and then warmed at 21° C. before separation.

means of the standard Babcock test, except in the case of the skim milk, for which the normal butyl alcohol modification of Hansen *et al.* (2) was used.

The reconstituted whole milk, cream and skim milk each were blended with appropriate non-stale products in the manner previously described. The results of the fat analyses and the judgments are given in table 2. Variations of the temperature of separation and the rate of flow apparently had little effect upon the distribution of the stale-flavor component between the cream and the skim milk. However, a more satisfactory separation was obtained at 43° C. with a normal rate of flow (6.0 quarts per minute) than under the other conditions investigated. Therefore, these conditions were maintained in subsequent work. Apparently, even though homogenization was avoided as much as possible during the manufacturing process, the reconstituted milk could not be separated with an efficiency at all comparable with that of commercial practice.

In all cases observed, the threshold value for the stale cream was lower than that of either the original stale reconstituted whole milk or the stale skim milk. Therefore, the stale-flavor component appeared to be more concentrated in the cream than in either the whole milk or skim milk.

TABLE 3

The effect of churning upon the distribution of the stale-flavor component

Product	Fat	Threshold value of stale product[a]	Fat from stale product at threshold value
	(%)	(%)	(%)
Cream	26.0	(2) 14.0 ± 0.0	3.6 ± 0.0
Butter	70.54	(6) 3.8 ± 0.5	2.7 ± 0.4
Buttermilk	3.1	(6) 43 ± 27	1.3 ± 0.8

[a] The numbers within the parentheses indicate the number of judgments. Rejected judgments are not included.

The effect of churning of stale cream upon the distribution of stale-flavor component. The excess stale cream and skim milk obtained in a previous separation experiment were frozen at −26° C. on the same day that they were prepared. On the afternoon preceding the day of churning, they were removed and stored at 7° C. until the following morning. The melting then was completed in a 21° C. water bath, with the temperature of the product not rising above 10° C. The melted cream and skim milk then were blended to yield a product containing approximately 25 per cent fat and churned at 9 to 14° C. in a 1-gallon glass churn. The buttermilk was drained off and the butter chilled and washed at 7° C.

Fat analyses were performed in duplicate. Heinemann's modification of the Mojonnier method (3) was used in testing the butter, while the buttermilk was analyzed by the normal butyl alcohol modification of the Babcock test (2).

The cream, butter and buttermilk each were blended with the appropriate non-stale product and judged in the manner previously described. The results of the fat analyses and the judgments are given in table 3. A comparison of the threshold values of the stale fractions indicated that the stale-flavor com-

ponent was more concentrated in the butter than in either the cream from which it was churned or the buttermilk resulting from the churning.

The effect of washing of stale cream upon the distribution of stale-flavor component. Stale cream was prepared and mixed with sufficient distilled water to make the total weight equal to the weight of the reconstituted whole milk from which the cream was separated. After agitation in the pilot-sized pasteurizer with a motor-driven stirrer for 30 minutes at 1550 r.p.m. at 41 to 46° C., this mixture was separated immediately in the De Laval separator. This process was repeated four times. At the end of the fourth treatment, the cream had "oiled off" almost completely. Fat analyses were performed in duplicate by means of the standard Babcock test, except in the case of the wash water for which the normal butyl alcohol modification (2) was used.

The cream, washed cream and washed water each were blended with appropriate non-stale products and judged in the manner previously described. The experimental results are recorded in table 4. The washed stale cream had a

TABLE 4

Effect of washing stale cream upon the distribution of stale-flavor component

Product	Fat	Threshold value of stale product[a]	Fat from stale product at threshold value
	(%)	(%)	(%)
Cream	40.0	(6) 5.0 ± 0.4	2.0 ± 0.2
Washed cream	77.6	(10) 2.0 ± 0.7	1.6 ± 0.5
Wash water	0.07	(6) not stale at 60%	.....

[a] The numbers within the parentheses indicate the number of judgments. Rejected judgments are not included.

lower threshold value than that of the original stale cream, while the wash water was reported as "not stale" when blended with non-stale condensed milk in the highest percentage possible without deviating from the composition of the original milk. Therefore the stale-flavor component appeared to be more concentrated in the washed cream than in either the original cream or the wash water.

The effect of preparation of stale butter oil upon the distribution of the stale-flavor component. Stale butter prepared in previous experiments was stored at −26° C. until used in this study. After the stale butter was melted at approximately 36 to 40° C. in a water bath, it was placed in solubility tubes and centrifuged in a heated Babcock centrifuge at 36 to 40° C. until a sharp boundary was obtained between the butter oil and butter plasma (10 to 30 minutes). The butter oil layer was decanted and filtered at 36 to 40° C. in an incubator. The butter plasma was analyzed for fat content in duplicate by the normal butyl alcohol modification of the Babcock test (2). The butter oil was assumed to be 100 per cent fat, since the available analytical methods would not yield reliable results within this range of fat concentration (4).

The butter, butter oil and butter plasma each were blended with appropriate non-stale products and scored in the manner previously described. These re-

sults are recorded in table 5. Some difficulties were experienced with the butter plasma fraction in these experiments. In the first experiment, the plasma apparently fermented during fractionation, while the amount of plasma obtained in the second experiment was so small that it was impossible to make up samples sufficiently concentrated to determine its threshold value.

However, the experimental results reported in table 5 indicate that the stale-flavor component is more concentrated in the butter oil than in either the original butter or the butter plasma when prepared under the conditions of this experiment. While a threshold value for the stale butter serum was not obtained, it was reported as "not stale" at concentrations higher than the threshold values for either the stale butter oil or stale butter.

TABLE 5

The effect of the preparation of butter oil upon the distribution of stale-flavor component

Product	Fat	Threshold value of stale product[a]	Fat from stale product at threshold value
	(%)	(%)	(%)
Expt. 1.			
Butter	70.54	(4) 3.5 ± 0.6	2.5 ± 0.4
Butter oil	100.0	(8) 3.0 ± 1.1	3.0 ± 1.1
Butter plasma	10.4	(8) Sour	.....
Expt. 2.			
Butter	83.35	(4) 4.0 ± 0.6	3.4 ±0.5
Butter oil	100.0	(6) 2.8 ± 0.1	2.8 ±0.1
Butter plasma	6.5	(3) Not stale at 6%	.....

[a] The numbers within the parentheses indicate the number of judgments. Rejected judgments are not included.

DISCUSSION

As an aid in the further interpretation of the result of this study, the amount of stale fat from a stale product present in the sample at the threshold value, expressed as the percentage of the total weight of the sample, has been calculated for all of the stale fractions and recorded in their respective tables. For the reconstituted whole milk, cream, washed cream, butter and butter oil, these values are the same within each experiment, considering the limits of accuracy of the judgments. Therefore it appears that the stale-flavor component is distributed between these fractions according to their milk-fat content and is concentrated in the milk-fat phase.

In the skim milk and buttermilk, the stale-flavor component has a higher concentration per unit weight of fat than might be predicted from the above conclusion. Two possible explanations can be advanced for this observation. First, if the stale-flavor component were adsorbed on the surface of the fat globule, the amount adsorbed per unit weight of fat would be greater the larger the surface area of the fat or the smaller the fat globule. Since the fat globules in the skim milk and the buttermilk may be expected to be smaller than in the other fractions, the concentration of stale-flavor component per unit weight of fat should be higher in these fractions if this hypothesis is correct.

A second explanation for these results would be the assumption of an equilibrium distribution of the stale-flavor component between the fat and plasma phases. The larger percentages of plasma in the skim milk and buttermilk fractions, even though its concentration of stale-flavor component was very low, might cause a higher apparent value per unit weight of fat. However, until a more accurate method for measuring the concentration of stale-flavor component is available, a choice between the two hypotheses is difficult.

It is impossible to test the conclusion that the stale-flavor component distributes itself between the fractions in proportion to the fat content in the case of either the wash water or the butter plasma fractions, since the concentrations of stale fractions attainable were insufficient to produce a detectable stale flavor.

It should be pointed out that the evidence secured so far in this study does not demonstrate the fraction in which the stale-flavor component originates, but only the one in which it is concentrated upon fractionation by the procedure used. Therefore, it should not be considered as supporting or conflicting with any of the current opinions of its origin (1, 5).

One observation made during this investigation should be emphasized. In order to estimate the relative concentration of stale-flavor component in the various fractions, it is necessary to judge all fractions in blends of approximately the same composition, particularly with respect to their fat content. Evidently the higher the fat content of the sample tasted the less *intense* is the *stale-flavor sensation* for the *same concentration* of *stale-flavor component.* For example, when the cream and skim milk were tasted without blending, *the intensity of the stale-flavor sensation* was greater in the skim milk than in the cream but, upon dilution with non-stale product to the same composition, much less stale cream than stale skim milk was required in order to yield a detectable stale flavor, which indicates that *the stale-flavor component was more concentrated* in the cream than in the skim milk. This same phenomenon was observed in the cream-washing experiment in which the *intensity of the stale-flavor sensation* was greater in the wash water than in the washed cream. However, upon dilution with appropriate non-stale products to the same composition, a concentration of only 2 per cent washed cream was necessary to yield a detectable stale flavor, while, even at a concentration of 60 per cent wash water, no stale flavor could be detected, indicating that the *stale-flavor component was more concentrated* in the washed cream than in the wash water.

SUMMARY

Dried whole milk was prepared without homogenization and at low spray pressure in order to facilitate fractionation of the reconstituted milk. The powder was stored under varied conditions to insure a continuous supply of stale dried whole milk for this study.

Reconstituted stale dried whole milk was separated mechanically into cream and skim milk at various temperatures of separation and rates of flow. The cream was churned into butter and buttermilk or washed with distilled water until it oiled off. The butter was melted, centrifuged and filtered, all at 40° C., to yield butter oil and butter plasma.

The relative concentration of the stale-flavor component in the various fractions was determined by establishing the *threshold concentration of the stale fraction* when blended with an appropriate non-stale product to the approximate composition of the original whole milk.

In all determinations made on the whole milk, cream, washed cream, butter and butter oil, the stale-flavor component appears to be distributed between these fractions according to their milk-fat content and therefore is concentrated in the milk-fat phase.

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A SOLUBILITY METHOD FOR THE DETERMINATION OF ALPHA AND BETA LACTOSE IN DRY PRODUCTS OF MILK

R. P. CHOI, C. W. TATTER, C. M. O'MALLEY AND B. W. FAIRBANKS
The American Dry Milk Institute, Inc., Chicago, Illinois

Since the form of lactose in dry products of milk is important in determining the physical properties of the products, a procedure for estimating the two forms of lactose is desirable from the standpoint of controlling product uniformity. A polarimetric method was reported by Sharp and Doob (7). The present proposed method is based upon the difference in solubility behavior of *alpha* lactose hydrate and the *beta* anhydride, the two stable forms of lactose.

From the work of Hudson (4), an equilibrium is believed to exist between the *alpha* and *beta* forms of lactose in solution. The rate of attainment of equilibrium is slow and can be followed by solubility measurements. Hudson (4) found that when *alpha* lactose hydrate is added in excess to water, a definite amount will dissolve initially, and then more will go into solution slowly until a final solubility is attained. The rate of dissolution is independent of the concentration of the solid phase as long as an excess is present. The initial solubility is considered to be the equilibrium concentration of the *alpha* form, while the slower dissolution is interpreted to arise from the mutarotation of the *alpha* to the *beta* form so that the difference between the final and the initial solubility represents the equilibrium concentration of the *beta* form. On this basis both equilibrium and rate equations have been derived by Hudson (4).

Likewise, *beta* lactose exhibits an initial and final solubility. At 0° C. where data are available (5), the initial solubility of *beta* lactose is approximately eight times that of the *alpha* hydrate. The solubility of *alpha* lactose hydrate in milk was investigated by Hunziker and Nissen (6), who came to the conclusion that the constituents of milk have no effect on the solubility of *alpha* lactose hydrate. This, together with the wide difference in the initial solubility of the two forms of lactose, provides the basis for the present method. Because of the high initial solubility of *beta* lactose, it may be expected that in any mixture containing an excess of *alpha* lactose hydrate and a quantity of *beta* lactose less than its initial solubility, the total initial solubility will consist of all the *beta* plus the initial solubility of the *alpha* hydrate. From experiments with artificial mixtures containing different proportions of *beta* lactose, it has been found that this simple relationship is realized below a concentration of *beta* lactose of approximately 10 g. per 100 ml. of water, corresponding to a total initial solubility of 55 m.mols. per 100 ml. of water. Therefore, for any mixture such as a dry product of milk, the essential steps in the procedure would consist of: (a) adding *alpha* lactose hydrate in excess to a known weight of the mixture, (b) determining the solubility at several time intervals and (c) extrapolating the results to zero time to obtain the total initial solubility from which the amount of *beta* lactose in the mixture may be calculated easily. The

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quantity of *alpha* lactose in the original mixture is the difference between the total lactose and the *beta* lactose.

In any extrapolation it always is desirable that the extrapolation be linear. In the present case this could be achieved by means of the equations derived by Hudson (4). When the concentration of lactose in solution is less than the final solubility, the solubility increases with time. The maximum rate of solution is given by equation I:

$$kt = \log \frac{S_\infty - S_o}{S_\infty - S_t},$$

where k is the rate constant; S_∞ is the final solubility, which at 25° C. is 63.3 m.mols. per 100 g. of water; S_o is the initial solubility of *alpha* lactose, or if *beta* lactose is present it is the total initial solubility; and S_t is the solubility at time t.

In a solution in which the concentrations of both the *alpha* and *beta* lactose are in excess of their equilibrium concentrations and in which *alpha* lactose hydrate also is present as a solid phase, Hudson (4) found that there is an immediate precipitation or crystallization of the excess *alpha* followed by a slow conversion of the excess *beta* to the *alpha* modification, which then crystallizes out as fast as it is formed. The maximum rate of crystallization under these conditions is given by equation II:

$$kt = \log \frac{C_o - S_\infty}{C_t - S_\infty},$$

where k is the rate constant; S_∞ is the final solubility; C_o is the total initial solubility of the *alpha-beta* mixture; and C_t is the solubility at time t. Both equations I and II describe first order reactions. Therefore, if we plot in each case the log of the denominator, that is, $\log(S_\infty - S_t)$ or $\log(C_t - S_\infty)$ against t, we should obtain a straight line whose slope is the velocity constant k and whose intercept is $\log(S_\infty - S_o)$ or $\log(C_o - S_\infty)$. The total initial solubility, which is S_o or C_o, can be calculated since the final solubility is known accurately from the work of Hudson (4).

EXPERIMENTAL PROCEDURE

Apparatus. The apparatus consisted of a Pyrex glass cylinder, 5.5 cm. in diameter and 15 cm. long, fitted with a two-hole rubber stopper. Through one hole an electrically-driven stirrer was inserted. The other hole was used as a sampling outlet and stoppered when not in use. The set-up was placed in a constant temperature water bath maintained at 25° C.

Total initial solubility with varying amounts of beta lactose. The proposed procedure first was tested using solid mixtures containing varying amounts of *beta* lactose and 30 to 40 g. of *alpha* lactose hydrate. With stirring applied, 100 ml. of distilled water at 25° C. was pipetted into the solubility chamber containing the solid mixture. At 10 minute intervals 10 to 15 ml. portions of the suspension were withdrawn and filtered immediately through a fritted glass filter of medium porosity with the aid of suction. An aliquot of the clear fil-

trate was analyzed for lactose by the Hinton-Macara method (3) and the solubility calculated as follows:

$$\text{m.mols. lactose/100 ml. } H_2O = \frac{\text{ml. } Na_2S_2O_3 \times \text{normality} \times 100}{2 \times \text{ml. filtrate} \times \text{water factor.}}$$

The water factor represents the fraction of water in the filtrate and can be determined by the toluol distillation procedure (1). The total initial solubility was calculated as described in the above section. The *beta* lactose content of the mixture then was plotted against the corresponding total initial solubility.

Procedure for dry products of milk. Except for roller process nonfat dry milk solids, 30 g. of the dry milk product generally were used. For roller process nonfat dry milk solids, only 25 g. could be used because of the high viscosity of the suspension. The sample was transferred to the solubility cylinder and mixed thoroughly with 30 g. of *alpha* lactose hydrate powder. To the solid mixture 100 ml. of distilled water at 25° C. were added and the time noted. Before transferring the flask to the water bath, it was necessary to free any material adhering to the sides and bottom of flask to insure rapid and complete dispersion. Stirring then was applied at a rate sufficient to keep the solids in suspension. At 10-minute intervals, 20–25 ml. of the suspension were withdrawn and immediately centrifuged for 3 minutes at approximately 1000 r.p.m. The centrifugate was decanted carefully and a 10-ml. portion used for lactose determination by the Hinton-Macara method (3). Total lactose also was determined for each dry milk sample. The solubility in m.mols. of lactose per 100 ml. of water was calculated as in the preceding section. When the above sample sizes were used, the total initial solubilities generally were less than 55 m.mols. per 100 ml. of water. Accordingly, log $(63.3 - S_t)$ was plotted against the time and the best straight line drawn through the points. From the intercept at $t = 0$, the total initial solubility was calculated. The *beta* lactose in the quantity of sample taken for analysis was evaluated by subtracting from the total initial solubility the initial solubility of the *alpha* lactose which is 25.3 m.mols. per 100 ml. of water. Knowing the total lactose, the *alpha* modification was calculated by difference. Results are expressed as per cent of the total lactose.

RESULTS AND DISCUSSION

Figure 1 shows a plot of the total initial solubility against the quantity of *beta* lactose in a mixture containing an excess of *alpha* lactose hydrate. The curve $(\alpha + \beta)$ is the experimentally determined curve; the curve β is calculated by assuming instantaneous dissolution of all *beta* lactose added. It can be seen from the parallelism of the two curves that below a concentration of 10 g. of *beta* lactose per 100 ml. of water, corresponding to a total initial solubility of about 55 m.mols. per 100 ml. of water, the total initial solubility is the sum of the initial solubility of the *alpha* hydrate and of the quantity of *beta* lactose added. Above this point the total initial solubility becomes progressively less than the expected sum. This deviation may result from conversion of some *beta* to *alpha* lactose, since the *beta* lactose is present in amounts greater than its equilibrium concentration.

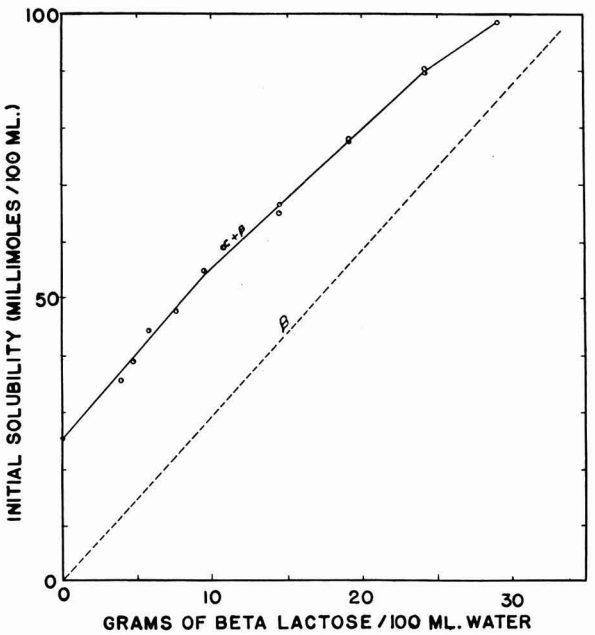

FIG. 1. Standard Curve ($\alpha+\beta$), determined with mixtures containing varying quantities of β-anhydrous lactose and excess amounts of lactose hydrate. Curve "β" plots the amount of *beta* anhydride added.

In table 1 are results showing the effect of sample size. It can be seen that within the range of 10 to 50 g., size of the sample seems to have no effect on the final results. However, with increasing sample size the suspension becomes progressively more viscous and difficult to handle.

To determine the reproducibility of the method, nine separate determinations were made on a sample of nonfat dry milk solids. Results are presented in table 2. Analysis of the results for *beta* lactose calculated as per cent of the total lactose yielded an arithmetic average deviation of 1.03 per cent and a standard deviation of 1.37 per cent indicating fairly good precision.

TABLE 1

Effect of size of sample

Nonfat dry milk solids	Beta lactose	Alpha lactose
(*g.*)	(%)	(%)
10.0	60.1	39.9
20.0	59.0	41.0
30.0	61.0	39.0
45.0	60.7	39.3
50.0	62.6	37.4

TABLE 2

Reproducibility of the method as applied to a sample of spray nonfat dry milk solids

Trial	Total initial solubility	Beta lactose	Alpha lactose
	(*m. mols./100 ml.* H_2O)	(%)	(%)
1	51.5	60.0	40.0
2	50.9	58.7	41.3
3	51.2	59.4	40.6
4	50.9	58.7	41.3
5	51.2	59.4	40.6
6	50.1	57.0	43.0
7	52.2	61.5	38.5
8	51.4	59.9	40.1
9	52.2	61.5	38.5
Av.	51.3	59.6	40.4

Arithmetic average deviation = 1.03% beta
Standard deviation = 1.37% beta

In table 3 results are presented for random samples of fresh spray and roller process nonfat dry milk solids and dry whey solids. In dry whey solids samples 1 to 3, the lactose is predominantly in the glass or amorphous state, while in the remaining dry whey samples the lactose is predominantly in the form of the crystalline *alpha* hydrate. The results for nonfat dry milk solids vary from 57.1 to 62.7 per cent *beta* and are in agreement with the values previously reported by Sharp and Doob (7) using the polarimetric method. The nonfat dry milk solids samples and dry whey solids samples 1 to 3 appear to contain *beta* and *alpha* lactose in the equilibrium ratio.

TABLE 3

Alpha and beta lactose content of some dry products of milk calculated as % of total lactose

Sample	Total initial solubility	Total lactose in sample taken	Beta lactose	Alpha lactose
	(*m. mols./100 ml.* H_2O)	(*m. mols.*)	(%)	(%)
	Spray nonfat dry milk solids			
1	51.4	42.3	61.7	38.3
2	51.4	41.7	62.6	37.4
3	49.5	40.4	59.9	40.1
4	52.4	44.4	61.0	39.0
5	51.3	45.6	57.1	42.9
	Roller nonfat dry milk solids			
1 (30.0 g.)	51.6	42.1	62.5	37.5
2	45.8	33.6	61.0	39.0
3	45.5	35.0	57.7	42.3
	Dry whey solids			
1	56.4	54.4	57.2	42.8
2	58.7	57.4	58.2	41.8
3	56.9	58.1	54.4	45.6
4	33.3	59.0	13.6	86.4
5	39.8	57.9	25.0	75.0
6	36.4	58.9	18.8	81.2
7	40.4	62.1	24.3	75.7
8	34.0	56.8	15.3	84.7
9	33.5	57.7	14.2	85.8
10	38.0	56.9	22.3	77.7

The method presented in this paper determines total *alpha* and *beta* lactose regardless of the state in which they exist in the dry products. For dry whey solids samples 4 to 10, inclusive, in table 3 most of the lactose has been crystallized as the *alpha* hydrate during processing. The rate of crystallization probably was greater than the rate of conversion of the *beta* to the *alpha* form so that it would be reasonable to believe all *alpha* lactose present in these products to be in the form of the crystalline monohydrate. Therefore, it would be interesting to compare results of the water of crystallization of *alpha* lactose calculated on this basis with those determined by the moisture desorption method and the indirect method previously published (2) for the determination of water of crystallization of *alpha* lactose. Such data are presented in table 4. In general, results by the solubility method are in satisfactory agreement with those by the other two methods.

TABLE 4

Water of crystallization of alpha lactose in some samples of dry whey solids as determined by three different methods

Sample	Water of crystallization		
	Desorption method	Indirect method	Solubility method
	(%)	(%)	(%)
4	2.67	2.75	3.05
5	2.52	2.71	2.61
6	2.89	2.79	2.87
7	2.70	2.76	2.88
8	2.89	2.95	2.81
9	2.89	2.95	2.96
10	2.73	2.62	2.65

SUMMARY

A method has been developed for the determination of the two forms of lactose in dry products of milk based upon the maximum rate of solution of lactose and the difference in solubility of the *alpha* and *beta* modifications. The essential steps consist of (a) adding an excess of *alpha* lactose hydrate to a known quantity of the sample, (b) determining the solubility at several time intervals and (c) extrapolating to zero time to obtain the total initial solubility. The *beta* lactose content may be ascertained easily, since below 55 m.mols. per 100 ml. of water the total initial solubility is the sum of the initial solubility of the *alpha* hydrate and of the quantity of *beta* lactose present. With the *beta* lactose known, the *alpha* modification is calculated by difference from the total lactose.

For a sample of spray process nonfat dry milk solids, it has been found that size of the sample, within the range of 10 to 50 g., seems to have no effect on the results obtained, but with increasing sample size the suspension becomes progressively more viscous and difficult to handle.

The method has been applied to nonfat dry milk solids and dry whey solids.

Results for the nonfat dry milk solids are in agreement with those reported in the literature. For the samples of dry whey solids in which the *alpha* lactose is present as the chief form, water of crystallization has been calculated, assuming complete crystallization of all *alpha* lactose present. Results are in satisfactory agreement with those determined by the moisture desorption method and the indirect method previously published (2) for the estimation of water of crystallization of *alpha* lactose.

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OBSERVATIONS ON THE APPLICATION OF THE NITROPRUSSIDE TEST TO HEATED MILK

STUART PATTON[1] AND DONALD V. JOSEPHSON[1]
Dairy Technology Department, Ohio State University

The nitroprusside test has proven to be a satisfactory technic for studying the presence and behavior of reduced sulfur in various mediums and under widely varying conditions. One of its classic uses is for the qualitative determination of sulfur in organic compounds in conjunction with the sodium fusion reaction (13). Other important applications include its use in studying protein denaturation (1) and in the detection of sulfhydryl compounds (11).

Many sulfur compounds are notorious for their intense and often disagreeable odor. The findings of many workers in the field of dairy research have demonstrated that sulfur compounds are implicated in flavor changes resulting from the heating of milk and dairy products. It is the consensus that consumer acceptance of milk products, the processing of which requires high heat treatment, could be improved greatly if the associated flavor problems could be overcome. The nitroprusside test should be a very useful research tool in the investigation and possible solution of these problems.

REVIEW OF LITERATURE

In 1911 Arnold (2) observed that denatured egg protein gives a color reaction with sodium nitroprusside. Anson (1) since has demonstrated that potassium nitroprusside may be used to measure quantitatively the sulfhydryl groups of denatured egg albumin. Shinohara and Kilpatrick (12) suggest that before hydrogen sulfide is liberated from cystine as a result of heating, the cystine is converted to cysteine, the reduced form. Such a theory is helpful in explaining the mechanism by which sulfhydryl compounds are liberated in heat-denatured proteins, since proteins behaving in such a fashion invariably contain comparatively large quantities of cystine.

Jackson (5) was the first to focus interest on the possible use of the nitroprusside test in connection with milk. He found that raw milk does not give a positive nitroprusside test, but that tests become positive if the milk first is treated with sodium cyanide, a strong reducing agent. He proposed that this phenomenon is traceable to the cystine in the protein complex of milk. Jackson *et al.* (6) reported that sterilization of cream produced "volatile sulfur" which could be detected by the nitroprusside test if heating was carried to 120° C. for 30 minutes. Gould and Sommer (4) could find no correlation between the intensity of the nitroprusside reaction and the temperature at which cooked flavor and sulfide liberation occur in milk. However, they did find some correlation between these factors when sodium cyanide was added to the milk

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[1] Present address: Department of Dairy Husbandry, Pennsylvania State College, State College, Pa.

following heating. In a similar investigation, Josephson and Doan (7) used the test as a method of measuring sulfhydryl compounds in heated milk and some other heated dairy products. They found very good correlation between the degree of cooked flavor and the intensity of the nitroprusside reaction and concluded that sulfhydryl compounds, liberated during heating, are responsible for cooked flavor of heated milk and milk products. It should be noted that different procedures were followed in the use of the nitroprusside test by these two groups of investigators which might account for the discrepancies in their findings with reference to the test. In fact, Gould (3) in a later publication states that satisfactory results (correlation with cooked flavor) were obtained with the nitroprusside test when a slight modification of the method of Josephson and Doan was utilized. More recently, Townley and Gould (14) used the test with apparent success in extensive experiments dealing with the heat labile sulfides of milk. They noted that prolonged heating of milk at high temperatures results in decreases in the intensity of the nitroprusside test and the quantity of volatile sulfides of the milk. At the same time, a gradual change in the flavor from cooked to caramelized, together with browning of the milk, occurred. Comprehensive data have been gathered on the source of sulfhydryl compounds in milk. The results of investigations by Gould and Sommer (4), Josephson and Doan (7), Gould (3) and Towley and Gould (15) indicate quite conclusively that serum proteins and fat globule membrane protein are the two principal sources.

The foregoing review presents evidence of the usefulness of the nitroprusside test, not only as a means of studying protein denaturation and the presence of sulfhydryl compounds, but also as a suitable instrument for investigating flavor changes resulting from the heating of milk. It seemed worthwhile to determine some of the factors which affect the test as it is applied to milk and to give further consideration to its research possibilities.

EXPERIMENTAL

The procedure of Josephson and Doan (7) for the nitroprusside test was used as a basis for study in these experiments. This procedure is as follows:

"5 ml. of sample were saturated by adding an excess of solid ammonium sulfate in a test tube and shaking. Then five drops of a 4.5 per cent solution of sodium nitroprusside (freshly made) was introduced with agitation, followed by five drops of concentrated (28 per cent) ammonium hydroxide. After again shaking the tube contents, the color was compared with a series of standards. . . ."

According to the observations of various workers (3, 7, 14), the intensity of the pink color developed in the test when it is applied to heated milk appears to be a direct function of the amount of heat treatment to which the milk has been subjected within certain limits. There also is a correlation between the amount of color developed in the test, the quantity of volatile sulfides and the degree of cooked flavor of the milk. Thus, the development of color in the test has quantitative significance in respect to these factors. A visual evaluation of the amount of color produced in the test could be used, but a set of standards made

up with various combinations of dyes provides a more definite comparison for semi-quantitative purposes. Such a set of standards, similar to those used by Josephson and Doan (7), was developed for the present investigation. The following procedure was adopted for making these standards:

Place 10 ml. of skim milk in each of seven test tubes. To each test tube add one drop of 0.1 per cent pontamine brown BT. Then, in successive graduation, add 0, 1, 2, 3, 4, 6, and 8 drops of 0.01 per cent safranin 0. Add two drops of chloroform as a preservative to each test tube, seal with rubber stoppers and agitate until the dyes are distributed evenly. Number the standards from 0 to 6, respectively, with increasing concentration of safranin 0. Store the standards in a cool place.

Standards made according to the above method give a wide color range and have been found satisfactory for use under most conditions. A possible recommendation is that the 6 standard should contain a small amount of purple color component. Tables contained in this report express intensity of nitroprusside reaction in terms of these numbered standards. The present set of standards is almost a year old and is still in a usable condition.

Since a number of reagents are employed in the nitroprusside test, it was considered advisable to investigate them as potential variables. In these studies raw milk heated to 90° C. momentarily and cooled to 20° C. was used as the test medium. The following quantities or concentrations of reagents were found optimum for the test: sodium nitroprusside, 4.5–5 per cent solution; ammonium hydroxide, not less than 16 per cent strength; ammonium sulfate, 4 to 5 g. per 5 ml. sample. The effect of age of the nitroprusside reagent as a factor in the test also was investigated. Samples of reagent as much as 40 days old gave satisfactory results. It was observed, however, that unless the reagent is stored in the dark, it will impart to the test sample a brown discoloration which intensifies with increasing age of the reagent. One sample of commercial grade ammonium sulfate was found to be unsuitable because of the grey color which it imparted to the test. Generally speaking, it seems advisable to use only the best quality of chemicals for the test.

Previous experience indicated that sample temperature might influence the results obtained with the test as it is applied to heated milk. Experiments concerning this variable showed that temperature is an important factor in the test. Samples of milk which were heated to 95° C. and immediately subjected to the nitroprusside test gave no color development whatsoever. As these samples were cooled to progressively lower temperatures increasing color intensity was secured in the test. The maximum amount of color was obtained when samples were cooled to 20° C. or lower. An appreciable difference in color intensity was produced in samples cooled to 20° as compared with those cooled to 30° C. This effect of temperature appears to be reversible. Samples of milk which were cooled to 20° C., reheated to 60° C. and then subjected to the test developed color comparable to that of samples cooled directly to 60° C.

It was observed further that color stability is enhanced by maintaining the samples at low temperatures during and after subjecting them to the test

TABLE 1

The effect of cooling temperature on permanence of color developed by the nitroprusside reaction in a sample of heated milk[a]

Sample treatment	Intensity of NP reaction after holding time (min.) of:						
	0	1	2	3	4	5	30
Cooled to 30° C., tested and held at room temperature (28°)	4+	2+	1	±	0	0	0
Cooled to 10° C., tested and held at room temperature (28°)	6+	6	5+	5	4	4	1
Cooled to 10° C., tested and held in an ice bath	6+	6+	6+	6+	6+	6+	6

[a] Heated to 95° C. momentarily and cooled as indicated.

(table 1). Permanence of color is quite advantageous when one wishes to make direct color comparisons between samples. This is accomplished best by cooling the samples in an ice bath, testing them and then storing them in an ice bath. Comparisons should be made within 30 minutes after testing.

The preceding study of the nitroprusside test demonstrated that the procedure of Josephson and Doan (7) for the test is quite satisfactory when temperature is controlled. In the balance of the experimental work reported in this paper, sample temperature was maintained at 20° C. or below for the test.

The disappearance of sulfhydryl compounds in milk under the influence of prolonged high heat treatment raises a new point of interest with respect to their behavior. Townley and Gould (14) were the first to point out this phenomenon and they also noted that it is correlated with browning and caramelized flavor

TABLE 2

The effect of heat treatment on the nitroprusside reaction of skim milk and some of its fractions

Heat treatment	NP reaction			
	Skim milk	Rennet whey	Dialyzed skim milk	Dialyzed skim milk plus lactose[a]
Unheated	0	0	0	0
78.9° C. flash	1	±	1	1
82.2° "	2	2	2+	2+
87.8° "	4	5	4	4
93.3° "	5	6+	5+	5
93.3° 15 min.	6	6+	6	5
93.3° 30 "	4	6+	4+	3+
93.3° 60 "	2	6+	4	1+
Color after heating[b]	brown	normal	normal	brown
Flavor after heating[b]	caramelized	cooked	cooked	caramelized

[a] 4.76 per cent lactose added prior to heating.
[b] 93.3° C. for 60 min.

development in heated milk. In an attempt to clarify this matter, skim milk and some of its fractions were subjected to prolonged heat treatment and the level of sulfhydryl compounds in each fraction was followed during heating by means of the nitroprusside test. After completion of the heat treatment, flavor and color of samples were evaluated by three experienced observers. Table 2 contains representative results from these experiments.

Dialysis of the skim milk was carried out at 4° C. using a cellophane membrane. In other trials it was noted that where the dialyzing water was changed more frequently a higher level of sulfhydryl substances was maintained in the dialyzed skim milk during prolonged heating. The data suggest that the disappearance of sulfhydryl compounds in skim milk heated for prolonged periods is dependent upon the interaction of lactose and casein. This contention is substantiated by data secured from samples of skim milk and its rennet whey after sterilization (116° C. for 15 minutes) and storage (11 months at 37° C.).

TABLE 3

The effect of rennet coagulation on the distribution of sulfhydryl compounds in heated skimmilk as measured by the nitroprusside reaction

Heat treatment	Nitroprusside reaction				
	Control skim milk	Whey from heated skim milk	Curd from heated skim milk	Raw Whey	Raw Curd
Unheated	0	0	0	0	0
78.9° C. flash	1	0	0	±	0
82.2° "	2	±	0	2	0
87.8° "	4	±	1	5	0
93.3° "	5	±	2	6+	0
93.3° 15 min.	6	±	2	6+	0
93.3° 30 "	4	±	1	6+	0
93.3° 60 "	2	±	0	6+	0

Following sterilization the skim milk had a caramelized flavor and showed considerable evidence of browning. Its reaction to the nitroprusside test was faintly positive. Under these conditions, the whey showed no evidence of caramelization either in flavor or color and gave a very strong reaction to the nitroprusside test. Storage merely amplified these differences. The skim milk became more caramelized and gave a negative nitroprusside reaction, whereas the whey showed a positive reaction and no caramelization after 11 months' storage.

Another interesting property of sulfhydryl substances, with respect to their physical stability, is that they may be precipitated from rennet whey by heat, yet they appear very stable in heated milk. The protein material which is precipitated from whey by heat is quite coarse and gives a very strong nitroprusside reaction. This precipitate has a physical character resembling that of cooked egg white. No such precipitate is obtained by heating skim milk. It would appear that casein prevents the aggregation of serum proteins into large coarse particles in heated skim milk. Keiferle and Gloetzel (8), Matsuo (9) and Menefee *et al.* (10) all have found decreases in albumin nitrogen (in some cases

complete disappearance) and compensating increases in casein nitrogen in heated milk. Matsuo (9) observed that the albumin content remained constant up to 70° C., after which there was a rapid decrease with only a trace remaining above 96° C. These interesting observations prompted an experimental approach using the nitroprusside test as an indicator of sulfhydryl distribution. The disposition of sulfhydryl groups in skim milk heated and then rennet-coagulated was investigated, as well as their disposition in raw skim milk, which was coagulated with rennet and the whey and curd then heated separately. This procedure enabled a study of sulfhydryl distribution to be made both in the presence and absence of casein. In all experiments dealing with this matter it was found that sulfhydryl substances associate themselves with the casein in heated milk. Since these substances have nothing with which to dispose themselves in heated whey, they gather as a precipitate. Data from these experiments are given in table 3. It also was seen that sulfhydryl substances could be removed from heated skim milk only in proportion to the amount of casein removed by supercentrifugation at 35,000 r.p.m. Supercentrifugation of heated whey (95° C. for 30 minutes) deposited a sludge on the centrifuge bowl which gave an intensely positive nitroprusside test.

DISCUSSION

Within fairly wide limits, the strength and the amounts of the reagents used apparently do not influence the sensitivity of the nitroprusside test as it is applied to heated milk. However, sample temperature at the time of testing is a variable which can affect markedly results obtained with the test. When samples of milk are heated to the critical point for sulfhydryl liberation, the intensity of the nitroprusside test will depend upon the temperature at which the test is made. Where temperature is not controlled, it would be possible to obtain negative test results at one temperature and positive results at a lower temperature with any given sample.

It is well to bear in mind that such factors as copper contamination, exposure of the milk to air or sunlight and the amount of lactalbumin present in the milk might influence results obtained with the nitroprusside test when such milk is heated. These factors were not studied in the present investigation.

The complexity of chemical changes taking place in skim milk heated for prolonged periods at high temperatures is revealed by the study dealing with the behavior of sulfhydryl substances in this medium. The data indicate that sulfhydryl substances do not disappear during the prolonged heating of whey, and, theoretically, the same condition obtains with respect to exhaustively dialyzed skim milk. The results which were secured when lactose was added to dialyzed skim milk show the critical importance of this milk constituent in the phenomena of browning, caramelized flavor development and the disappearance of sulfhydryl substances in heated skim milk. The fact that these changes are not observable in heated whey established the importance of casein also in this connection. The logical inference is that sulfhydryl groups disappear by reaction with substances formed from lactose and casein under the influence of heat.

The evidence presented in this and other investigations (8, 9, 10) supports the contention that heat-denatured serum proteins are associated physically and/or chemically with casein in milk heated to high temperatures. Supercentrifugation of heated skim milk should effect a separation of casein and serum proteins containing sulfhydryl groups. Attempts to separate these protein fractions in such a manner were unsuccessful in this investigation. Perhaps the effective mass of the two types of particles is the same, and thus they are removed together, or possibly the two types of particles are associated physically and/or chemically and thus are removed together. The latter presents a more likely explanation. The former, if true, would be quite coincidental. At least, some form of colloidal protective action seems indicated based on the differences in behavior of serum proteins in heated milk as compared with heated whey.

Such an association, resulting from the heating of milk, may be explainable on the basis of changes in electrostatic charge between the two types of protein particles or the liberation of certain chemical groups having an affinity for one another. The differences in curd characteristics of heated and unheated milk may result in part from this association. A casein curd containing denatured serum proteins hardly could have the same physical or chemical characteristics as a pure casein curd. Theoretically, the structure of the curd should be weaker and therefore softer due to the hindering effect of serum proteins on the so-called network formation. The effect of heat in reducing the amount of calcium ion in milk also must be considered as a factor influencing curd tension and curd particle size. In any case, the apparent association of casein and serum proteins in heated milk is worthy of further research.

SUMMARY

The procedure of Josephson and Doan (7) for the nitroprusside test was found to be satisfactory in its application to heated milk when the factor of temperature was controlled. For optimum results, samples should be cooled to 20° C. or lower before subjecting them to the test.

Experiments utilizing the nitroprusside test as an indicator of sulfhydryl behavior demonstrated that these groups disappear in skim milk heated for prolonged periods at high temperatures. This disappearance depends upon a reaction involving lactose and casein and is correlated with the development of caramelized flavor and browning.

The distribution of sulfhydryl substances in heated skim milk was studied, using the nitroprusside test. These substances associate themselves physically and/or chemically with the casein in heated skimmilk. This phenomenon may be an important factor in explaining the soft curd characteristics of highly heated milk.

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MILK SURFACES. I. THE SURFACE TENSION OF FRESH SURFACES OF MILK AND CERTAIN DERIVATIVES[1]

CARRELL H. WHITNAH,[2] RALPH M. CONRAD,[3] AND GLEN L. COOK[4]

This investigation started with the assumptions that the surface tension of a freshly-formed milk surface should not differ greatly from the surface tension of pure water and that it might be possible to observe early changes in surface tension of freshly-formed milk surfaces. At least, it was hoped to find ways of so modifying or fractionating milk that an early rapid fall in surface tension could be measured. Any such fall in surface tension would be some indication of the accumulation or orientation of surface-active material on the surface.

REVIEW OF LITERATURE

A sufficient introduction to the history of measurements of the surface tension of milk and to the nature of surface-active substances to be expected in milk is given in recent papers by El-Rafey and Richardson (5, 12) and by Aschaffenburg (3) and in papers cited by these authors.

The vibrating-jet method of measuring surface tension as proposed by Rayleigh (11) and refined by Pedersen (10) and Bohr (4) seemed most promising for very young surface ages. This method was used with some simplification by Addison (1) to measure the rate of fall of surface tension of solutions of certain alcohols. In Addison's solutions the fall of surface tension measured a rate of adsorption in the surface from the bulk of the solution. Addison referred to the changing surface tension in young surfaces as dynamic, and to the constant value obtained later as static. He considered his static values to represent a true equilibrium between the surface and the bulk of the solution. If a surface-denatured protein accumulates on a milk surface and if this denaturation is irreversible, the static or nearly constant surface tension would not represent a true equilibrium (8). The simplified theory of this method is that if a jet of liquid flows from an elliptical orifice, the surface tension of the jet pulls it into circular cross section. The momentum of this motion later produces another elliptical cross section with the major axis at right angles to the major axis of the orifice. Repetition of this process produces a series of standing waves which can be photographed and measured. With any given set of conditions, a decrease of surface tension increases the wave length.

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[2] Present address Chemistry Department, Kansas State College, Manhattan, Kansas.

[3] Deceased.

[4] Present address U. S. Bureau of Mines, Laramie, Wyoming.

The formulas of Pedersen and Bohr (10, 4) using suitable symbols may be expressed as follows:

$$T = \frac{(P_1 + P)k^2r^3c^2J_2(irk)}{(3 + r^2\ k^2)irk\ J_2'(irk)} \times \left[1 + 2\left(\frac{2\mu}{Pcr^2k}\right)^{3/2} 3\left(\frac{2\mu}{Pcr^2k}\right)^2\right] \times \left(1 + \frac{37}{24}\frac{n^2}{m^2}\right)$$

T = Surface tension dynes/cm.
P_1 = Density of medium (air) g./cc.
P = Density of liquid g./cc.
k = $2\pi/l$. $\pi = 3.1316$.
l = Wave length cm. (node-to-node or loop-to-loop).
r = Equivalent radius or $\sqrt{ab}$.
a = 1/2 long axis = "r max.".
b = 1/2 short axis = "r min.".
c = Velocity of jet cm./sec. = $f/(\pi ab)$.
f = Flow rate of jet g./sec.
μ = Coefficient of viscosity.
m = $(a+b)/2 \cdot n = (a-b)/2 \cdot i = \sqrt{-1}$.
J_2 = Bessel's function of order 2.
J'_2 = First derivative of J_2.

$$u_2 = 4\sqrt{\pi}\ \frac{J_2(irk)}{(3 + r^2\ k^2)\ irk\ J'_2\ (irk)}$$ (Given in Pedersen's table for values of rk.)

The term in brackets is Bohr's correction for the viscosity of the liquid in the jet. The third term $\left(1 + \frac{37}{24} \cdot \frac{n^2}{m^2}\right)$ is Bohr's correction for the finite difference $a - b$. A finite value of this difference definitely was excluded in Rayleigh's original calculations but is needed to make the wave lengths measurable. These last two terms were omitted in Pedersen's formula. They are not important in the work of Pedersen or Bohr, but in the present study were found to reach values as high as 1.02 and 1.20, respectively.

After years of study with other methods of measuring surface tension, Harkins and Anderson (6) selected the Wilhelmy hanging slide for measuring differences in static surface tension. Materials for a similar apparatus were available for parts of the present study. The pendant drop method of Andreas *et al.* (2) might have been more suitable but would have required the building of another elaborate apparatus.

Although there are no known studies of possible decomposition products arising from the method of removing protein fractions proposed by Harland and Ashworth (7), this treatment seemed mild and was different from the methods used by El-Rafey and Richardson (5) and by Aschaffenburg (3).

APPARATUS

The optical methods for measuring the wave lengths of vibrating jets that depend on the lens-like action of the jet are not available for an opaque liquid like milk. Therefore, the jets were photographed and measurements of both length and diameter were made from these photographs. On early plates both the lengths and diameters were measured on a projected image of the photograph where the total magnification was about 25. On later plates the diame-

ters were measured with a microscope fitted with a mechanical stage capable of reading .0001 cm. This stage was mounted on a lathe carriage so that the longitudinal and transverse feed screws measured changes in position of the plate. Rotation of the arm carrying the microscope permitted the selection of a convenient range for the cross feed. A mirror from a 16 mm. gun camera permitted a horizontal eyepiece and also permitted alignment of the image of the jet axis with the longitudinal motion of the stage.

The position of the wave ends on the photograph could not be judged as accurately with the microscope as on the screen. Therefore, all wave lengths were measured on the screen. In early photographs the pictures were taken with white light. Later a mercury vapor lamp with Corning filters to isolate the line at 435 mμ was used.

Orifices were arranged to produce three simultaneous, nearly horizontal jets in a single vertical plane. The axis of a machine screw, selected for uniformity of thread pitch, also was placed in this plane to serve as a basis for determining

TABLE 1

Characteristics of Orifices

Orifice no.	Material	Major axis	Minor axis	Thickness	Surface tension of water at 25° C.
		(*cm.*)	(*cm.*)	(*cm.*)	(*dynes/cm.*)
1	Steel	.050	.035	.0051	73.9
2	Brass	.084	.069	"	72.3
3	Steel	.127	.100	"	71.1
4	Glass	.0424	.0318	.0170	95.3
5	"	.0645	.0466	"	61.6
6	"	.0724	.0636	"	72.3
7	Gold	.0422	.0304	.0045	71.6
8	"	.0503	.0369	"	71.0
9	"	.0737	.0540	"	70.2

magnification. The three simultaneous pictures helped to separate irregularities in the jets and their measurements from variation between samples of milk.

The orifices were formed in thin plates because of Addison's finding (1) that initial disturbances in the jets vanish more quickly if the orifices are plates rather than tubes. Three groups of orifices were tried.

In the first group, an orifice was formed in a thin sheet of brass or steel. To form an orifice, a round hole was first drilled in a plate with a jeweler's drill of the size desired for the minor axis. The hole then was made nearly elliptical by tilting the drill. The final shape of the hole then was formed by filing with a roughened wire until the shape appeared satisfactory under a microscope. A steel orifice was of harder material and could be fashioned more easily into acceptable shape but rusted easily so that repolishing was necessary before each use. It was difficult to obtain a smooth edge on a brass orifice as the sheet showed grain, fiber or flaws. The surface tension of milk at ages from .0007 to .0265 seconds was measured with these orifices, using white light and the projector for both the lengths and diameters of the waves. Some

characteristics of these orifices are given as numbers 1, 2 and 3 of table 1. The sheet was soldered onto the end of a brass tube and the tube was mounted with glyptal cement in the end of a glass tube. This procedure of mounting was satisfactory if the orifices could be aligned by inspection. When the photographs were twice natural size it was necessary to produce jets and align the orifices before the cement hardened completely. After such procedure some cement dissolved and frequently accumulated in the orifice, changing its size and shape.

The second group of orifices was made in glass plates. An electric spark was used first to punch or tear a hole in a pyrex coverglass made for microscope slides. This hole then was enlarged with a soft wire carrying an abrasive. The hole was finished much as in the first system. It was not possible to get the edges of the orifice entirely free from splinters extending part way through the thickness of the glass. Also, the edge near the ends of the major axis was beveled somewhat. Three orifices of this type were cemented to the ends of glass tubes and baked in an oven to harden the cement. The tubes then were sealed to the supply tubes in such a way that the orifices appeared in proper position. The tubes were realigned, if necessary, to bring the three jets into one plane. It was not found possible to make the three jets exactly parallel in this plane. Jets from these orifices were reproducible and could be read for a greater number of waves than for orifices of the first system. However, the jets were not satisfactory because the surface tension of water was irregular and because of uneven wave lengths and of irregular positions of occasional nodes. These orifices are described as numbers 4, 5 and 6 of table 1.

The third group of orifices was made in sheets of 14-karat gold. Three tapered holes were drilled on the center line of a stainless steel plate which fitted as a cover for one side of a tank or chest of similar metal. A sheet of gold then was soldered over the small end of each hole and the entire assembly imbedded in plastic. The three orifices then were drilled through the plastic and the gold plates with a Gorten pantograph milling machine. The plastic was removed after the orifices were formed. The controlled motion of the table of the milling machine permitted accurate placing of both the position and direction of the axes of the orifices. These orifices are numbers 7, 8 and 9 of table 1.

The orifices, the machine screw and nearly all of each jet were enclosed in a jet house. This was to avoid evaporation from the surface of the jets, change in temperature of the jets and disturbance from currents of air. The jet house had double windows on both the side toward the condensing lens and on the side toward the camera. Just enough warm air was blown into the space between each of these double windows to prevent fog from collecting on the inner surfaces. Three holes in the end of the jet house away from the orifices permitted each of the three jets to flow into the container or jet catcher where the flow for a measured time was caught and weighed. The three containers were mounted in a rack which could be moved along sliding ways in front of the jets as a stopwatch was started and away from the jets as the watch was stopped. A diagram of the final form of the apparatus is shown in figure 1.

For static measurements of surface tension, a torsion balance with dial calibrated to read 500 mg. at 2 mg. per division was used. A table on a vertical screw was mounted under the balance arm. Rods from this table extended down through the base of the balance into an air-conditioned metal cabinet where they carried a shelf on which samples were placed. A fine wire extended from the

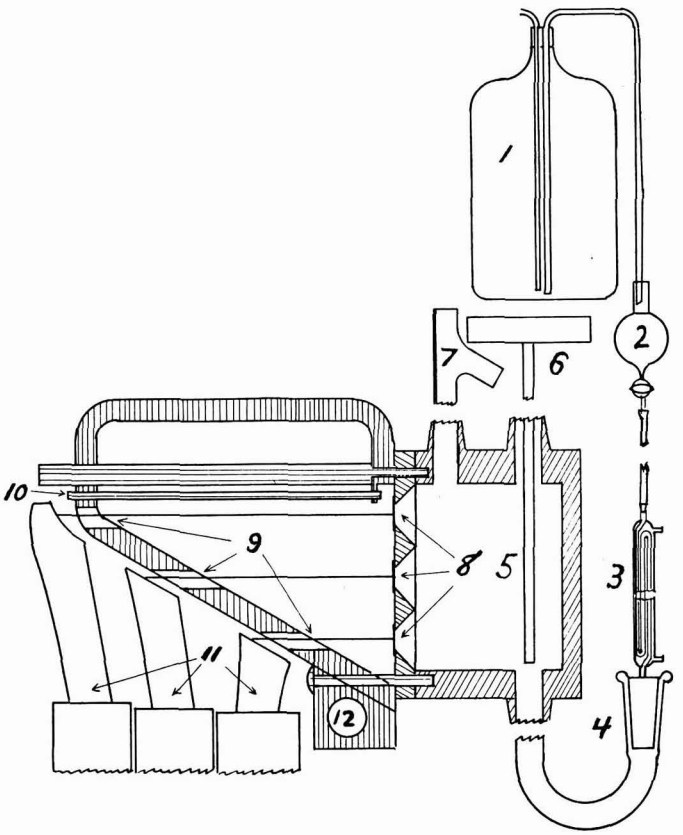

FIG. 1. Vibrating Jet Assembly Parts 1–3 = ⅛ size. Parts 4–12 = ½ size. 1. Supply with syphon and control. 2. Reservoir with stopcock. 3. Heat exchanger. 4. Ground glass joint. 5. Stainless steel chest. 6. Dial thermometer in glass joint. 7. Overflow tube. 8. Tapered holes, orifices, and jets. 9. Exit holes in jet house. 10. Machine screw for scale. 11. Jet catchers and containers. 12. Inlet for warm air. Steel section = ||| = |||. Brass section = ||| = ≡.

balance arm into the cabinet to carry the slide which made the surface contact. The slides used were 22 × 35 mm. pyrex coverglasses made to cover microscopic slides. A lamp outside, but near a window of the cabinet, kept the window free from condensed moisture and also lighted the interior of the cabinet.

When milk was rehomogenized, this was done by passing it three times through a single-cylinder hand homogenizer.

PROCEDURE

To measure surface tension by the vibrating-jet method, milk or other liquid, cooled below the lowest temperature to be used, was placed in the supply system. Water to maintain the desired temperature was placed in or circulated through the outer chamber of the heat exchanger. The liquid was allowed to flow at a rate to supply the jets and cause from 30 to 120 drops per minute to fall from the overflow.

While the chest and jet house were coming to temperature equilibrium, the alignment and focus of the camera and lamp were checked. If the experiment was being conducted at more than 5° C. above room temperature, a stream of warm air was blown through the space between the double windows of the jet house. As soon as the temperature in the chest became constant, the weighed jet-catchers were slid in front of the jets with one hand while a stop watch was started with the other. After about 1 minute the air-blower and water-circulating pump were stopped for a few seconds to avoid vibration while the actual photographic exposure was being made. The pump then was restarted and let run until the discharge from the jets had been collected for about 2 minutes. The jet catchers then were pushed away from the jets and the watch was stopped. The circulating pump, water bath heater and lamp then either were turned off or were set for a higher temperature.

The jet-catchers containing the liquid collected during the measured time were wiped clean, adjusted to room temperature and weighed. The temperature at the time of exposure and the reading of the stop-watch were recorded.

Wave lengths were measured by projecting the photograph of the jet on a screen of drawing paper. The position of each node and loop was marked on the screen. Then the distance of each node (N_0, N_1, N_2 . . .) and each loop (L_0, L_1, L_2 . . .) from the orifice was measured. The marking and measuring of these positions were repeated ten times and the ten values for each distance were averaged. The difference between successive average values of N or L was taken as a wave length (1). The wave beginning at N_0 and ending at N_1 was considered to have an average distance from the orifice of L_0. This distance and the flow rate were used to calculate the age of this wave.

If diameters were measured on the screen, the procedure was similar to that for wave lengths. If diameters were measured with the microscope, the plate was placed on the stage so that the axis of the jet would remain on a center line in the eyepiece during longitudinal motion of the carriage. The longitudinal position for the first minimum width (N_0) of the jet was selected and the width measured ten times. These values then were averaged for ND_0. Similarly for LD_0, ND_1, etc.

The diameter measured at L_0 was used as the major axis ($2a$) there. The corresponding minor axis ($2b$) was assumed to be the average of values measured at N_0 and N_1. When the correction factor for amplitude was not used,

2a and *2b* were taken as the average of all available consecutive values, with the limitation that first and last values were either both nodes or both loops. These average values were used to determine the equivalent radius (r) even when the particular correction factor for amplitude was applied to each wave.

A specific gravity balance and an Ostwald viscosimeter were used to determine the densities and viscosities at the temperatures used for measuring surface tension. The values were determined relative to water (9).

For measurements with orifices 1–3 the first term of the formula of Bohr (4) and Pedersen (10), as given above, was used without either correction factor. For measurements with orifices 7–9, the amplitude correction was used on each wave. The viscosity correction was important only for evaporated milk.

The liquids thus tested included (a) water, (b) commercially homogenized milk, (c) evaporated canned milk, (d) rehomogenized milk diluted 10 times with water, (e) the filtered serum obtained after saturating milk with sodium chloride and holding overnight at 40° C., and (f) the above serum after bringing to pH 2 with hydrochloric acid, holding overnight and filtering again. Milk and the two sera just described also were diluted with water until changes of surface tension with surface age could be measured by the jet method and also, after further dilution, on the static balance.

RESULTS AND DISCUSSION

The surface tensions of water measured with the orifices used for milk and other liquids are shown in the last column of table 1.

A summary of 215 measurements on commercial homogenized milk at 25° C. and at surface ages ranging from .0007 to .0265 seconds, is shown together with standard deviations (13) in table 2. There was some decrease of surface tension within this range of surface age. However, the surface tension of the youngest surface was still nearly equal to the static value for milk.

The gold orifices produced longer jets from each of which a greater number of waves could be measured. Also overtones were not noticeable in these jets. The values for surface tension at different ages, however, were no more consistent than values in table 2 for the same surface ages. The measurements on milk with the gold orifices therefore were used only to detect any change of surface tension at the youngest possible ages. The average correction factors needed to reduce the surface tension of water and of milk at L_0 and N_1 to the average value from L_1 to the end of the jet (x) are shown in table 3.

At L_0 the factors for milk are only slightly larger than corresponding factors for water, for orifices 7 and 8. For orifice 9 the factor for milk is slightly smaller than for water. If the surface tension of milk relative to water were decreasing at these surface ages, the correction factor for milk should be correspondingly larger than for water. The similarity of factors indicates that there was no great change in the surface tension of milk at these surface ages. Therefore, most of any change in the surface tension of milk relative to water had taken place before the surface had reached the age of .0003 seconds.

It is not surprising after the above results that no change with age was

TABLE 2

Summary of surface tensions of commercially homogenized milk at 25° C. and increasing surface ages

No. of values averaged	Av. age	Surface tension (*dynes/cm.*)		
		Av.	Standard deviation	Standard error of mean
	(*sec.*)			
7	.0007	58.39	2.52	.95
17	.0014	56.07	2.42	.59
14	.0021	55.08	2.90	.77
19	.0028	55.28	4.01	.92
19	.0035	55.10	4.66	1.07
9	.0042	53.29	2.12	.71
19	.0049	50.51	3.16	.72
10	.0056	52.48	2.27	.72
8	.0063	50.98	1.97	.70
11	.0070	50.45	3.11	.94
11	.0080	51.38	2.86	.86
11	.0090	51.42	2.36	.71
8	.0100	52.05	2.88	1.02
5	.0110	52.11	1.56	.70
9	.0120	52.60	2.67	.89
10	.0130	50.45	2.46	.74
8	.0145	50.30	4.89	1.73
7	.0165	49.51	2.52	.95
5	.0185	49.00	2.03	.91
3	.0205	51.96	2.21	1.28
3	.0225	52.07	2.93	1.69
2	.0265	46.82	1.73	1.22

found in the surface tension of evaporated milk. The viscosity of .199 poises of this product at 15° C. was so great that wave lengths in the jets could not be measured, although a very clear picture of the jet was obtained. Measurements at 48 and 66° C. gave average surface tensions of 50.3 and 50.7 dynes/cm., respectively. Viscosities at these temperatures were .045 and .024 poises, respectively.

When milk was modified by diluting with 10 parts of water or by removing the casein or total protein (7) the surface tension did change at measureable values of surface age. From varying short intervals after the first measurements, the surface tension dropped at a rapid, nearly constant rate. After a later surface age, which also varied with the particular liquid, the surface tension changed at

TABLE 3

Correction factors for surface tension at L_0 and N_1 needed to make these values equal to corresponding average values for L_1 to end of the jet (x)

Orifice no.	7			8			9		
Wave no.	L_0	N_1	x	L_0	N_1	x	L_0	N_1	x
Liquid	Correction factor								
Water	.7610	.9634	N_7	.7657	.9452	L_6	.9416	.9560	N_6
Milk	.7987	.9124	N_5	.8026	.9363	N_5	.8992	.9569	N_5
Surface age (sec. × 100,000)	28	55		45	80		82	133	

TABLE 4

Surface tension of modified milks at characteristic surface ages

Liquid	Milk diluted 1 milk + 10 water				Non-casein filtrate		Non-protein filtrate	
Temp. ° C.	50		15		15		15	
Characteristic	Age[1]	T[2]	Age	T	Age	T	Age	T
Fall starts	10	65.8	20	66.0	10	88.0	10	91.0
Break[3]	20	61.0	60	59.0	35	80.0	30	80.0
1st rate[4]	4800		1750		3200		5500	
Oldest age	70	55.4	100	57.0	70	79.4	70	79.2
2d rate	1120		500		171		200	
Static T	44.0		50.4		54.7		51.0	

[1] Seconds × 10,000.
[2] Surface tension (*dynes/cm.*)
[3] Intersection of two nearly straight portions of curve for surface tension vs. surface age.
[4] Rate of fall in surface tension (*dynes/cm./sec.*).

another nearly constant but much slower rate (table 4). Before using these data as precise characteristics of the modified milks, many more observations and more careful definitions of the liquids are needed. The data, however, do furnish a definite contrast to the nearly constant surface tension of whole milk at similar surface ages.

A 1 per cent solution of milk, or either of the above filtrates undiluted, would reach a constant surface tension within 1 minute. Dilutions of 1 per cent, for the filtrate, or of .01 or .005 per cent for milk were satisfactory for observing, with the static balance, the change in surface tension. Static surface tensions of rehomogenized milk and of commercially-homogenized milk, freshly warmed to temperatures from 15 to 70° C. after storage at about 5° C. for 1 to 7 days, and of fresh dilutions of the stored commercially-homogenized milk are shown in table 5. For each pair of values at a given age and temperature, the surface tension for the commercially homogenized milk was slightly greater than for the rehomogenized milk. Data are not available to show how universal this relationship is.

TABLE 5

Static surface tensions of rehomogenized milk and commercially homogenized milk freshly warmed to indicated temperatures after storage at about 5° C. for 1 or 7 d. and of fresh dilutions of the stored commercially homogenized milk

Temp. ° C.	Rehomogenized		Commercial		Commercial diluted to:			
	1 d.	7 d.	1 d.	7 d.	10%	1%	.1%	.01%
				(*dynes/cm.*)				
15	47.9	46.1	53.5	48.0	50.4	.....	53.3	.....
25	46.3	45.0	48.8	45.9	46.9	51.6	51.5	56.5
30	45.5	44.8	46.7	45.4	45.8	50.2	50.2	53.8
40	44.9	43.9	45.1	44.9	44.8	49.2	47.4	52.7
50	43.3	43.3	44.2	43.7	44.0	48.0	46.4	51.9
60	42.8	42.6	44.0	44.1	43.6	46.9	45.6	50.9
70	41.8	43.0	43.5	.....	42.7	46.5	43.9	45.9

TABLE 6

Surface tensions of diluted milk, diluted non-casein filtrate and non-protein filtrate in relation to cleaning of slide before each reading, depth of solution and surface age

Temp. ° C.	25	25	20	20	20	20
Cleaned slide	No	No	Yes	Yes	Yes	No
Substance	Milk	Milk	Milk	N.C.F.	N.P.F.	N.P.F.
Diln. to %	.005	.005	.01	1	1	1
Vol. ml.	20	120	20	20	20	20
Container	A	A	B	B	B	B
Age (*min.*)	Surface tension (*dynes/cm.*)					
1	71.0	70.5	72.1	.....	72.6	71.7
1.5	70.5	69.7	71.6	55.0	.....	71.4
2	70.1	69.0	.....	54.7	72.6	71.0
3	69.0	67.6	70.8	54.5	.....	70.5
4	68.8	66.8	.....	.....	.....	69.9
5	68.3	66.0	70.8	54.3	.....	69.2
8	67.9	64.8	70.8	54.1	72.5	67.9
12	67.4	63.9	70.5	53.8	72.5	66.3
18	67.4	62.9	69.4	53.6	73.1	64.3
73	.....	.....	.....	53.0	.....	.....
93	.....	.....	63.2	.....	.....	.....
115	.....	.....	.....	52.7	72.2	.....
176	.....	.....	60.4	.....	.....	.....
225	.....	.....	60.4	52.3	70.4	.....
346	.....	.....	.....	.....	64.9	.....
390	.....	.....	.....	.....	62.5	.....
626	.....	.....	.....	.....	61.8	.....
1146	.....	.....	.....	50.3	.....	.....
1338	.....	.....	.....	.....	59.6	.....

In table 6 are shown surface tensions of dilutions of milk, non-casein filtrate and non-protein filtrate, measured with the static balance with and without cleaning the cover glass before each measurement, on solutions of different depths and at different surface ages.

TABLE 7

Rate of fall in surface tension, at various ages, of high dilutions of each milk, non-casein filtrate, and non-protein filtrate; from values in table 6

Surface Age	Rate of fall		
	.01% milk	1% N.C.F.	1% N.P.F.
(*min.*)		(*dynes/cm./min.*)	
1.5	1.0	.....	.....
2	.....	.6	.....
12	.08	.08	.00
93	.08	.....	.....
115	.....	.....	.003
176	.046	.....	.....
225	.000	.036	.016
346	.....	.....	.045
390	.....	.....	.055
626	.....	.....	.003
1146	.....	.002	.....
1328	.....	.....	.003
Total fall as % of initial value	16.2	8.5	17.9

The progressively smaller fall in the surface tension of the 20 ml. sample of .005 per cent milk compared with the 120 ml. sample at identical surface ages indicates that the smaller sample contained an inadequate amount of surface active material to quickly or fully saturate the surfaces of the solution.

For the two identical solutions of non-protein filtrate, the consistently lower values with the slide not cleaned before each measurement (table 6) indicate that the contact edge or surface of the cover glass must absorb an appreciable amount of surface active material before it can give a constant tension. It seems quite possible that this absorption may produce a contact angle greater than zero. Such a disturbance probably would be detected less easily but be more serious with a wire ring than with the cover glass.

The changes of surface tension with age when the cover glass was cleaned before each measurement and when the volume of the solution and the shape of the container were identical are shown in table 7.

The initial objective of this phase of the study was to modify milk so that the rate of change of surface tension could be observed with simple apparatus. This objective has been achieved. An explanation of the lag of nearly 2 hours before the surface tension of the diluted non-protein filtrate started to fall or of the relatively small total fall in the surface tension of the non-casein filtrate is outside the scope of this paper.

SUMMARY

The vibrating-jet method of measuring surface tension was applied to milk.

The surface tensions of commercially homogenized milk at 25° C. were determined at surface ages ranging from .0007 to .0265 seconds. Correction factors needed to reduce the measured surface tensions at surface ages as young as .0003 seconds to average values excluding the first two waves were nearly identical for milk and water. Any great change in the surface tension of milk relative to water therefore must have taken place before the surface age of .0003 seconds.

When milk was diluted with ten parts of water, or when the casein was precipitated by saturating the milk with sodium chloride or when other proteins also were precipitated by acidifying with hydrochloric acid, large decreases of surface tension were found in the age range .001 to .01 seconds.

When milk was diluted to .01 per cent or when the above filtrates were diluted to 1 per cent, decreases in surface tension could be observed by ordinary methods for periods of several hours.

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EFFECTS OF VITAMIN A AND CAROTENE INTAKE ON DEPLETION TIME OF YOUNG DAIRY CALVES

W. C. JACOBSON, H. T. CONVERSE, AND L. A. MOORE

Bureau of Dairy Industry, Agricultural Research Administration, United States Department of Agriculture

The present practices of rearing dairy calves with limited amounts of whole milk have altered considerably the quality and quantity of food a calf receives up to 4 months of age, as compared with former feeding practices in which whole milk was fed more liberally or the calves were allowed to suckle their dams. Insofar as vitamins are concerned, the intake of vitamin A has been reduced materially by present-day feeding practices. Moore and Berry (8) found that when calves were reared according to present-day methods of limited whole-milk feeding, the vitamin A content of the blood plasma from birth to 4 months of age was in the deficient range, as judged by blood values of vitamin A-deficient calves 4 to 14 months of age. Moore *et al.* (9) reported that the vitamin A content of the blood plasma of dairy calves reared on a limited whole-milk feeding program was one-third lower than that of beef calves of the same age that were permitted to suckle and thus obtained considerably more whole milk. Wise *et al.* (13) found that the vitamin A content in the blood serum of calves at 5 weeks of age was 50 per cent lower than it was at the colostrum feeding period and at 10 weeks of age when the calves had started to consume more hay.

Krauss *et al.* (5) reported a decrease in the incidence of pneumonia in calves that received 15,000 I.U. of vitamin A concentrate daily as compared with a similar group that received no concentrate. Gullickson and Fitch (3) noted less trouble from digestive disturbances in young calves fed cod-liver oil than in calves not receiving the supplement. Whole milk was fed at the rate of one-eighth of the body weight per day for the first 30 days, followed by skim milk to 6 months of age. While calves in both groups had scours, some of the calves that received no supplement died. Phillips *et al.* (12) reported that the administration of a high vitamin A potency shark-liver oil plus certain of the B vitamins eliminated diarrhea and lowered the mortality caused by pneumonia.

In experiments at the Michigan station Moore (7) found that young calves invariably died of pneumonia and scours before 3 months of age when placed on a vitamin-A deficient ration. Converse and Meigs (1) showed that calves on a low vitamin-A intake died before 100 days of age. These reports suggest that vitamin A might have played a part in building resistance against bacterial infections in young calves. The evidence, while not clear-cut, seems to indicate that calves reared according to present-day methods of limited whole milk feeding may not receive sufficient vitamin A from birth to 4 months of age.

A summary of the Beltsville data (2) on the vitamin A requirements of calves from birth to 6 months of age indicates that a minimum daily intake of between

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10 and 25 γ of vitamin A (from cod-liver oil) per lb. of body weight was necessary to maintain normal growth. A study of the data reported by Lewis and Wilson (6) indicates that the minimum requirement for growth lies between 4.5 and 9 γ of vitamin A daily per lb. of body weight. These figures are somewhat lower than those reported from Beltsville. However, Lewis and Wilson (6) found that a daily intake of 9 to 18 γ of vitamin A per lb. of body weight was necessary to maintain the blood plasma vitamin A values above the deficient range.

Apparently the minimum quantity of vitamin A required per lb. of body weight to maintain good health, growth, and a normal level of vitamin A in the blood lies between 18 and 25 γ per day per lb. of body weight. If an arbitrary value of 25 γ is chosen and this figure is doubled for optimum results under practical farm conditions, a 100-lb. calf would need 5,000 γ of vitamin A or about 20,000 I.U. per day.

In 1941 Phillips *et al.* (12) noted that supplementing the ration with 5,000 I.U. of vitamin A plus niacin and ascorbic acid in capsules was effective in preventing scours and pneumonia in young calves. These data have received wide publicity, and as a result, several drug houses have placed capsules on the market containing these ingredients. However, other data (4, 11) show that the feeding of these capsules is of little value in preventing scours in calves reared under practical farm conditions. Possibly addition of 5,000 I.U. per day to the ration was not sufficient to bring out differences in response of calves to vitamin A feeding.

Apparently there is need for further carefully controlled experiments to determine the requirements for vitamin A and also the value of vitamin A supplements in the ration of the dairy calf up to 4 months of age, especially the effect of supplementing with larger quantities than 5,000 to 10,000 I.U. per day.

The object of this experiment was to determine the difference in blood plasma vitamin A levels and vitamin A stores between calves fed various amounts of supplemental vitamin A and those reared under natural conditions, as well as those reared using present-day feeding practices.

EXPERIMENTAL PROCEDURE

Fifty-two calves of the Jersey and the Holstein breeds were used in this experiment. Since no data are available on the blood plasma vitamin A and carotene levels in dairy calves reared under natural conditions, two cows were turned on pasture approximately 2 weeks before parturition. The cows calved on pasture and the calves were allowed to run with their dams on pasture until they were 90 days of age. Thus the calves not only had access to all the whole milk they could consume, which would be high in vitamin A, but they also had access to whatever fresh grass they desired to consume.

Fifty male calves received colostrum for 3 days and then were given a limited quantity of whole milk daily to 60 days of age and a grain mixture and alfalfa hay from birth to 90 days of age. A total of about 360 lb. of whole milk was fed to 60 days of age in this experiment. Twenty-four of these calves received sup-

plementary vitamin A in cod-liver oil. Eleven of the 24 calves received 25,000 I.U. of vitamin A per day for varying periods of time up to 42 days of age, and 13 of the 24 received 50,000 I.U. of vitamin A per day to various periods ranging up to 90 days of age. Ten to 15 ml. of cod-liver oil were used to furnish 25,000 I.U. of vitamin A, depending on its potency, while double these quantities was used to furnish 50,000 I.U. The factor 4 was used to convert micrograms of vitamin A to International units.

The whole milk the calves received was from cows on dry feed and was analyzed monthly for vitamin A and carotene. Weekly carotene determinations were made on a composite sample of the hay that the calves received. Records were kept on feed consumption of each calf and the total carotene and vitamin A intake to 90 days of age was calculated from these data. The calves were weighed every 10 days and the number of days they scoured was recorded.

At 90 days of age all the calves were placed on a vitamin A-free ration, consisting of grain and skim milk, for the purpose of depleting their vitamin A stores. The time required for depletion was determined by following the changes in the vitamin A level of the blood plasma. A calf was considered depleted when the blood plasma contained less than 4 γ of vitamin A per 100 ml. for 2 consecutive weeks. Weekly vitamin A determinations were made on all calves from birth throughout the experimental period.

RESULTS AND DISCUSSION

The time required for the blood plasma vitamin A to decrease to 4.0 γ per 100 ml. after the various calves were placed on the depletion ration is shown in table 1. It will be noted that the two calves permitted to run with their dams on pasture required up to 4 months for depletion, whereas the calves on limited whole milk and no supplemental vitamin A usually required only 2 to 3 weeks. The exceptions in the latter group are due to the fact that some calves received hay of exceptional quality, the effect of which will be discussed later.

In most cases the calves that received supplemental vitamin A had depletion times which fell between the two extremes, depending on the amount of supplementation. Calves that received supplemental vitamin A at the rate of 50,000 I.U. per day for 50 days or more had almost the same vitamin A storage as the two calves that were reared under natural conditions. However, when either 50,000 I.U. or 25,000 I.U. of vitamin A was fed for periods shorter than 50 days, considerably less storage was observed. The depletion time of these calves generally was greater than that of the calves that received no supplement. It is not surprising, therefore, that the feeding of 5,000 to 10,000 I.U. daily in capsules had no particular effect on the health of the calves, since in these experiments it required five to ten times that quantity to materially affect the depletion time.

Considerable variation will be noted, however, (table 1) in the relation of depletion time to the amount of vitamin A fed. It should be kept in mind that the calves used were of widely different weights, as affected by individual and breed differences. They also received hay of varying carotene content and consumed

it in varying quantities. Previous data (9, 10) have shown that vitamin A and carotene requirements are proportional to body weight. Therefore, it seemed desirable to express the total vitamin A intake as a ratio with body weight and then correlate the ratio with depletion time. In the present case the ratio would be the vitamin A intake per lb. of body weight.

TABLE 1

Effect of vitamin A intake on depletion time[1]

Animal no.	Treatment	Depletion time
278	With dam on pasture to 90 days of age	120
329	With dam on pasture to 90 days of age	113
708	50,000 I. U. to 98 days of age	117
513	50,000 I. U. to 92 days of age	104
2723	50,000 I. U. to 70 days of age	116
2725	50,000 I. U. to 70 days of age	149
527	50,000 I. U. to 51 days of age	94
525	50,000 I. U. to 46 days of age	59
517	50,000 I. U. to 40 days of age	98
2399	50,000 I. U. to 35 days of age	69
2713	50,000 I. U. to 30 days of age	82
712	50,000 I. U. to 30 days of age	32
713	50,000 I. U. to 30 days of age	32
515	50,000 I. U. to 30 days of age	45
2707	50,000 I. U. to 27 days of age	53
2902	25,000 I. U. to 42 days of age	40
2715	25,000 I. U. to 31 days of age	83
2718	25,000 I. U. to 31 days of age	79
2720	25,000 I. U. to 31 days of age	54
2391	25,000 I. U. to 30 days of age	74
509	25,000 I. U. to 30 days of age	66
523	25,000 I. U. to 30 days of age	67
716	25,000 I. U. to 30 days of age	30
521	No extra vitamin A	57
2714	No extra vitamin A	56
2392	No extra vitamin A	52
2597	No extra vitamin A	46
2928	No extra vitamin A	43
715	No extra vitamin A	41
512	No extra vitamin A	31
516	No extra vitamin A	30
364	No extra vitamin A	26
519	No extra vitamin A	26
518	No extra vitamin A	25
2703	No extra vitamin A	24
2594	No extra vitamin A	18
522	No extra vitamin A	18
520	No extra vitamin A	17
2700	No extra vitamin A	16
526	No extra vitamin A	15
711	No extra vitamin A	13

[1] Only 41 calves are listed, since 8 died before they were 90 days old, 2 died before they were depleted and 1 was slaughtered.

Obviously it would be advantageous to express the total carotene and the vitamin A intake in terms of International units. The carotene intake was converted to I.U. by using the figure 0.6 γ of carotene as 1 I.U. Micrograms of vitamin A were converted to I.U. by multiplying by four. The total vitamin A intake, including the carotene, is expressed in I.U. per lb. of average body weight for the first 90 days.

Using such calculations, the total vitamin A intake, including carotene, for the first 90 days was determined. From these data the average daily vitamin A intake per lb. of body weight and the depletion time were plotted in figure 1. Only 30 calves were included since data were not available on the carotene content of the milk and the hay received by 11 of the 41 calves that survived the experiment. All the various values fall fairly close to the calculated regression line, indicating a good correlation between the calculated vitamin A intake per lb. of body weight and depletion time.

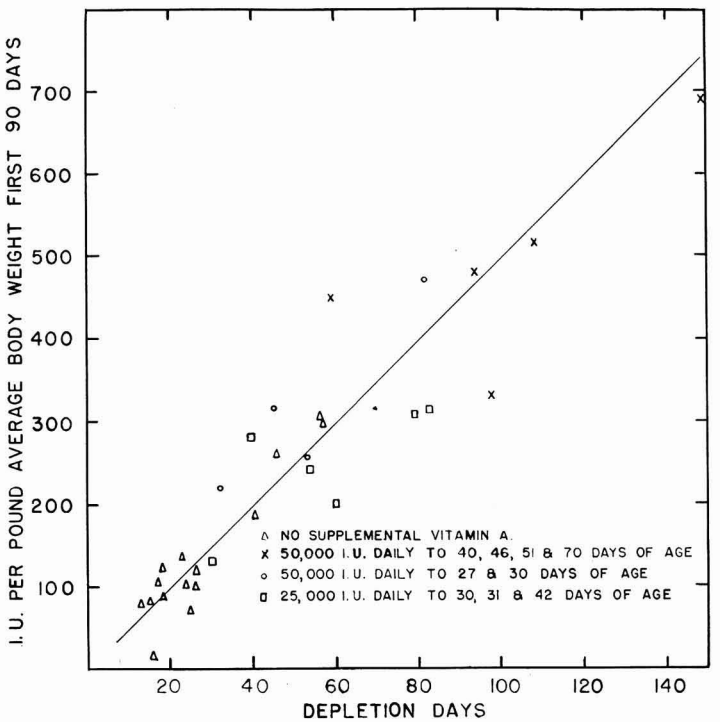

FIG. 1. The relationship between vitamin A depletion time and the total vitamin A intake per lb. average body weight first 90 days.

If it is assumed that a calf has an average weight of 100 lb. from birth to 90 days of age and that each day during this period it receives a capsule containing 5,000 I.U. of vitamin A, it would receive from the capsule 50 I.U. daily per lb. of body weight for the period. As indicated by the data in figure 1, this intake would afford only a 10-day reserve supply. If the capsules were fed for only 30 days the calf theoretically would have stored only a $3\frac{1}{3}$ day reserve from the capsules.

The relationship between carotene intake derived from hay only and deple-

tion time also has been determined for the unsupplemented calves. The average daily carotene intake per lb. of body weight has been calculated in a manner similar to that for total vitamin A intake. These data are shown in table 2. The average daily carotene intake per lb. body weight for the calves receiving no supplement was plotted against the depletion time in figure 2. The regression coefficient was found and the regression line was drawn. Larger carotene intake from the hay was associated with greater storage of vitamin A and longer depletion time.

Previously published data (9, 10) showed that a carotene intake of 30 γ for Holsteins and 34 γ for Jerseys per lb. of body weight were the minimums necessary to maintain a normal spinal fluid pressure in growing calves 4 to 14

TABLE 2

Relation of the carotene intake from hay, per pound of body weight to the depletion time of the non-supplemented calves[1]

Calf no.	Av. wt. first 90 d.	Hay consumed first 90 d.	Av. carotene content of hay	Total carotene intake from hay	Av. daily carotene intake/lb. body wt.	Depletion time
	(*lb.*)	(*lb.*)	(γ/*g.*)	(*mg.*)	(γ)	(*d.*)
2714	69.0	53.3	42.6	1031.3	166.1	56
521	93.5	70.9	42.6	1371.6	163.0	57
2597	147.5	89.1	48.9	1979.6	149.1	46
715	164.5	117.0	26.7	1419.5	95.9	41
364	140.0	65.2	33.8	1000.4	79.4	26
516	102.5	73.1	18.4	611.4	66.3	30
522	85.0	25.0	44.4	503.5	65.8	18
519	98.0	63.4	18.2	526.1	59.7	26
2703	97.0	53.8	15.9	387.3	44.4	24
711	121.0	45.7	18.6	386.3	35.5	13
520	80.0	44.2	13.8	277.2	38.5	17
2594	142.5	69.8	16.3	545.7	38.2	18
526	80.5	24.0	22.3	242.7	33.5	15
518	68.5	14.1	18.1	121.1	19.8	25
2700	66.5	9.3	22.3	94.4	15.8	16

[1] Three of the non-supplemented calves are not shown as the carotene content of the hay they consumed was not available.

months of age. The four calves which received carotene at about the minimum, as determined in older calves, and received in addition the vitamin A and carotene in a limited feeding of whole milk, showed only about a 2-week supply (table 2) at 90 days of age. Even doubling this intake (calves 364, 516, 522) only increased the depletion time approximately 7 days. Probably minimum requirements should be increased several-fold for optimum results. This point is emphasized further by the fact that the two calves that suckled their dams while on pasture had sufficient storage at 90 days of age to carry them for eight to nine times longer.

From figure 2 and table 2, it also is obvious that the quality and quantity of the hay fed are very important items in rearing a calf so that its body stores of vitamin A will be more nearly normal. The calves that received the hay with the higher carotene content stored more vitamin A and, therefore, had a

greater depletion time. It also should be pointed out that the hay fed to the calves in this experiment had a higher carotene content than average hay. Moreover, the calf feeder was diligent in picking out the best bales of hay from the best lots of purchased hay.

Under farm conditions, most hay would average about 15 γ or less of carotene per g. of hay. Only one calf in this experiment received hay with an aver-

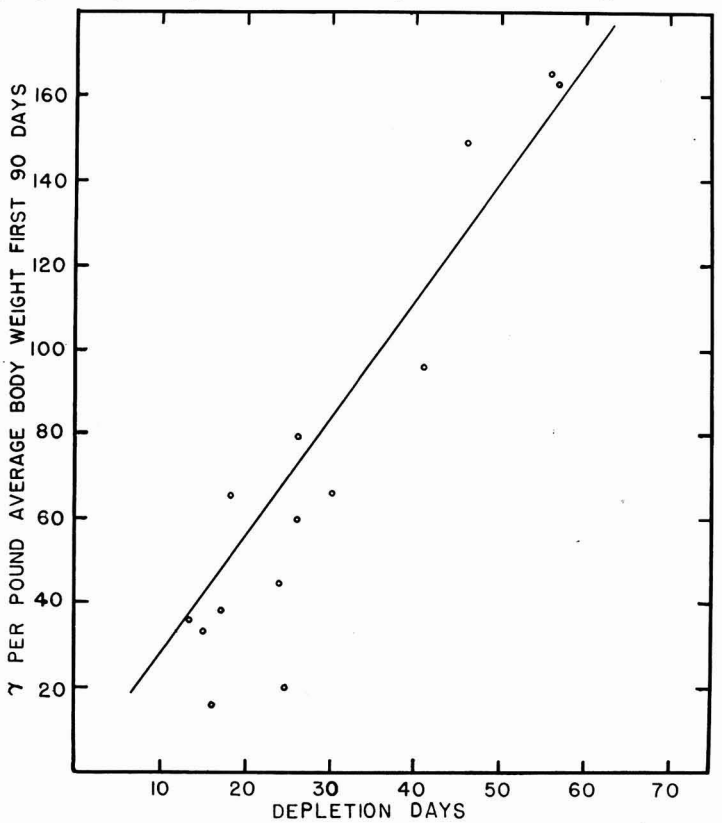

FIG. 2. The relationship between vitamin A depletion time and the carotene intake per lb. average body weight the first 90 days.

age carotene content below this figure, as shown in table 2. One might wonder how much vitamin A the calves would have stored if they had received hay that averages only 10 γ per g., which still would be a good quality of hay. However, in this experiment even the calves that got the very best hay did not have nearly so great a store of vitamin A as those reared under natural conditions with the dams.

Table 3 shows the average level of vitamin A in the blood plasma of the

various groups of calves at various ages. The plasma values for the non-supplemented group are about half those of some of the other groups up to 80 days of age. The increase in these calves and in those which received 25,000 I.U. of vitamin A as a supplement, which is evident at about 80 days of age, is probably a reflection of increased hay intake at this time. The group that received supplemental vitamin A at the rate of 50,000 I.U. per day for the first 50 to 98 days had vitamin A blood levels that corresponded to blood levels encountered in calves reared under natural conditions. The groups of calves which were supplemented for only 30 days had low blood vitamin A values up to 60 or 70 days of age, even when they had been supplemented at the rate of 50,000 I.U. per day. Apparently to maintain a level of vitamin A in the blood plasma of dairy calves reared under present day feeding practices equal to those reared under natural conditions, about 50,000 I.U. of vitamin A must be fed each day until the calf reaches the age of 50 or 70 days.

The average weight gain is summarized in table 4. In the Holstein group, there is little difference in weight gain between the non-supplemented calves

TABLE 3

Effect of supplemental vitamin A on average vitamin A level in the blood plasma

Age	No extra vitamin A	25,000 I. U. 27 & 30 days	50,000 I. U. 27, 30, 40 & 46 days	50,000 I. U. 51, 70, 92 & 98 days	Pasture with dam
(*d.*)	*18 calves*	*8 calves*	*8 calves*	*5 calves*	*2 calves*
			(γ/*100 ml.*)		
8–21	7.5 ± .4	9.4 ± .5	10.0 ± .5	12.4 ± .7	12.9
22–35	5.8 ± .3	8.3 ± .3	9.6 ± .7	12.4 ± .9	11.5
36–49	5.7 ± .3	8.2 ± .5	9.8 ± .9	13.9 ± .8	10.4
50–63	5.8 ± .4	7.2 ± .7	9.3 ± .6	13.1 ± .8	11.8
64–77	7.6 ± .5	9.3 ± .5	10.0 ± 1.0	12.7 ± .7	11.2
78–91	10.1 ± .7	12.0 ± .5	9.8 ± 1.0	13.3 ± .8	12.5
92–105	9.5 ± .7	15.2 ± 1.1	11.3 ± .6	14.4 ± .7	12.1

and the supplemented calves, but the number of Holstein calves is too small for a good comparison. The Jerseys, on the other hand, show some differences in weight gain. The Jerseys which received the supplemental vitamin A gained on the average 9 lb. more than the non-supplemented group. Statistical treatment of this difference showed no significant difference.

The Jersey calves that received no supplemental vitamin A during the first 90 days scoured on an average of 12 days per calf, while the supplemented Jersey calves scoured on an average of 9 days per calf. The Holstein calves that received no supplement scoured on an average of 7 days per calf, while the supplemented Holstein calves scoured on an average of 2.5 days per calf.

Mortality may be a better measure of the value of supplemental vitamin A than data on the frequency of scours, since it is rather difficult to measure the severity of the scours. In this experiment, 2 calves out of 23 in the group that received supplemental vitamin A died of pneumonia and scours before they reached 90 days of age, while 6 out of 24 calves in the non-supplemented group died before they reached 90 days of age.

In general the data presented in this paper indicate that the feeding of fairly large dosages of vitamin A may be of some value. However, the results should be checked further before a general overall recommendation is made to dairymen to feed large dosages of vitamin A. As a matter of fact, the use of sulfa drugs to control diarrhea and pneumonia may be a more practical solution of the problem. Sanitation is also a most important factor in the control of scours and pneumonia in calves. It has been amply demonstrated that mortality can be reduced materially by proper sanitation and management. It seems possible that where sulfa drugs and proper sanitation and management practices are used the amounts of vitamin A needed to rear calves successfully may be less than when sulfa drugs are not used or where poor sanitation is prevalent.

It may be argued that a large number of calves is reared each year on a limited whole milk-feeding program without any supplemental vitamin A. Yet it is known that in many large herds mortality can run high and it may be that the bacteria causing scours or pneumonia have an opportunity to build up virulence by passing from calf to calf. One might ask if the vitamin A intake

TABLE 4

Comparison of total gain to 1, 2 and 3 months of age of the supplemented and non-supplemented calves

Breed	Treatment	No. of calves	Av. body wt.	Av. total gain 1st mo.	Av. total gain to 2 mo.	Av. total gain to 3 mo.
			(*lb.*)	(*lb.*)	(*lb.*)	(*lb.*)
Jersey	No supplemental vit. A	14	57	15 ± 1.5	31 ± 2.9	50 ± 4.4
Jersey	Supplemental vit. A	16	58	15 ± 1.7	38 ± 2.5	59 ± 5.1
Holstein	No supplemental vit. A	6	93	20 ± 2.4	55 ± 5.8	95 ± 8.6
Holstein	Supplemental vit. A	5	96	16 ± 1.7	57 ± 4.1	95 ± 24.2

had been high in the first place, would the bacteria have had the chance to build up virulence? While the literature on the relationship of vitamins to resistance to disease is not very encouraging, a few questions in this direction need to be answered with calves. However, information is needed on the bacteria or viruses that may cause scours and pneumonia in calves, in order to be able to conduct properly-controlled experiments and evaluate correctly the value of supplementation.

Whether or not the amounts of vitamin A, which have been shown in the present paper to be necessary to maintain what may be considered to be maximum stores and blood levels of vitamin A, are necessary to raise calves successfully under present-day conditions of feeding cannot be determined with the data available. The data do suggest that feeding 5,000 to 10,000 I.U. of vitamin A for relatively short periods of time can have little effect on the amounts of vitamin A stores even though these amounts would prevent the appearance of gross deficiency symptoms. Therefore, it is not surprising that several groups of investigators (4, 11) have been unable to demonstrate any beneficial effects on the incidence of scours by feeding capsules containing 5,000 or 10,000 I.U. of vitamin A.

The proper technic to use in determining the relative quantity of storage of vitamin A in the calf is open to question. It has been observed in using other technics, as well as in the present technic, that the level of blood plasma vitamin A in itself is not a good indication of storage where greater-than-minimum requirements of vitamin A or carotene are fed. In most previous experiments the calves have been slaughtered and the livers analyzed for vitamin A. The disadvantage of this technic is that the calf is not available for further use. Also it might be questioned whether calves with the same or widely different body stores of Vitamin A would utilize the reserves with the same efficiency.

Previously, Moore and Berry (8) had suggested the technic used in this study. In the present study, as the vitamin A of the plasma approached the level of 4.0 γ per 100 ml., the calves usually showed a decreased rate of gain. This decrease in rate of gain is additional evidence that the vitamin A stores are about depleted. The technic appears valid since there is a good correlation between intake and depletion time. The correlation was especially good in the non-supplemented group as shown by the grouping of the data in figure 2.

In presenting the data in figures 1 and 2, in which the calculated intake of vitamin A and carotene have been plotted against depletion time as a straight line, it is realized that exceptionally large dosages would not be utilized as efficiently as smaller ones and under certain conditions of supplementation this straight line relationship would not hold. Apparently the dosages used in these experiments were utilized with about equal efficiency.

SUMMARY

1. Calves that received varying quantities of vitamin A for the first 90 days of age then were given a vitamin A-deficient ration to determine the time required to deplete their stores. The stores were considered depleted when the blood plasma vitamin A values reached 4.0 γ per 100 ml.

2. Two calves that were permitted to run with their dams on pasture required 4 months on the ration deficient in vitamin A to deplete their stores.

3. Calves reared according to present methods of limited whole-milk feeding with hay of above average quality required a depletion time of 2 to 4 weeks.

4. The feeding of hay of exceptionally good quality (high in carotene content) increased the depletion time up to 6 to 8 weeks.

5. Fifty thousand I.U. of vitamin A for 50 or more days, in addition to the vitamin A received in the feed, was necessary in order to maintain stores and blood levels equal to those of calves reared with the dams on pasture. The depletion time of these calves was from 3.5 to 4 months. Feeding 25,000 or 50,000 I.U. of vitamin A under similar conditions for periods of 30 to 45 days reduced the depletion time to intervals ranging from 30 to 98 days.

6. The groups that received supplemental vitamin A showed somewhat better gains, fewer cases of scours, and less mortality than the non-supplemented groups.

7. The technic of determining the number of days after 90 days of age that were required for the blood plasma values to decrease to 4.0 γ per 100 ml. appears to give a good estimation of the vitamin A stores.

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FILLED MILKS FOR DAIRY CALVES. I. SOYBEAN OIL VERSUS MILK FAT[1]

N. L. JACOBSON, C. Y. CANNON AND B. H. THOMAS
Iowa State College

One of the major expenses in raising dairy calves is the whole milk fed. Fairly good growth can be obtained when calves are fed skim milk supplemented with hay and grain (1, 4), although young calves fed in this manner do not gain weight so rapidly as those fed whole milk and do not exhibit so thrifty an appearance (4). During the first month after birth, when the calf eats very little hay and grain, milk fat is important, especially as a source of energy, since it has about one-half the total digestible nutrient value of whole milk. Thus the presence of fat in the diet of the young calf is desirable for optimum development.

The question then arises as to whether a milk in which a less expensive fat or oil has been substituted for the butterfat might be equally as satisfactory as whole milk as a feed for young calves. Skim milk into which tallow or lard has been homogenized has proved satisfactory as a feed for young calves (3, 4). The growth and general appearance of animals fed such a milk, however, have been inferior to those of calves fed whole milk. Vegetable fats, which generally are less expensive than animal fats, have proved unsatisfactory in calf feeding (1, 3, 4). One of the oils that has been least satisfactory and which recently has become an important agricultural by-product in the Midwest is soybean oil. Previous experimental work has shown that feeding filled milk containing 3 per cent or more soybean oil to young dairy calves produces poor growth and excessive scouring (1, 3, 4, 5). The diarrhea commonly was in evidence within a few days after the introduction of soybean oil into the ration. Weakness, emaciation and high mortality result when calves are fed such a soybean oil-filled milk for an extended period of time.

In preliminary work at this station (5), an attempt was made to improve the nutritional value of soybean oil-filled milk by various modifications of the product prior to feeding. These modifications were (a) partial hydrolysis of the soybean oil immediately prior to feeding by the addition of lipase, (b) addition of a buffer solution, (c) inclusion of additional carbohydrate in the form of dextrinized starch, (d) addition of finely-ground alfalfa leaf meal, (e) addition of emulsifying agents and (f) addition of rumen fluid from a cow that was fed a ration composed of alfalfa hay and a concentrate mixture. These modified soybean oil-filled milks enhanced neither growth nor general appearance of young dairy calves to which they were fed.

Gullickson (2) and Gullickson and Fitch (3) suggested that a possible explanation for the poor growth of calves fed filled milks containing crude

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vegetable oils may be that these oils interfere either with utilization of B-complex vitamins by the calf or with the bacterial synthesis of these nutrients in the digestive tract. These authors also indicate that calves fed a filled milk containing "Crisco", a hydrogenated cottonseed oil, gained weight more rapidly than calves that received a filled milk containing the unhydrogenated product.

In view of the results of Gullickson and Fitch (3) and the preliminary work at this station (5), the experiment reported herein was designed to investigate this problem further.

EXPERIMENTAL

Thirty-five calves from the Iowa State College dairy herd were allotted to seven groups. Four of the calves in each group were Holsteins or Holsteins and Brown Swiss, and the fifth was an Ayrshire, Guernsey, Jersey or Milking Short-

TABLE 1

Ingredients of rations fed experimental calves

Group	Rations[a]					
	Whole milk[b]	Dried skim milk	Butter oil	Crude expeller soybean oil[c]	Hydrogenated soybean oil[d]	Water
	(%)	(%)	(%)	(%)	(%)	(%)
I	100	.....	.....	.....	.....	.....
II	.....	10	3	.....	.....	87
III	.....	10	.....	.....	.....	90
IV	.....	10	.....	2	.....	88
V	.....	10	.....	3	.....	87
VI[e]	.....	10	.....	3	.....	87
VII	.....	10	.....	.....	3	87

[a] All groups received daily supplements of vitamins A and D and a mineral mixture.
[b] Approximately 3 per cent fat.
[c] Produced by Swift and Company Soybean Mill, Des Moines, Iowa. Melting point approximately 40° F.; iodine number, 130 (7).
[d] Produced by Swift and Company, Chicago, Illinois. Melting point 100–103° F.; iodine number, 75 (7).
[e] Supplemented with 10 mg. thiamine, 10 mg. riboflavin, 10 mg. pyridoxine, 50 mg. calcium pantothenate, 100 mg. nicotinic acid amide, 250 mg. ascorbic acid and 50 mg. mixed tocopherols per calf daily.

horn. Within these two breed groupings, the assignment of calves to experimental groups was at random.

Each calf was allowed to remain with its dam for 3 days immediately following birth. On the fourth day, the calf was transferred to the experimental milk, which was given at the rate of 10 lb. per 100 lb. body weight per day. The experimental milks were fed twice daily from nipple-type pails. When calves began to scour, there was no reduction or modification of the ration. The amount of milk fed to each calf was adjusted each time the calf was weighed. The weight and the height at withers of each calf were determined at the age of 4 days and weekly thereafter. The calves, placed in individual pens, were muzzled at all times except when being fed. The calves were given no feeds other than experimental milks and vitamin and mineral supplements for the duration of the experiment.

Spielman *et al.* (9) successfully controlled infectious scours in young calves by the daily oral administration of 4 to 8 g. of "sulfathalidine" per calf during the first 7 days after birth. In this experiment each calf received 6 g. of "sulfathalidine" per 100 lb. body weight daily, administered in two equal doses prior to each feeding for the first 10 days following birth.

All milks (table 1) except whole milk were homogenized at approximately 3,000 lb. pressure. The whole milk was obtained twice daily from Holstein cows producing milk averaging 3 per cent fat. All milks were fed at a temperature of approximately 37° C.

Each calf received daily a gelatin capsule containing approximately 5,000 U. S. P. units of vitamin A and 1,000 U. S. P. units of vitamin D. In addition, approximately 25,000 U. S. P. units of vitamin A per 100 lb. body weight were fed to all calves daily during the first 10 days of the experimental period. In the latter case, the fish liver-oil concentrate containing the vitamin A was added to the milk prior to homogenization. In the case of the whole milk, which was unhomogenized, the vitamin A supplement was mixed with the milk by vigorous hand-stirring. All calves received a mineral mixture[2] in capsules at the rate of 7 g. daily per 100 lb. body weight.

Observations for evidence of scouring were made each time the calves were fed.

An analysis of variance and the t-test (8) were employed in the statistical evaluation of the data.

RESULTS AND DISCUSSION

The data regarding the growth and general health of calves fed the various rations are presented in table 2. Gains in weight and increases in height at withers are expressed as per cent of initial values.

The recommended daily allowance of total digestible nutrients for a 100-lb. calf is 2 lb. (6). It generally is recommended that calves be fed no more than 10 lb. of milk daily per 100 lb. body weight, since higher levels sometimes cause indigestion and scouring. Therefore, all calves in this experiment were fed at the latter level, even though the total digestible nutrients supplied were less than the recommended intake. Normally, at 2 to 4 weeks of age, calves begin eating hay and grain. In the experiment reported herein, hay and grain were excluded from the rations because of the variability among individual animals in the rate of consumption of these feeds. All calves, except a few individuals that developed severe indigestion and scouring, drank the prescribed quantity of milk. The filled milk containing 3 per cent fat provided, according to calculations, 1.5 lb. of total digestible nutrients daily per 100 lb. body weight. The milk containing 2 per cent oil and the reconstituted skim milk supplied 1.3 and 0.8 lb., respectively, of total digestible nutrients.

There were no statistically significant differences in mean gain in weight, in mean increase in height at withers or in incidence of scouring among the groups

[2] The mineral mixture was composed of the following: Tricalcium phosphate, 400 parts; sodium chloride, 200 parts; magnesium oxide, 15 parts; calcium carbonate, 11 parts; potassium chloride, 11 parts; ferrous sulfate, 2 parts; manganous sulfate, 0.5 part; zinc oxide, 0.5 part; potassium iodide, 0.5 part; cobaltous acetate, 0.5 part; copper sulfate, 0.2 part.

TABLE 2

Growth and incidence of scouring of calves fed whole or various reconstituted milks during an eight-week experimental period

Dietary Groups	Breed[a]	Initial wt. (4 d.)	% gain in wt.	Initial height (4 d.)	% gain in height	Incidence of scouring[b]	Condition[c]
I		(*lb.*)		(*cm.*)		(%)	
Butterfat, 3% (whole milk)	H	105	41	75.0	12.7	0.0	Excellent
	H	100	35	77.0	9.7	3.5	Excellent
	H	88	32	72.5	7.6	3.5	Excellent
	G	96	17	75.0	9.3	8.0	Very good
	H	63	32	68.0	11.8	0.0	Very good
	Av.	90.4	31.4	73.5	10.2	3.0	
II							
Butter oil, 3%	H	81	38	73.5	8.8	0.0	Excellent
	H	92	48	75.5	7.9	3.5	Excellent
	A	103	32	76.5	10.5	0.0	Excellent
	H	92	38	75.0	7.3	9.7	Excellent
	H	92	45	77.0	9.1	0.9	Excellent
	Av.	92.0	40.2	75.5	8.7	2.8	
III							
Low fat (reconstituted skim milk)	H	90	18	75.5	9.3	0.0	Very good
	G	87	−16	75.5	0.7	4.4	Fair
	H	106	12	77.0	5.2	1.8	Very good
	H	88	− 5	75.0	4.0	8.0	Fair
	H	95	7	77.0	3.9	3.5	Good
	Av.	93.2	3.2	76.0	4.6	3.5	
IV							
Crude expeller soybean oil, 2%	H	81	20	71.5	9.1	6.2	Good
	BS	85	8	74.5	4.0	15.0	Fair
	J	47	− 8	64.5	5.4	38.1	Poor
	H	100	23	75.0	6.7	10.6	Very good
	H	93	19	76.5	4.6	25.7	Very good
	Av.	81.2	12.4	72.4	6.0	19.1	
V							
Crude expeller soybean oil, 3%	H	100	−19	75.0	0.0	46.7	Died (13 d.)
	BS	92	22	74.0	8.8	23.9	Fair
	MS	87	−10	74.0	2.0	58.8	Died (11 d.)
	H	76	−11	73.0	−1.4	65.3	Died (40 d.)
	H	83	29	71.5	8.4	24.8	Fair
	Av.	87.6	2.2	73.5	3.6	43.9	
VI							
Crude expeller soybean oil, 3% + vitamin supplement	H	104	35	77.5	7.7	21.2	Good
	J	47	−13	63.0	−1.6	45.5	Poor[d]
	H	96	21	77.0	8.4	25.7	Fair
	H	54	−22	67.0	0.0	50.0	Died (12 d.)
	BS	92	− 9	74.5	3.4	48.4	Died (52 d.)
	Av.	78.6	2.4	71.8	3.6	38.2	
VII							
Hydrogenated soybean oil, 3%	BS	111	35	78.0	10.3	2.7	Excellent
	A	71	35	70.0	10.0	11.5	Excellent
	H	80	51	73.5	11.6	0.9	Excellent
	H	78	47	72.0	10.4	4.4	Excellent
	H	80	41	71.0	8.5	0.9	Excellent
	Av.	84.0	41.8	72.9	10.2	4.1	

[a] A, Ayrshire; BS, Brown Swiss; G, Guernsey; H, Holstein; J, Jersey; MS, Milking Shorthorn.

[b] Observations made for scouring at each feeding.

$$\text{Incidence of scouring} = \frac{\text{Number of times scouring observed}}{\text{Total number of examinations}} \times 100.$$

[c] Estimate of physical condition at end of expt.

[d] Removed from expt. at 9d. to save life.

fed whole milk (group I), reconstituted milk containing butter oil (group II) and a filled milk containing hydrogenated soybean oil (group VII). All calves receiving the foregoing rations were in good physical condition at the end of the experimental period.

A comparison of the mean weight gains of calves receiving whole milk with the mean weight gains of those fed reconstituted skim milk and of those fed the various rations containing crude expeller soybean oil showed the differences to be significant statistically at the 1 per cent and the 5 per cent levels of probability, respectively. When the mean weight gains of the calves fed reconstituted milk containing butter oil (group II) and those fed a filled milk containing hydrogenated soybean oil (group VII) were compared to those of calves fed the other rations (excluding whole milk), the differences in all cases were significant at the 1 per cent level of probability.

The mean per cent increase in height at withers among the groups receiving whole milk (group I), reconstituted milk containing butter oil (group II) and filled milk containing hydrogenated soybean oil (group VII) differed significantly from those of groups receiving reconstituted skim milk (group III) and filled milk containing 2 per cent expeller soybean oil (group IV).

The reconstituted skim milk ration (group III) was included in the experiment to determine whether the fats incorporated in the various rations improved the growth of the calves. In general, the calves fed skim milk maintained weight and exhibited relatively little skeletal development as measured by height at withers. This retarded growth probably was due to the smaller total digestible nutrient intake of these calves.

Calves that were fed a filled milk containing 3 per cent crude expeller soybean oil (group V) exhibited poor growth and excessive scouring. Three of the calves in this group died before the end of the 8-week experimental period. Gullickson and Fitch (3) stated that calves fed vegetable oils "showed a marked benefit" from the supplementation of the ration with various members of the vitamin B-complex, but these authors did not specify the vitamins fed. One group of calves (group VI) in the present investigation received a vitamin supplement containing thiamine, riboflavin, nicotinic acid, calcium pantothenate, pyridoxine, ascorbic acid and mixed tocopherols. No improvement in growth or physical condition of the calves resulted from the supplementation of filled milk containing 3 per cent crude expeller soybean oil with liberal amounts of these vitamins. Two of the calves in this group died during the experiment and a third probably would have died had it not been removed from the experiment.

Post-mortem examinations were made of the five calves which died during the experiment.[3] Pneumonia was observed in two calves (those which died at 40 days and at 52 days of age, respectively), but in the other three, pathogenic organisms apparently were absent. The symptoms most frequently exhibited prior to death were severe scouring, emaciation, anorexia, weakness, abdominal pain, stiffness of the rear quarters and severe dehydration.

[3] Post-mortem examinations conducted by Iowa Veterinary Diagnostic Laboratory, Iowa State College, Ames, Iowa.

In general, calves fed a filled milk containing crude expeller soybean oil at a level of 2 per cent (group IV) grew better, as judged by increases in body weight and in height at withers, and scoured less frequently than those fed the rations containing 3 per cent crude expeller oil. This suggests a possible tolerance level for the oil. However, the marked within-group variations indicate that some calves were more susceptible than others to the adverse effects resulting from the ingestion of crude expeller soybean oil.

The results of this investigation do not explain why unsatisfactory growth occurs when young calves are fed filled milks. However, the fact that hydrogenated soybean oil can be fed successfully, suggests that the first step in the solution of this problem should be the clarification of the cause for the differences in growth response of young calves fed hydrogenated soybean oil-filled milk as compared with those fed crude expeller soybean oil-filled milk. The results of experiments designed to clarify this problem further will be reported later.

SUMMARY

Under the conditions of this experiment, a filled milk containing hydrogenated soybean oil produced growth in young dairy calves equal to the growth of calves fed whole milk. There was no significant difference in gain in weight, in increase in height at withers, in incidence of scouring or in physical appearance between the two groups. The growth and general appearance of the group of calves fed hydrogenated soybean oil were in sharp contrast to those of the group fed crude expeller soybean oil, the latter being characterized by poor growth, severe scouring and high mortality. Supplementation of the rations of young dairy calves fed a filled milk containing 3 per cent crude expeller soybean oil with various members of the vitamin B complex, ascorbic acid and mixed tocopherols failed to improve growth or reduce the incidence of scouring.

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MILK LIPASE SYSTEM. II. COMPARISON OF SOLVENT EXTRACTION AND CHURNING METHODS FOR OBTAINING FAT FROM MILK FOR FREE FATTY ACID MEASUREMENT.[1]

B. C. JOHNSON AND I. A. GOULD[2]
Maryland Agricultural Experiment Station, College Park

The direct titration of milk fat to measure the free fatty acid content is a widely-used procedure for determining the extent of lipolysis in milk and its products. It was established by Gould and Trout (4) that this procedure is a far more sensitive means of detecting lipolysis than by titration of the milk or by pH measurements. Later, Herrington and Krukovsky (5) reported that when titration was conducted on the fat itself rather than upon the milk, it was not necessary to correct for non-fatty acidity due to proteins, salts and moderate amounts of lactic acid.

Although many workers have utilized fat titers (acid degrees) as a basis for measuring lipase activity, little consideration has been given to methods of removing the fat from milk for analysis. The general practice has been to churn the milk or cream, then purify the fat by melting, centrifuging and filtering. The weakness of this method of obtaining the fat lies in the loss of the water-soluble and flavor-producing free fatty acids in the buttermilk. This loss was indicated by Gould (2), who found that fat obtained by churning rancid milk did not possess a rancid flavor even though the free fatty acid content was extremely high.

Efforts to associate changes in fat characteristics with lipolysis have been, in general, unsuccessful (4, 7). However, in such studies the fat for analysis was obtained by churning. Even a six- to nine-fold concentration of the free fatty acids by alcohol extraction of the fat did not permit the differentiation between rancid and non-rancid fat on the basis of Reichert-Meissl, Polenske, saponification and iodine values (4). Possibly such measurements may be revealing if the fat is obtained from the milk in a manner to retain the lower fatty acids which have been freed by lipase action.

In earlier unpublished studies the observation was made that extraction of milk or cream with solvents may yield more complete recovery of the fatty acids than is obtained by churning. The development and application of such a method constitutes the basis for this paper. An earlier abstract dealt with a portion of these findings (8).

PROCEDURE

Fresh, raw milk from the University herd was used in all studies. Lipolysis was accelerated by homogenizing with a rotary homogenizer and storing for

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[2] Present address: Dairy Technology Dept., Ohio State University, Columbus.

several hours at 35 to 40° F. (3). The rancid milk was separated to give about 30 per cent cream and the cream heated to 65° F. for 10 minutes to stop further lipase action. Control or non-rancid cream was produced in the same manner, but with homogenization omitted.

Methods of obtaining fat. Purified milk fat for chemical analysis was obtained from the cream either by the churning method or by solvent extraction. In the former method, the cream was churned, the butter granules washed free of buttermilk with a minimum of cold water, the butter melted and centrifuged and the clear fat layer removed by siphonation and purified by filtration through paper.

The solvent extraction procedure was as follows: To 125 g. of cream in a 1-l. Erlenmeyer flask were added 100 ml. of ethanol. The flask was stoppered and shaken vigorously for 15 seconds and allowed to stand for 5 minutes to aid in extraction. A total of 200 ml. of the extractants then was added and the mixture shaken vigorously for 30 seconds. The extractants were ethyl ether and Skellysolve F.[3] Trials were conducted to determine the proper proportion of the two extractants and whether they should be added together or separately. Following the addition of the solvents, centrifugation was used to break the emulsion and the ethereal layer was removed by siphonation. In the earlier portion of the study, the solvents were vaporized on a hot plate at 135° C. until bubbles ceased to rise and the last traces were removed by heating the fat at 100° C. under reduced pressure of about 100 mm. mercury for 10 minutes. It later was demonstrated that lower temperature and higher vacuum permitted more efficient recovery of the lower fatty acids.

Analysis of fat. Chemical analyses were conducted on the fat obtained by churning and by extraction. The methods used were those of the A.O.A.C. (1), except for such changes as noted. Reichert-Meissl, Polenske, iodine (Hanus) and saponification values and acid degree were determined.

The apparatus used for the Reichert-Meissl and Polenske determinations was constructed with ground glass connections, and six analyses (four fat samples and two blanks) were conducted simultaneously. Small pieces of porous plate, about 2 mm. in diameter, and one or two small glass beads added before saponification were found to be more effective than pumice as boiling stones.

Additional chemical determinations were made upon the various fractions resulting from extraction of the fat with boiling ethanol. The method used for ethanol extraction of milk fat is as described by Gould (3) with the exception that the fat was obtained by solvent extraction rather than by churning.

EXPERIMENTAL RESULTS

Development of the solvent extraction procedure. To find the ratio of solvents which would yield the most efficient extraction of the fat, the proportions of ethyl ether to Skellysolve were varied in the ratios of 4:0, 3:1, 1:1, 1:3 and 0:4. The method of addition and mixing the solvents with the cream-alcohol mixture was varied, the solvents being added either separately with 15-second

[3] A petroleum solvent, boiling range 30–60° C.

shaking after each addition or together followed by 30-second shaking. The results obtained in this portion of the study are shown in figure 1.

In general, the acid degree of the fat increased and the recovery of the fat decreased as the amount of Skellysolve increased. The most uniform results occurred when the ratio of solvents was in the range of 3 : 1 to 1 : 3 ethyl ether to Skellysolve. In general, when the ratio of ether to Skellysolve was above 1 : 1 and often at 1 : 1, there was retention of water and solids-not-fat in the ethereal extract. This condition was observed consistently when the proportion of 3 : 1 (ether to Skellysolve) was used and was pronounced when ether was used alone. On the

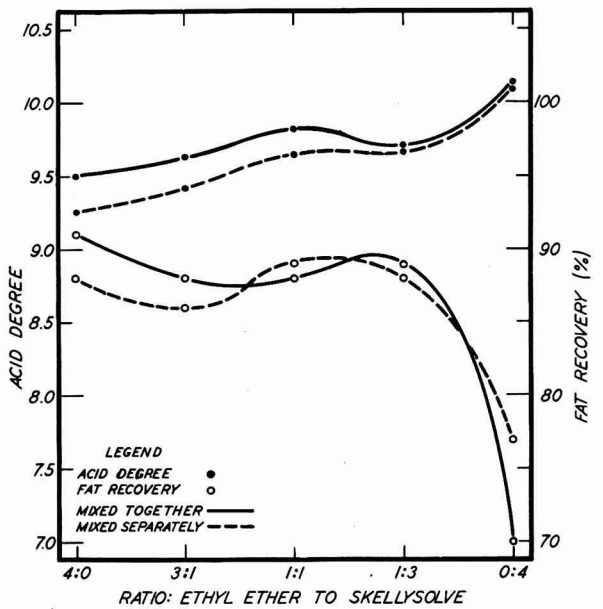

FIG. 1. Effect of varying the method of mixing and the ratio of solvents upon the acid degree and percentage recovery of milk fat by the solvent extraction method.

other hand, when Skellysolve alone was used as the extractant, low recovery of fat nearly always was encountered, accompanied by high and inconsistent acid values of the fat.

The data also indicate that slightly higher and more uniform acid degree values may be obtained when the solvents are added to the sample at the same time than when added separately. That is, when the solvents were in the ratio of 1 : 1 and added together to the sample, the average acid degree of the fat was 9.82, as compared to 9.65 when the solvents were added separately. The average acid degree of the fat obtained by churning the same cream was 7.45, a value 32 per cent lower than that of the fat extracted using the 1 : 1 ratio of extractants. In addition, the fat recovery was much less by the churning method, averaging about 70 per cent. On the basis of these observations, the procedure for fur-

ther trials consisted of adding the solvents at the same time and in the ratio of 2:3 (80 ml. of ethyl ether to 120 ml. of Skellysolve).

Observations of available data reveal that from the uniformity standpoint, variations in acid degrees between fat samples obtained by duplicate extractions or churnings were similar. For example, average acid degree differences between duplicates for rancid fat were 0.114 when the fat was obtained by extraction and 0.171 when it was obtained by churning.

Effect of lactic acid and/or formalin. Since in certain cases formalin may be

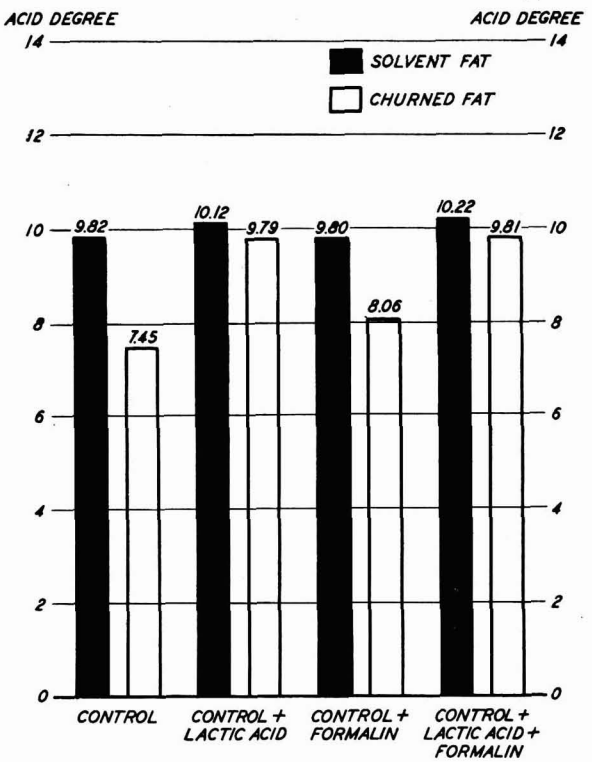

FIG. 2. Effect of lactic acid and/or formalin in the cream upon the acid degree of milk fat obtained by solvent extraction and churning methods.

added to the milk as a preservative, or in other cases lactic acid may be present due to bacterial action, the effect of these two substances upon the extraction and churning procedures and upon the free acid content of the fats was studied. In this study, rancid cream containing 50 per cent butterfat was divided into four lots and treated as follows: lot 1, control; lot 2, control + lactic acid (to give a concentration of 0.2 to 0.3 per cent); lot 3, control + formalin (1 ml./lb. of cream); lot 4, control + lactic acid + formalin (each added as above). Following this

treatment, fat samples were obtained from the various lots of cream by extraction and by churning and fat titrations were conducted. Results are illustrated in figure 2.

The figure shows that the addition of lactic acid and formalin had a marked effect upon the acid degree of fat obtained by churning but only a slight effect upon the acid degree of fat obtained by solvent extraction. The lactic acid addition produced an increase of 31.4 per cent in the acidity of churned fat, as compared to an increase of 3.1 per cent in the acidity of solvent fat. The same general trend, but to a lesser degree, resulted when formalin was present in the cream extracted or churned. In this instance, the acid degree of the resulting churned fat increased 8.2 per cent, whereas that of the solvent fat showed no appreciable change. When both lactic acid and formalin were added to cream prior to extraction or churning, the results were similar to those obtained when lactic acid alone was added, there being an increase of 31.7 per cent in acid degree in the churned fat, whereas that in the solvent fat was only 4.1 per cent.

TABLE 1

Recovery of butyric, caproic, capric and oleic acids from cream by solvent and churning methods

Trial No.	Butyric		Caproic		Capric		Oleic	
	Solv.[a]	Ch.[b]	Solv.	Ch.	Solv.	Ch.	Solv.	Ch.
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	.....	.....	36.13	23.75	.....	.....	.....	.....
2	4.03	1.44	14.42	13.11	.....	.....	92.36	88.28
3	.....	.....	42.05	6.27	.....	.....	104.20	83.77
4	9.33	0.62	24.20	10.70	.....	.....	71.40	77.10
5	6.59	1.69	25.40	7.99	76.1	84.8	90.25	80.40
Av.	6.65	1.25	28.44	12.36	76.1	84.8	87.05	82.36

[a] Solvent method.
[b] Churned method.

Churning was very difficult in the homogenized and rancid product and was made more so by the presence of formalin. Less than 50 per cent of the fat was recovered in such cases, whereas recovery by the solvent process was affected only slightly by such treatment of the cream.

Recovery of fatty acids from cream. The efficiency with which pure fatty acids are recovered from cream by solvent extraction and churning was studied. Butyric, caproic, capric and oleic acids were used. Approximately 0.25 *N* solutions of these acids were standarized accurately and added to good quality 30 per cent cream at the rate of 5 ml. of acid per 100 g. of cream. Fat was obtained from cream with and without added fatty acid by solvent extraction and by churning. Acid degree determinations were made and percentage recovery of the acids calculated. These data are presented in table 1.

Results reveal that the degree of recovery of the acids increased with increasing molecular weight of the acid. The solvent method gave somewhat better results with butyric and caproic acids and both methods were approximately equally efficient when capric and oleic acids were recovered.

Temperature and pressure of solvent removal. As described in the procedure, the general method for removing solvents was by heating the ethereal solution on a hot plate at 135° C., with final heating at 100° C. at a pressure of 500 mm. mercury. Since poor recoveries were obtained of the lower fatty acids, as revealed in table 1, it appeared desirable to determine the possibility of improving this recovery through the use of lower temperature and pressure for removing the solvents from the fat. Preliminary trials were conducted in which pure fatty acids were added to fat dissolved in ethyl ether and Skellysolve. The solvents were removed at (a) 100° C. and a pressure of 500 mm. mercury and (b) 60° C. and 20 mm. mercury. Recovery of butyric acid was increased from 22 to 80 per cent and that of caprylic from 80 to 100 per cent by reducing the temperature and pressure of solvent removal from the higher to lower levels. Loss of oleic acid was negligible in either case. On the basis of this work, the recovery of butyric acid from cream was studied, utilizing the solvent removal temperatures and pressures indicated above. Recovery of free butyric acid from cream was improved by lowering the pressure and temperature of solvent removal, with the recovery increasing from 12.2 per cent for the high temperature-high pressure procedure to 22.5 per cent for the low temperature-low pressure method. Since butyric acid comprises less than 4 per cent of milk fat, loss of even all of this acid which may have been freed by lipase action may not have any determinable effect upon the acid degree of a fat sample from rancid cream.

The improvement in the recovery of lower fatty acids added to cream by the use of lower temperatures and pressures raises the question as to whether or not such conditions would increase the recovery of those free fatty acids produced normally in milk by lipase action. To study this possibility, several trials were conducted in which fat samples from normal and rancid creams were obtained by solvent extraction and by churning with the solvent-extracted fat being dried under the two conditions of temperature and pressure. The results in acid degrees were 0.853 and 0.875 for normal cream, 10.262 and 10.267 for rancid cream for the high temperature and low temperature treatment, respectively. Therefore, these data reveal no appreciable differences between the acid degrees of the extracted fats obtained and, thus, no advantage in favor of the lower temperature is indicated.

Flavor of extracted and churned fat. In connection with various phases of this study, flavor observations were made on the fat obtained by churning and by extraction. Results for some of these observations are presented in table 2.

These limited data indicate that no churned fats were rancid, whereas a number of the extracted fats from rancid milk showed appreciably rancid flavors which were characterized as butyric, caprylic, goaty or bitter. It also was noted that temperature and pressure of solvent removal affected the flavor of the fat. When the temperature and pressure were 60° C. and 20 mm. mercury, respectively, the fat more often was butyric- or caprylic-flavored. However, when the solvents were removed at 100° C. and 500 mm. mercury, goaty or bitter flavors predominated in the resulting fat.

Analysis of churned and extracted fats. To determine the chemical differences between the fat isolated by churning and by extraction, fat samples obtained

TABLE 2

Effect of method for obtaining fat on its flavor

Method for obtaining fat	Flavor of cream	Flavor and incidence of flavor in fat
Churning	Normal	Oxidized, 2[a]
	Rancid	Oxidized, 5
Solvent extraction	Normal	Oxidized, 5; solvent, 4;
	Rancid	Butyric, 4; caprylic, 4; Goaty, 4; ester, 2; solvent 3.

[a] Figure indicates flavor intensity, 1 being minimum; 5, maximum.

from normal (control) and rancid cream by the two procedures were subjected to analysis. In these trials, the ethereal solution in the solvent method was evaporated at 60° C. and 20 mm. mercury. Results obtained are presented in table 3. These data reveal that, with the exception of the acid degree values, such determinations fail to show any appreciable difference between solvent and churned fats and between rancid and non-rancid fats. The Reichert-Meissl values gave slightly, but consistently, lower values for the rancid fats in comparison to the control fats. Differences in the Polenske and saponification values and in iodine numbers are insignificant.

The acid degree determinations on these fats gave the only results which show that appreciable differences exist between rancid and control samples and between extracted and churned fats. For the churned fat, there was a 17-fold difference in acid degree between the normal and rancid samples (0.46 and 7.95) and for the extracted fat the difference was greater than 18-fold (0.77 and 13.94, respec-

TABLE 3

Chemical composition of solvent-extracted and churned fats

Fat characteristic	Trial	Churned fat		Solvent fat	
		Control	Rancid	Control	Rancid
Reichert-Meissel value	4	28.54	27.78	28.51	27.39
	14	27.36	27.17	27.42	26.72
	21	29.77	29.54	29.79	28.84
	Av.	28.56	28.16	28.57	27.65
Polenske value	4	1.60	1.65	1.70	1.64
	14	2.10	2.09	2.09	1.99
	21	2.27	2.21	2.39	2.30
	Av.	1.99	1.98	2.06	1.98
Iodine value	4	43.10	42.93	43.28	42.75
	14	37.82	38.14	37.85	37.62
	21	33.98	34.31	34.05	34.09
	Av.	38.30	38.46	38.39	38.15
Saponification value	4	226.6	225.5	225.5	226.8
	14	222.4	223.0	223.7	221.5
	21	228.4	227.2	226.5	226.5
	Av.	225.8	225.2	225.2	224.9
Acid degree	4	0.64	7.19	0.925	15.375
	14	0.38	6.53	0.72	13.950
	21	0.357	10.115	0.661	12.505
	Av.	0.459	7.945	0.769	13.943

tively). The solvent-obtained fat in all cases yielded higher acid degrees than did the respective churned fats. The rancid solvent fat was 75 per cent greater in acid degree than that obtained by churning, and the control solvent fat exhibited 68 per cent greater acidity than did the churned fat.

Ethanol extraction of fat. In the first paper of this series, an ethanol extraction procedure is described which permits a high concentration of the free fatty acids present in the fat (3). Since the previous study was of churned fat it seemed desirable to subject the solvent extracted fat to this ethanol fractionation to ascertain if it would reveal more information as to the fatty acids involved in lipase action.

Milk fat obtained by the solvent method from non-rancid and rancid cream was fractionated by extracting 60 g. of fat in three successive portions of boiling ethanol, and then cooling and filtering the extract. Three fractions were obtained. I. Ethanol-insoluble fat, (portion remaining after extraction); II. Cold

TABLE 4

Chemical characteristics of the fractions obtained by extraction of control and rancid fats with ethanol (three trials)

Fraction analysed	Acid degree	Reichert-Meissl value	Polenske value	Saponification value	Iodine value	Refractive index	Wt. obtained/100 g. original fat
							(*g.*)
Original fat							
Control	0.74	26.87	1.86	222.4	40.25	1.4546	.....
Rancid	13.41	25.40	1.88	221.5	38.65	1.4542	.....
Cold ethanol extract							
Control	9.06	49.09	4.55	237.2	42.73	1.4551	6.33
Rancid	78.14	37.89	3.01	225.8	36.91	1.4526	13.51
Cold ethanol precipitate							
Control	0.79	41.60	2.32	235.1	32.14	1.4530	7.90
Rancid	5.19	38.24	2.34	232.1	30.29	1.4528	8.83
Ethanol insoluble fat							
Control	0.15	21.79	1.74	218.2	40.34	1.4551	82.30
Rancid	1.37	19.56	1.39	215.1	39.67	1.4547	73.29

ethanol precipitate, (that portion which precipitated from the ethanol after it stood overnight at 4–5° C. and which was removed by filtration); III. Cold ethanol extract (portion remaining in solution in the ethanol after cooling, i.e., the filtrate of II). The average weights of these various fractions obtained from 100 g. of normal milk fat were 82.3 g. of ethanol-insoluble fat, 7.9 g. of cold ethanol precipitate and 6.3 g. of cold ethanol extract. From 100 g. of rancid fat these weights were 73.3 g., 8.8 g. and 13.5 g., respectively. Chemical analysis of these fractions and of the original fat are shown in table 4.

These data reveal, as was found previously (3), that the free fatty acids in fat may be concentrated by alcohol extraction. The acid values of the alcohol extracts show approximately a 12-fold increase in the case of the control product and a 6-fold increase in the rancid product, when compared to the corresponding original fat. In contrast, the cold ethanol precipitate contained about the same amount of free acidity as the original fat in the control and less acidity in the rancid product. The acid degrees of 0.15 and 1.37 for the ethanol-insoluble fat

for the control and rancid samples, respectively, indicate that the alcohol extraction removes the major portion of the free fatty acids from milk fat.

Reichert-Meissl values of the various fractions from non-rancid and rancid fat show that the volatile soluble fatty acids are concentrated in the cold ethanol extract and precipitate. As expected, the ethanol-insoluble fat contained fewer of these short-chain acids. The volatile insoluble fatty acids also were concentrated in the ethanol extract and precipitate, as shown by the Polenske values.

The results obtained by the Reichert-Meissl and Polenske determinations are substantiated by the saponification values, which again are higher for the ethanol extract and precipitate and lower for the ethanol-insoluble fat, as compared to the original fat.

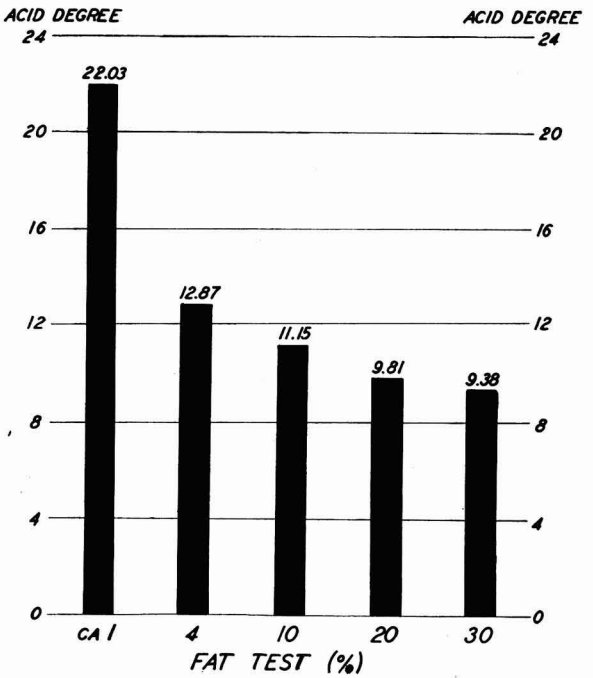

FIG. 3. Relationship between the fat content of the product and the acid degree of the fat obtained by extraction.

The iodine values obtained show no definite trend, except that they were lower for the ethanol precipitate than for the other fractions.

The refractive indices reflect roughly the values obtained by the other determinations. For instance, the large differences in refractive indices between the control and rancid ethanol extracts may be explained by the lower content of unsaturated fat and the greater amount of free fatty acid in the latter.

Application of the solvent extraction procedure to milk. Since the procedure in the foregoing studies involved the separation of rancid milk to obtain

the cream for subsequent extraction or churning, it was thought that an appreciable amount of the free fatty acids, especially the water-soluble acids, may be lost in the skim milk. To ascertain this effect, trials were conducted in which the extraction procedure was applied to milk and cream varying widely in fat content. Raw milk was homogenized, allowed to become rancid and separated to 30 per cent cream. Portions of this cream were standardized to 4, 10 and 20 per cent fat with the skim milk. Due to homogenization, separation was inefficient and about one per cent fat remained in the skim milk. All of these products were extracted and the acid degrees of the extracts determined. The data obtained are portrayed in figure 3.

This figure shows that the acid degree of the fat decreases with increases in the fat content of the product extracted. The value of 22.03 for the skim milk extract is nearly twice that of 12.87 for 4 per cent milk, and further decreases in fat acidity are apparent as the fat content of the products increases to 30 per cent. The fat extracted from the 4 per cent milk, which may be considered to be the original rancid milk before separation, had more than 36 per cent greater acidity than the fat from the 30 per cent cream, the only difference in the two products extracted being the amount of skim milk present.

DISCUSSION

In past work, little attention was paid to the method for isolation of the milk fat in lipase studies. The fat was obtained merely in the quickest and most convenient manner, usually by churning, without special regard for fatty acids which might be lost through such treatment. The results obtained in this study reveal the advantages of fat recovery by solvent extraction rather than by churning. Not only does the solvent method result in more complete recovery of the fatty acids, as revealed by the higher acid degree of the fat, but the results are affected less by the presence of such substances as lactic acid and formalin. Thus, the procedure may be utilized successfully on a fermented product or on a preserved product. Such is not the case with the churning procedure, where the values are affected appreciably by the presence of either lactic acid or formalin. A further advantage of the extraction method is its use in the isolation of lipids for titration from homogenized products of low fat content or from milk homogenized at high pressures.

Many studies have been conducted in which the titer of fat obtained by churning has served as the basis of comparison. For example, threshold values for flavor have been suggested (2, 5). Also, results have been obtained in which acidity changes in fat obtained by churning have been correlated with production and transportation methods for raw milk (5, 6). On the basis of the results herein reported, the need for a re-evaluation of all studies made when the fat was obtained by churning is indicated.

Further evidence of the greater efficiency of the extraction procedure is given by the fact that rancidity was detected in solvent-extracted fat from rancid milk, whereas churned fat from the same source did not exhibit a rancid odor. That the flavor of several samples was typical of the "goat" acids rather than of butyric acid indicates that the free caproic, caprylic and capric acids are

recovered more efficiently by the extraction procedure than is the more water-soluble butyric acid. This is borne out by the fact that the best recovery of butyric acid from cream was only about 23 per cent. Lack of rancid odor in churned fat may be expected since negligible recovery of butyric and caproic acids results from the churning procedure. The low recovery of butyric acid in solvent extraction may be attributed chiefly to its inefficient extraction from the serum phase, since a rather drastic method of solvent removal was shown to account for only a 20 per cent loss of the acid added to a solution of butterfat. The distribution ratios for butyric acid between ethyl ether and water are involved in this connection. These ratios (ether to water) vary from 4.2 : 1 to 5.3 : 1 for concentrations of the acid from 0.01 per cent to 0.12 per cent, respectively (10), values which would account at least partially for losses during the actual extraction.

The application of the extraction procedure to low-fat products or to homogenized products further emphasizes the weakness of the churning method. The data reveal the effect of separation on the loss of ether-extractable acids, losses which would not be detected when the fat is isolated by churning. The loss of these acids during separation, in addition to those lost if the cream were churned rather than solvent-extracted, would result in recovery of less than one-half the free fatty acids obtainable by direct extraction of the milk.

Chemical analysis of churned and solvent fat failed to show any appreciable differences between these fats, whether normal or rancid, except through comparison of acid degrees. These data agree with previous results based on fat obtained by churning (4). The data presented serve to illustrate that only a small portion of the fat is affected by lipolysis. An average saponification number of 225 is equivalent to an acid degree of 402 if the fat is totally hydrolyzed. On this basis, only 1.97 per cent of the churned rancid and 3.46 per cent of the solvent rancid fat was hydrolyzed. Therefore, small losses of free fatty acids, through either solvent extraction or churning, would have no appreciable effect upon the characteristics of the fat obtained.

Analysis of the various fractions resulting from ethanol extraction of solvent-extracted milk fat gave no definite indication of selective fat hydrolysis by the lipase system. However, as indicated previously (3), the free fatty acids may be concentrated by such extraction. It is evident that not only the free fatty acids are extracted but also any mono-, di-, and triglycerides which may be soluble in the hot ethanol. The precipitate formed upon chilling of this solution is comparatively low in free acids and high in Reichert-Meissl, Polenske and saponification values, indicating that glycerides of shorter-chain acids are involved. The cold alcohol-soluble fraction contained the bulk of the fatty acids, and probably mono- and diglycerides of the lower fatty acids, as indicated by high acid degree, Reichert-Meissl, Polenske and saponification values.

SUMMARY

A method for the removal of fat from milk products which involves the use of ethanol, ethyl ether and Skellysolve F was developed.

The application of this solvent extraction method to rancid milk yielded fat averaging 30 per cent higher in acidity than fat obtained by churning and re-

sulted in better recovery of the fat. The solvent method is adapted particularly to the removal of fat from homogenized products of low fat content, thereby eliminating the loss of water-soluble fatty acids through separation. Moreover, the addition of lactic acid and/or formalin to cream had little effect upon the acidity of the fat resulting from solvent extraction, but increased appreciably the acidity of that obtained by the churning process.

The solvent method was superior to the churning method for recovery of pure fatty acids from cream, particularly the lower acids, butyric and caproic. This is emphasized by the fact that many samples of fat which were solvent-extracted from milk exhibited a rancid flavor, whereas churned fat from the same source did not. However, even with the solvent method, butyric acid recovery was low as determined by titration.

Improved recovery of butyric acid added to cream resulted when the temperature and pressure of solvent removal from fat was lowered from 100° C. and 500 mm. mercury to 60° C. and 20 mm. mercury. However, when rancid cream was extracted, these modifications proved to be of questionable value so far as fat titration values were concerned, due to the small amounts of volatile, water-soluble fatty acids present.

Chemical analysis failed to show any appreciable differences, other than in acid degree, between solvent-extracted and churned fat, whether the fat was from normal or rancid milk. Also, analysis of the ethanolic soluble and insoluble fractions of solvent-extracted fat failed to indicate definitely selective hydrolysis by milk lipase.

The data presented in this study indicate the need for re-evaluation of results from lipase studies which are based upon the titration of fat obtained by churning methods.

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MILK LIPASE SYSTEM. III. FURTHER STUDIES OF THE SOLVENT EXTRACTION PROCEDURE FOR OBTAINING FAT FROM MILK FOR TITRATION[1]

B. C. JOHNSON AND I. A. GOULD[2]
Maryland Agricultural Experiment Station, College Park

In previous work (5) a solvent extraction procedure was developed which proved superior to standard churning methods for the obtaining of fat in milk lipase studies. However, even this solvent method was found to be inefficient in removing butyric and caproic acids from cream. Thus, it seemed desirable to modify the extraction method to obtain greater recovery of the fatty acids resulting from milk lipase activity. The results of such modifications are presented in this paper. In addition, a comparison was made between the extraction procedure as developed, and a continuous extraction method used by Kelly (6, 7) to obtain fat for titration.

METHODS

The general conditions of the experiment were as described in the preceding paper (5). Fresh, raw milk was obtained from the University herd and separated to a 10 per cent product. The milk was homogenized by a rotary machine to accelerate the lipase activity. Samples were incubated at 37° C. with formalin (1 ml. per lb. of milk) as preservative. Lipase action was stopped by heating the milk to 65° C. or above for 10 minutes.

The fat was obtained for titration either by the solvent extraction procedure or by a continuous extraction method adapted from Kelly's work (7). In the solvent extraction method, 125 g. of cream were shaken vigorously 15 seconds with 100 ml. of ethanol and allowed to stand for 5 minutes. Then 80 ml. of ethyl ether and 120 ml. of Skellysolve[3] were added and the mixture was shaken again for 30 seconds. The emulsion was broken by centrifugation and the ethereal layer removed. The fat was freed of solvents at 60° C. and 20 to 24 mm. mercury. The solvent extraction procedure was modified in two ways. In the first modification, the cream or milk was saturated with either NaCl or $MgSO_4$ before the extraction was conducted. In the second modification, the cream or milk was adjusted to pH 2 with H_2SO_4 (1 + 3), using rapid agitation, prior to extraction.

In the continuous extraction method, the sample was mixed with two to three times its weight of plaster of Paris, allowed to harden overnight and then extracted with ethyl ether in a Soxhlet apparatus. A 1,000-ml. size extractor was used, requiring 4.5 to 5 minutes per cycle. Extraction was carried out for at

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[2] Present address: Dairy Technology Dept., Ohio State University, Columbus.

[3] Skellysolve F—a petroleum ether, boiling range 30 to 60° C.

least 3.5 hours per sample. Under these conditions, recovery of the fat was 95 per cent or better.

In previous work (6), fat titrations were made by the A.O.A.C. method (1). Although this method was found to give acceptable results, some difficulty was experienced with the endpoint, especially in highly rancid samples. This matter of titration was investigated and comparisons made among four methods, those of Breazeale and Bird (2), Herrington and Krukovsky (4), Clarke *et al.* (3) and A.O.A.C. (1). The results were comparable for all methods. However, the alcoholic KOH method of Breazeale and Bird was chosen for this work because the titration was in a clear solution and the endpoints were the most definite and exhibited the least fading. Titration results were expressed in acid degrees (the number of ml. of *N* alkali required to neutralize the acids in 100 g. of fat).

In studies on recovery of pure fatty acids, the acids were standardized accurately at approximately 0.25 *N* and added to 30 per cent cream at the rate of 5 ml. per 100 g. or to 10 per cent milk at the rate of 2 ml. per 100 g.

EXPERIMENTAL

Saturation with Neutral Salts. In the first phase of this work, the effect of saturation of the cream with either NaCl or $MgSO_4$ prior to extraction on the recovery of butyric acid from 30 per cent cream was determined. Results are presented in table 1. These data reveal that saturation of cream with NaCl tended to improve recovery of butyric acid, whereas saturation with $MgSO_4$ did not appreciably affect recovery of the acid. Addition of NaCl increased recovery of butyric acid by 11 per cent.

TABLE 1

Effect of salt-saturation of the cream upon the recovery of butyric acid

Treatment of the Cream	Recovery of Butyric Acid		
	Trial 1	Trial 2	Av.
	(%)	(%)	(%)
Control (cream plus butyric acid)	19.0	9.48	14.24
Control plus NaCl	31.5	18.96	25.23
Control plus $MgSO_4$	23.5	8.03	15.77

In view of these results, studies were conducted on normal and rancid milk (10 per cent) in which the fat was obtained by solvent extraction with and without the aid of NaCl saturation. The results presented in table 2 reveal that the acid degree of the fat obtained from both normal and rancid products was not affected appreciably by saturation of the milk with the salt, although the results were inconsistent between trials.

Acidification with H_2SO_4. In studies involving the effect of lowering the pH the recoveries of butyric, caproic, capric and oleic acids from acidified and untreated 10 per cent milk were compared. Results are presented in table 3. Acidification of the milk with H_2SO_4 was found to increase appreciably the re-

TABLE 2

Effect of NaCl-saturation of the milk before extraction upon the acid degree of the fat

	Acid Degree of the fat			
	Trial 1	Trial 2	Trial 3	Av.
	(%)	(%)	(%)	(%)
Without NaCl				
Normal fat	1.13	1.22	0.87	1.07
Rancid fat	13.59	27.03	15.84	18.82
With NaCl				
Normal fat	1.04	0.67	0.70	0.80
Rancid fat	13.70	27.16	15.46	18.77

covery of various fatty acids from 10 per cent milk. The greatest increases were noted with butyric and caproic acids. Recovery of the former was more than tripled (9.48 to 30.59 per cent) and that of the latter nearly doubled (42.39 to 72.26 per cent). Total recovery of caprylic and oleic acids was achieved when the pH of the milk was adjusted prior to extraction.

TABLE 3

Effect of acidification of milk before extraction upon the recoveries of added fatty acids

Fatty acid added	Acid degree			Recovery of pure fatty acid	
	Calculated increase	Actual increase			
		Not acidified	Acidified	Not acidified	Acidified
				(%)	(%)
Butyric	6.13	0.58	1.87	9.48	30.59
Caproic	5.57	2.36	4.02	42.39	72.26
Capric	5.32	4.46	5.43	83.79	102.20
Oleic	4.61	4.17	4.73	90.45	102.80

The effect of acidification of normal and rancid 10 per cent milks upon the acid degree of the extracted fats is shown in table 4. In all cases, the acid degrees of the fats from acidulated creams were higher, averaging 1.38 and 19.79 for normal and rancid acid-treated samples, as compared to 1.07 and 18.82, respectively, for the untreated samples. Since qualitative tests for the sulfate ion were negative, the increase could not be attributed to entrained H_2SO_4.

TABLE 4

Effect of acidification of the milk before extraction upon the acid degree of the fat

	Acid degree of the fat			
	Trial 1	Trial 2	Trial 3	Av.
	(%)	(%)	(%)	(%)
Cream not acidified				
Normal fat	1.13	1.22	0.87	1.07
Rancid fat	13.59	27.03	15.84	18.82
Cream acidified with H_2SO_4				
Normal fat	1.37	1.62	1.16	1.38
Rancid fat	14.13	28.49	16.73	19.79

Comparison with Continuous Extraction Method. The data obtained when the standard solvent extraction method was used were compared to those which resulted from the continuous extraction of milk dried with plaster of Paris. Results are presented in table 5. Continuous extraction of dried milk, whether normal or rancid, produces fat of much lower acidity than does standard solvent extraction. When the milk was not acidified prior to extraction, the average differences in acid degree between fats from rancid and normal milks were 8.24 for the former method and 17.75 for the latter, or a difference of 115 per cent. Acidification of milk prior to extraction increased the acidity of fat obtained by standard extraction to a lesser extent than that of fat obtained by continuous extraction; however, the acid degree obtained by the former method was still

TABLE 5

A comparison of the acid degree of fat obtained by solvent extraction and by continuous extraction of milk previously dried with plaster of Paris

	Acid degree of the fat when the cream was:	
	Not acidified	Acidified
Solvent extraction method		
Normal	1.07	1.38
Rancid	18.82	19.79
Difference	17.75	18.41
Continuous extraction method		
Normal	0.78	0.87
Rancid	9.02	12.84
Difference	8.24	11.97

54 per cent greater than that by the latter – 18.41 as compared to 11.97. Percentage recovery of the fat was satisfactory by either method.

DISCUSSION

Since butyric acid is the most volatile and water-soluble fatty acid in butterfat, the problem of recovery of all of the fatty acids present becomes one of obtaining more complete recovery of this acid. Substances which are appreciably soluble in water often may be extracted more successfully with ether if an inorganic salt is first added to the solution to reduce the solubility of the substance in the water. Although NaCl was found to increase the extraction of butyric acid to some extent, the improvement in butyric acid recovery by saturation of the milk with NaCl does not appear sufficiently great to warrant its use; the effect is slight and inconsistent when based on the acid degree of the fat from rancid and non-rancid milk. Saturation of cream with $MgSO_4$ did not improve butyric acid recovery.

The improved recovery of butyric, caproic, capric and oleic acids which resulted when the milk was adjusted to pH 2 prior to extraction is sufficient to justify the acceptance of such treatment as a part of the solvent extraction procedure. In addition, when this method was used with rancid cream, the acid degree of the resulting fat was appreciably higher than when the fat was extracted without pH adjustment. Apparently, under normal conditions, an ap-

preciable portion of the free fatty acids is bound in the milk, probably as salts, and thus is not removed by ordinary solvent extraction.

The results obtained in this work raise considerable question about the accuracy of the continuous extraction of milk which has been dried with plaster of Paris. Even with excessively long extraction times, the acid degree of fat obtained by continuous extraction was less than one-half that obtained by the standard solvent procedure and the results lacked consistency.

SUMMARY

1. Results are presented of two attempts to modify the solvent extraction procedure for the obtaining of fat in lipase studies so as to increase the efficiency of recovery of the lower fatty acids. The two modifications studied were: (a) the saturation of the milk with salts ($MgSO_4$ and NaCl) before extraction and (b) the acidification of the milk to pH 2 with H_2SO_4 before extraction.

2. Of these modifications, only the acid adjustment of the milk or cream was found to yield sufficient improvement in recovery as to warrant its adoption as a part of the solvent extraction procedure.

3. A comparison of the solvent extraction method and a procedure involving continuous extraction of milk previously dried in plaster of Paris reveals that the latter method does not remove efficiently the free fatty acids from milk.

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A COMPARISON OF TORSION PENDULUM TYPE VISCOSIMETERS FOR MEASUREMENT OF VISCOSITY IN DAIRY PRODUCTS[1]

F. E. POTTER, E. F. DEYSHER, AND B. H. WEBB
Bureau of Dairy Industry, Agricultural Research Administration, U. S. Department of Agriculture

In conjunction with studies on the viscosity of dairy products it was necessary to examine various viscosimeters to determine their accuracy and operating characteristics. The purpose of this article is to show some of the difficulties encountered in determining the viscosity of dairy products and to present conversion factors, for torsion pendulum viscosimeters, which may be of use to others in similar studies.

Whitaker and Herrington (4), using the Mojonnier-Doolittle viscosimeter, developed an equation for the conversion of degrees retardation to absolute viscosity. Herschel (1, 2), studying the MacMichael viscosimeter, found the constants (factors) obtained with liquids of a known viscosity to be nearly identical with the calculated constants for wires of 26, 30 and 34 gauge. However, the 34 and 36 wires gave nearly identical results and the constant for the 36 wire was considerably larger than the calculated constant. He concluded that this wire was of larger diameter than the standard for that gauge. Sheely (3) reported that the values obtained with two of the pipet type viscosimeters agreed very closely on liquids of known viscosity, whereas the MacMichael gave slightly higher values. This difference increased with an increase in viscosity.

EXPERIMENTAL PROCEDURE

In this study three viscosimeters of the torsion pendulum type were used, namely the Brookfield,[2] the MacMichael,[3] and the Mojonnier-Doolittle.[4] The operation of the instruments was conducted as specified by the manufacturers. The Brookfield viscosimeter was used with four attachable spindles or plungers, and operated at speeds of 6, 12, 30 and 60 revolutions per minute. Wires of a standard gauge numbering from 18 to 30, inclusive, with both large and small plungers, were used with the MacMichael viscosimeter. The three interchangeable plungers provided with the Mojonnier-Doolittle viscosimeter were used with three wires of the same size.

All determinations in this study were conducted at 86° F. (30° C.). A separate portion of the sample was used for each determination to eliminate any error caused by structural breakdown due to the action of the plungers.

The depth of plunger immersion in the product to be tested was uniform for each viscosimeter. The Brookfield spindles were immersed to the indentation on

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2 Brookfield Engineering Laboratories Inc., Stoughton, Massachusetts.

3 Eimer and Amend, New York, N. Y.

4 Mojonnier Bros. Co., Chicago, Illinois.

TABLE 1

Mojonnier-Doolittle viscosimeter conversion factors[a] obtained with oils of known viscosities

Standard oils		Wire no.	Size of plunger					
			Small		Medium		Large	
Oil no.	Viscosity at 86° F.		Reading[b]	Factor	Reading[b]	Factor	Reading[b]	Factor
	centipoises							
M –14	148.3	1	8.33	17.8	60.66	2.44	224.66	0.660
M –14	148.3	2	8.00	18.5	59.66	2.48	209.66	0.707
M –13	155.0	1	5.33	29.0	58.59	2.64	219.17	0.707
M –13	155.0	2	7.33	21.1	59.36	2.61	214.93	0.721
M –13	155.0	3	.....	.....	55.50	2.79	211.00	0.735
N –15	648.0	1	18.66	34.7	197.33	3.28	.....	.....
N –15	648.0	2	24.66	26.2	201.66	3.21	.....	.....
OB– 3	13,930.0	1	222.77	62.5	.....	.....	.....	.....
OB– 3	13,930.0	2	224.69	61.9	.....	.....	.....	.....
OB– 3	13,930.0	3	222.00	62.7	.....	.....	.....	.....
	Av. Factors			37.2		2.78		0.706

[a] Factor × reading = centipoises.
[b] Each reading represents an average of five or more determinations.

the spindle shaft; for the MacMichael, the topmost mark was used for the small plunger and the bottom of the small knob on the side of the cup for the large plunger. With the Mojonnier the level of the fluid was adjusted to cover exactly the bulb of the plunger.

Standard viscosity oils were obtained from the National Bureau of Standards for instrument standardization. The viscosity of these oils at 86° F. is included in the data of table 1 with the exception of oil P8, which had a viscosity of 43,630 centipoises at 86° F.

RESULTS

In the standardization of the viscosimeters it was found that the conversion factors furnished with the Brookfield were satisfactory when tested with the standard oils.

The conversion factors obtained with the Mojonnier-Doolittle viscosimeter are presented in table 1. The data show only a slight variation in results obtained

TABLE 2

Factors for converting MacMichael viscosimeter readings taken at 86° F. to centipoises when the viscosimeter cup is turned at 21 r.p.m.

Wire	Factors[a]	
Standard Gauge no.	Small Plunger	Large Plunger
18	11,368	217
20	4,475	93
22	1,694	37
24	703	13.6
26	286	5.8
28	82	1.73
30	43	0.901

[a] Factor × °M = Centipoises.

with the different wires, and this variation probably is within the accuracy of the determination. The factors for the small plunger varied from 17.8 to 62.7, the medium plunger 2.44 to 3.28, and the large plunger 0.660 to 0.735, with average factors of 37.2, 2.78, and 0.706, respectively.

Table 2 shows the factors obtained in the standardization of the MacMichael viscosimeter. These data represent the average of several trials with two or more oils for each wire, the individual determinations varying only slightly.

Figure 1 shows a straight line relationship between the logarithm of the factors and the wire or spindle size for both the MacMichael and Brookfield viscosimeters. A similar plot of the Mojonnier data gives a curve which indicates a somewhat different relationship between the logarithm of the factor and the plunger sizes of this instrument.

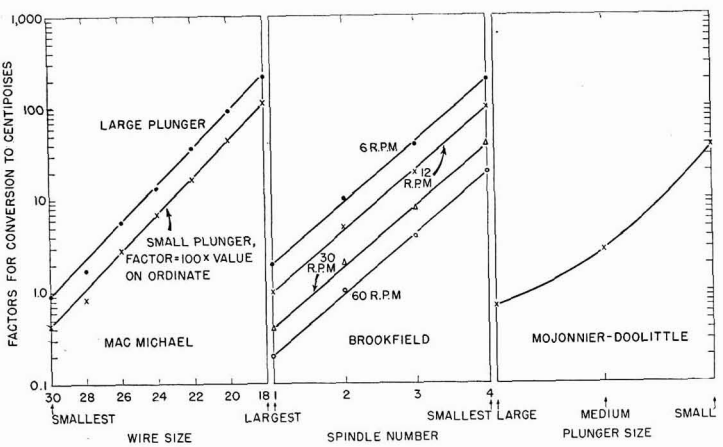

FIG. 1. The relationship between viscosity conversion factors and the wire or spindle sizes of three different viscosimeters.

Measurements next were made on various dairy products and the viscosities were calculated by using the factors determined for the different viscosimeters. Several determinations were made on each of a number of samples.

The data of table 3 show the variations in values obtained with the three viscosimeters, as well as differences found in the viscosity values when different wires or plungers were used with the same instrument. With the MacMichael viscosimeter, the viscosity decreased with an increase in the wire gauge for both the large and small plunger. Although this table does not show values obtained with other wires, the same relationship existed. In the results obtained with the Mojonnier-Doolittle viscosimeter, the data show a decrease in the viscosity value with an increase in the plunger size. For the Brookfield viscosimeter an increase in the revolutions per minute of the spindle caused a decrease in the viscosity value. In addition, in nearly all cases when operating at the same speed, the larger the spindle used, the smaller the viscosity value. This relationship was found in many other samples.

TABLE 3

Viscosity values of various dairy products determined with the three viscosimeters and converted to centipoises with the factors obtained for each instrument

Product	MacMichael viscosimeter		Mojonnier viscosimeter		Brookfield viscosimeter						Av. value
	Large plunger		Medium plunger	Large plunger	#1 Spindle[a] R.P.M.[b]				#2 Spindle R.P.M.		
	#28 wire	#30 wire			6	12	30	60	30	60	
	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)	(*c.p.*)
Evaporated milk	42.8	40.9	55.6	53.0	48.0	49.0	43.9	39.4	48.0	40.7	46.1
Condensed skim milk	66.7	61.0	94.6	74.8	82.0	79.0	71.2	65.0	70.0	67.0	73.1
Reconstituted skim milk (approx. 30% solids)	51.3	47.9	58.4	57.2	54.0	51.0	49.2	47.5	58.0	50.3	52.5
Ice cream mix[c]	56.4	54.0	69.6	66.4	87.4	74.7	60.0	51.2	67.4	52.0	63.9
	Small plunger		Small plunger		#3 Spindle R.P.M.		#4 Spindle R.P.M.				
	#28 wire	#30 wire			6	12	6	12	30	60	
Sweetened condensed whole milk	2,654	2,616	2,235		3,040	2,840	3,060	2,870	2,600	2,460	2,708
Sweetened condensed skim milk	9,436	8,328	5,550		11,040	9,494	10,800	9,500	7,840	6,620	8,734

[a] Number 1 spindle is the largest, number 4 is the smallest.
[b] R.P.M. = revolutions per minute.
[c] This sample of ice cream mix was abnormally low in viscosity.

DISCUSSION

It is well known that the usual viscosity values obtained on such products as ice cream mix and sweetened condensed milk are not absolute; they do not take into consideration plasticity effects and they must be run in the same manner each time if comparative figures are to be obtained. Nevertheless, relative viscosity determinations do give numerical values which reflect the treatment of products during manufacture and storage and which provide a means of comparison and of grading.

The factors presented here will be useful to workers wishing to make relative viscosity determinations on dairy products. It should be pointed out, however, that even though the appropriate conversion factors are used, the viscosity values will vary with the wire or plunger size as well as with the speed of rotation. The conversion factors furnished by the manufacturers of the Brookfield viscosimeter were found to be satisfactory. With this instrument the operating speed had a greater influence on the viscosity value of dairy products than did the spindle size.

In general, the faster the speed of rotation and the larger the spindle size, the lower the viscosity value.

Conversion factors for each MacMichael wire with both the large and small plungers checked very closely with all oils. A speed of 21 revolutions per minute for the MacMichael cup was used in this study, and operation at another speed would give a different set of factors for the respective wires. The factors for other speeds can be calculated, since the product of the speed and factor yields a constant. Therefore $F = K/S$, where F = Factor, S = Revolutions per minute and K = Constant. This relationship was checked on standard oils. Each spindle of the Brookfield viscosimeter also yields a constant when the speed of rotation is multiplied by the factors furnished by the manufacturer.

When the MacMichael was used for determining the viscosity of dairy products, the use of different wires did not give equal viscosity values. However, a general trend prevailed in which the viscosity value decreased with an increase in the gauge of the wire.

In the standardization of the Mojonnier viscosimeter, the viscosity of the oils had an effect on the factors. The greater the viscosity, the larger were the factors for each plunger. This increase was the greatest for the small plunger, whereas the largest plunger showed only a slight difference with the various oils. The large and medium Mojonnier plungers gave viscosity values on dairy products which agreed fairly well with the values obtained with the other viscosimeters. However, the smallest plunger gave considerably lower values.

This study was not concerned with temperature effects but some mention should be made of them, since the Brookfield viscosimeter instructions make no statement regarding temperature. Standard oils at a temperature of 20 and 25° C. were used with the Brookfield and MacMichael viscosimeters. The temperature did not seem to change the factors furnished for the Brookfield viscosimeter but a decrease in temperature increased the factors for the MacMichael.

SUMMARY

Torsion pendulum viscosimeters operated under similar conditions gave satisfactory results in the determination of relative viscosity in dairy products. When tests in a series were to be compared, it was found advisable to use the same standardized instrument for all the tests and to maintain constant conditions with regard to speed of rotation, wire and plunger size, depth of immersion of plunger, temperature, and agitation, stirring or preparation of the sample.

Conversion factors were determined for the MacMichael and Mojonnier viscosimeters at 86° F. The factors furnished by the manufacturers of the Brookfield viscosimeter were found satisfactory. A decrease in the wire size and an increase in plunger size or in speed of rotation when applied to a given instrument caused a decrease in the apparent viscosity of various dairy products.

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PROPERTIES OF THE COLOSTRUM OF THE DAIRY COW. IV. EFFECT OF FORM OF VITAMIN A AND OF TOCOPHEROL SUPPLEMENTS ON CONCENTRATIONS OF VITAMIN A AND CAROTENOIDS[1]

D. B. PARRISH, G. H. WISE,[2] AND J. S. HUGHES

Kansas Agricultural Experiment Station, Manhattan, Kansas

Previous studies (2, 10, 13) have demonstrated that giving massive amounts of vitamin A to dairy cows during the terminal weeks of gestation usually increases the vitamin A content of colostrum and early milk. Information was lacking, however, on the effects of dietary supplementation of tocopherols (vitamin E) and of different forms of vitamin A, alcoholic and esterified, on the concentrations of vitamin A and carotenoids in the early postpartum mammary secretions. Accordingly, a study of this problem was undertaken.

EXPERIMENTAL PROCEDURE

Vitamin A and carotenoid concentrations in colostrum and early milk from cows and heifers that received barn rations supplemented with vitamin A ester were compared with concentrations in similar secretions from cows that received the same rations supplemented with either vitamin A alcohol or vitamin A alcohol plus tocopherols in the free, unesterified form. This last combination of supplements was used because it was believed that any evidence of the sparing action of tocopherols would be manifested more clearly in conjunction with the less stable alcoholic form (11) than with the natural ester. Also, the vitamin A and carotenoid contents of the early mammary secretions from several cows receiving barn rations supplemented with tocopherols were compared with those from cows fed unsupplemented barn rations. Since no information on prepartal tocopherol supplementation was available, different levels were given.

Preparturient dairy cows that calved during a period from November, 1946, to February, 1947, were assigned on the basis of breed, number of lactations (first or later) and type and/or level of supplement fed to two major dietary groups, each consisting of three subgroups (table 1). Unfortunately, the limited number of animals available and three unavoidable casualties disrupted the equalization of subgroups. General feeding and management practices have been published (8).[3] Types of vitamins, levels of administration and periods of supplementation are shown in table 1. All supplementation was discontinued at parturition. Variations in lengths of time cows received the

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[1] Contribution no. 380, Department of Chemistry and no. 182, Department of Dairy Husbandry.

[2] Present address, Department of Animal Industry, North Carolina State College, Raleigh, N. C.

[3] The identification of the groups is not the same as in the previous report and data on colostrum from additional cows are included in this study.

TABLE 1

Schedule of vitamin A and tocopherol supplementation of prepartal ration of dairy cows

Group	No. of cows	Days previous to date of expected parturition	
		28 – 14	13 – 0
		Ration supplement given	
I a	7	500,000 I.U. vit. A ester	1,000,000 I.U. vit. A ester
b	8	500,000 I.U. vit. A alc.	1,000,000 I.U. vit. A alc.
c	6	500,000 I.U. vit. A alc. plus 0.5 g. $\alpha-\gamma$ tocopherols	1,000,000 I.U. vit. A alc. plus 1 g. $\alpha-\gamma$ tocopherols
II a	5	None	None
b	1	0.5 g. $\alpha-\gamma$ tocopherols	1 g. $\alpha-\gamma$ tocopherols
c 1	1	4 g. mixed tocopherols	4 g. mixed tocopherols
c 2	1	5 g. $\alpha-\gamma$ tocopherols	5 g. $\alpha-\gamma$ tocopherols
c 3	3	10 g. mixed tocopherols	10 g. mixed tocopherols

Note: $\alpha-\gamma$ tocopherols contained either 50 or 90% γ-tocopherol; all tocopherols were in the free, unesterified form.

supplements resulted from differences between expected and actual calving dates, but in no instance was the average time for each group less than that indicated in table 1.

Samples were collected from each milking during the first 4 days and on the eighth day postpartum. Vitamin A and carotenoids were determined on individual samples from the first four milkings only and on daily composites thereafter. Collection procedures and analytical methods have been reported (10).

RESULTS

Effect of form of vitamin A supplement. Group means (I-a and I-b, table 2) indicate that in the early stages of the transition from colostrum to milk the vitamin A content per unit of fat was greater in secretions from cows receiving the alcoholic form of vitamin A than from those receiving the esterified. Similar results were obtained when averages were computed on a per-unit-of-secretion basis (table 3). However, comparisons of data from paired animals of the two groups revealed that in several instances the higher values were in

TABLE 2

Vitamin A and carotenoid contents of fat in colostrum and early milk from groups of cows given different vitamin supplements

Group	Ration supplement	Number of milking						
		1	2	3	4	5 + 6[a]	7 + 8	15 + 16
		Vitamin A ($\mu g./g.$ of fat)						
I-a	Vit. A ester	113	96	71	46	33	23	9
I-b	Vit. A alcohol	139	145	93	64	36	21	9
I-c	Vit. A alc. and tocopherols	107	91	91	71	35	22	9
		Carotenoids ($\mu g./g.$ of fat)						
I-a	Vit. A ester	39	32	23	18	14	8	4
I-b	Vit. A alcohol	39	37	22	16	11	6	3
I-c	Vit. A alc. and tocopherols	36	31	23	18	11	7	4

[a] Composite samples.

TABLE 3

Vitamin A and carotenoid contents of colostrum and of early milk from groups of cows given different vitamin supplements

Group	Ration supplement	Cows		Vitamin A							Carotenoids						
		Herd no.[a]	Lactation	Number of milking							Number of milking						
				1	2	3	4	5+6[b]	7+8	15+16	1	2	3	4	5+6[b]	7+8	15+16
				(μg./100 ml. of secretion)							(μg./100 ml. of secretion)						
I-a	Vitamin A ester	H-132	1	740	594	282	175	170	114	27	113	77	38	31	31	15	4
		H-128	2	978	414	226	109	67	51	47	109	52	28	18	9	6	8
		A-241	2	622	310	320	151	91	105	33	217	124	84	45	31	27	14
		J-378	1	172	400	358	375	188	116	55	62	141	125	171	67	49	14
		G-468	1	773	1,030	1,070	181	174	184	86	198	250	275	66	70	77	35
		J-358	2	405	350	279	365	184	107	45	237	211	161	210	111	53	27
		G-453	2	324	600	359	138	91	53	28	285	427	254	96	83	46	33
		Mean		573	528	413	213	138	104	46	174	183	138	91	57	39	19
I-b	Vitamin A alcohol	H-137	1	990	646	292	214	119	95	35	135	88	30	17	17	8	0
		A-252	1	1,185	1,420	972	575	98	125	77	143	214	105	64	11	11	18
		H-115	3	460	320	169	195	113	62	47	140	92	45	51	33	16	12
		A-243	2	450	1,050	970	514	301	112	57	70	130	122	72	50	29	12
		J-379	1	287	439	248	350	229	140	17	83	146	68	96	75	48	4
		G-465	1	870	660	520	226	149	121	39	478	175	253	99	66	63	27
		J-365	2	355	776	338	176	110	116	43	116	230	91	46	38	37	23
		G-452	2	620	685	407	236	142	62	34	388	383	235	157	102	36	30
		Mean		735	750	490	311	158	104	44	194	182	119	75	49	31	16
I-c	Vitamin A alcohol and tocopherols	H-135	1	320	386	600	499	147	115	43	70	88	94	103	38	34	11
		H-136	1	681	695	296	636	94	96	42	116	117	37	93	29	17	10
		J-374	1	770	520	337	272	172	390	42	366	257	99	76	46	112	25
		J-380	1	221	212	915	383	345	89	47	49	75	209	101	88	27	14
		G-458	2	1,200	470	610	460	151	134	57	369	134	151	105	54	38	29
		G-459	2	293	248	205	108	70	65	40	330	208	152	83	53	50	38
		Mean		581	422	494	393	163	148	45	217	147	124	94	51	48	21

[a] The symbols H, A, J and G refer to the breeds Holstein, Ayrshire, Jersey and Guernsey, respectively.
[b] Composite samples.

TABLE 4

Vitamin A and carotenoid contents of cholostrum and of early milk from groups of cows receiving either unsupplemented barn rations or the same rations plus tocopherol

Group	Ration supplement	Cows		Vitamin A							Carotenoids						
		Herd no.[a]	Lactation	Number of milking							Number of milking						
				1	2	3	4	5+6[b]	7+8	15+16	1	2	3	4	5+6[b]	7+8	15+16
				(μg./100 ml. of secretion)							(μg./100 ml. of secretion)						
II-a	None	H-175	6	144	119	107	75	76	52	31	103	118	71	60	55	38	22
		H-105	4	446	262	119	77	72	48	38	156	112	55	40	30	21	20
		A-230	3	291	278	119	.....	78	37	25	204	215	100	.....	71	21	19
		G-432	5	213	135	81	67	54	40	27	368	250	121	95	75	54	34
		G-433	5	216	113	125	87	69	39	25	365	222	236	184	120	70	40
		Mean		262	181	110	77	70	43	29	239	183	117	95	70	41	27
II-b	0.5–1 g. tocopherols	G-451	2	199	177	89	59	43	48	22	570	515	264	176	108	87	53
II-c_1	4 g. tocopherols	G-467	1	289	693	284	180	105	56	42	226	487	239	152	92	63	56
II-c_2	5 g. tocopherols	A-240	2	215	182	125	36	68	33	8	138	117	86	23	41	23	27
II-c_3	10 g. tocopherols	H-138	1	582	852	112	100	51	35	22	133	192	33	36	22	12	7
		A-200	7	408	220	176	172	101	65	61	239	116	98	98	51	32	12
		J-365	2	316	227	155	113	104	74	43	359	248	176	127	120	73	36
		Mean, group II-c		362	435	170	120	86	53	35	219	232	126	87	65	41	28

[a] The symbols H, A, J and G refer to the breeds Holstein, Ayrshire, Jersey and Guernsey, respectively.
[b] Composite sample.

colostrum from cows fed vitamin A ester. Moreover, a pronounced individual variation among cows was observed. Thus, the superiority of one form of dietary vitamin A over the other for augmenting the levels of vitamin A in colostrum was not indicated.

The carotenoid contents of colostrum and early milk from cows receiving the alcoholic form of vitamin A also were similar to those from cows receiving the natural ester (tables 2 and 3).

Effect of supplements of tocopherols. Average levels of vitamin A in the first two samples of mammary secretions collected from cows receiving supplements of alcoholic vitamin A were higher than those from cows that also received tocopherols (tables 2 and 3). After the first two milkings, consistent differences were not apparent. In view of the wide variability among samples (table 3), the differences in the vitamin A contents of the mammary secretions from the two groups probably have little, if any, significance.

Although high levels of tocopherol supplementation of the ration during the later stages of gestation appeared to effect an increase in the average concentrations of vitamin A in colostrum and early milk (groups II-a and II-c, table 4), variations in results on samples from individual cows tend to nullify differences between means. Previous work (10) has shown that vitamin A levels generally are higher in colostrum from cows in their first lactation than in a later. Therefore, if comparisons of vitamin A levels are made only on colostrum from cows in their second or later lactations, the results from cows receiving tocopherols approach those from cows fed unsupplemented rations. Thus, as judged by these few data, it is questionable whether high levels of prepartal tocopherol supplementation substantially increase the amounts of vitamin A in colostrum and early milk.

The effect of feeding tocopherol supplements in conjunction with either normal dietary sources of vitamin A or massive amounts of vitamin A alcohol on carotenoid contents of the early mammary secretions were variable, and no consistent trends were discernible (tables 2, 3 and 4).

DISCUSSION

Previous work (9) has shown that the levels of vitamin A and its state of occurrence were practically the same in the blood of cows given supplements of either esterified or alcoholic vitamin A. Therefore, differences in the form of vitamin A ingested would not be expected to affect the quantities of this vitamin eliminated in the mammary secretions. Results of the present study tend to substantiate the foregoing view. Recent studies of vitamin A blood levels of Holstein heifers (12) also indicate that cattle utilize vitamin A alcohol and vitamin A ester to approximately the same degree.

Several reports cited by Hickman and Harris (6) have indicated a synergism between tocopherols and vitamin A in laboratory animals, but in another investigation (1) this relationship was not observed. Likewise, studies with cattle have not revealed this synergism when levels of vitamin A in either milk (5) or milk fat (14) were used as criteria. With the possible exception

of results on colostrum samples from cows given 10 g. of tocopherols daily, data reported herein are in accord with those from the foregoing milk investigations. Since it has been indicated that tocopherols are effective in increasing liver storage of vitamin A only when given at proper levels (6), the possibility that the cows might not have received proper levels and ratios of vitamins to disclose a synergism whereby tocopherols affect the levels of vitamin A in colostrum and early milk should not be overlooked.

Tocopherol supplements given to cows in post-colostral stages of lactation were reported to have increased concentrations of fat in the milk by 27 per cent (5), but in other trials the increases were not observed (3, 4, 14). The present study did not reveal any definite effect of tocopherol supplementation on either fat levels in or yields of colostrum. However, it should be noted that the fat content of early colostric secretions may vary widely among different cows and from milking to milking from the same cow (7). Thus, unless the effects of tocopherol supplementation are more marked than the normal variations, differences would not be detectable.

SUMMARY

The rations of dairy cows and heifers were supplemented with either various amounts of tocopherols or with large quantities of vitamin A ester, vitamin A alcohol or vitamin A alcohol plus tocopherols during the terminal 4 weeks (average minimum) of gestation. The relative effects of these prepartal supplements on vitamin A and carotenoid concentrations of colostrum and early milk were investigated.

In view of the individual variation observed within the same groups, differences found in vitamin A concentrations in colostrum and early milk could not be ascribed to the form or combination of vitamin supplements given. Thus, vitamin A ester, vitamin A alcohol and vitamin A alcohol plus tocopherols appeared to be of a similar value in affecting increases in vitamin A_1 levels of colostrum and early milk.

In a trial with a limited number of cows, addition of tocopherols at various levels to barn rations did not increase substantially vitamin A content of colostrum and early milk.

Neither the form of vitamin A supplement given nor the addition of tocopherols had a significant effect on carotenoid levels of the early mammary secretions.

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THE NUTRITIVE VALUE OF ALFALFA HAY. III. CORN AS A SUPPLEMENT TO AN ALL-ALFALFA HAY RATION FOR MILK PRODUCTION[1]

C. F. HUFFMAN AND C. W. DUNCAN

The Departments of Dairy and Agricultural Chemistry, Michigan Agricultural Experiment Station, East Lansing

In previous reports from this Station (13, 14, 15, 16), it has been demonstrated that milk production can be increased when properly depleted cows have had a part of the alfalfa hay in the ration replaced by concentrates on an equal total digestible nutrient basis. Several other investigators also have reported that cows fed alfalfa hay alone do not utilize efficiently the total digestible nutrients for milk production except in the early stages of lactation (8, 9, 11, 12, 19, 22, 23). All of these results suggest the possibility that the decreased amount of milk produced by feeding alfalfa hay alone may be due to certain dietary deficiencies.

Since alfalfa hay is sometimes low in phosphorus, Haag *et al.* (8, 10) determined the phosphorus balances of cows on an all-alfalfa hay ration and found that the balances always were negative. Huffman and Duncan (17) have shown further that the addition of a phosphorus supplement in the form of bone meal to an all-alfalfa hay ration failed to prevent the decline in milk production.

Haag (9) and Wright and Haag (27) showed that L-cystine had a favorable supplementary effect upon rats when alfalfa leaf meal was fed at a 9 per cent protein level. On the other hand, Huffman and Duncan (14) reported that the ingestion of 20 g. of L-cystine per day per cow as a supplement to an all-alfalfa hay ration produced no significant effect on milk production.

Kellner and Köhler (20) found that the addition of 1 kg. of digestible protein starch, cane sugar, crude fiber or fat per day to a maintenance ration of steers resulted in the production of 235, 248, 188, 253 and 474–598 g., respectively, of fat. Their experiments with concentrates and roughages also showed that the total digestible nutrients in roughages produced less than the calculated amount of fat. As a result of their work, the production of fat from digestible nutrients would appear to vary with the crude fiber content of the ration. The higher the fiber content, the less the feeding value of the digestible nutrients. These results provide the basis of the present discount systems, such as "starch values", "net energy values" and "productive energy values", used in the evaluation of feedstuffs. Huffman and Duncan (15), using properly depleted cows, have shown that the addition of either corn starch or corn sugar to an all-alfalfa hay ration did not cause an increase in milk production. When 6 lb. of corn replaced 6 lb. of starch or glucose, however, milk production always increased. The level of crude fiber in the rations remained unchanged in both the corn-feeding and starch- or sugar-feeding periods, which suggests that

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the corn grain contributed a dietary factor or factors needed for milk production which are not present in the alfalfa hay or in the corn starch or corn sugar These experiments also eliminated a lack of available energy as the factor responsible for the low producing power of alfalfa hay.

Smith *et al.* (24) studied the effect on milk production by replacing 13 to 25 per cent of the total digestible nutrients in an all-alfalfa hay ration, on an equal total digestible nutrient basis, with various concentrates. Soybeans were most effective in increasing milk production, whereas cane molasses and sugar were least effective. Davis and Kemmerer (1) reported that milk production was increased when dried grapefruit peel was added to an all-alfalfa hay ration.

The investigation reported in this paper was made for the express purpose of obtaining additional information on the amount of milk produced when a part of the digestible nutrients in alfalfa hay was replaced with corn.

EXPERIMENTAL

Seven Holstein cows (A5, A18, D5, D12, D14, 266 and 267), three Jersey cows (74, 77 and 78), and two Brown-Swiss cows (A45 and 238) were used in the 15 trials reported in this paper. Cows A5, A18 and D12 were used on two different trials but with different hays.

The depletion technic developed at this Station to exhaust the cows of their reserve milk-producing factors consists of the following practice: The cows are placed on an all-alfalfa hay ration (a) either at the time of parturition or (b) at an advanced stage of lactation and are continued on this regime until they are depleted of the factor(s) needed to balance the total digestible nutrients in the hay. The depletion period usually required from 6 to 8 weeks for almost all of the cows used in this study; however, the cows in a more advanced stage of lactation usually were depleted within 2 weeks. Depletion of the factor(s) was indicated by an initial decline and then a leveling-off in milk production. Both types of depleted cows were used in this study. The period just prior to the replacement of a part of the total digestible nutrients with corn was used as the basal period—usually a 15-day period. The cows were fed twice a day and had water available in drinking cups at all times. They were weighed at the same hour every third day. The cows were milked twice a day and the milk was weighed after each milking. The equivalent number of pounds of 4 per cent fat-corrected milk was calculated by the formula proposed by Gaines (4). Three-day composite samples were taken for butterfat determinations.

The 11 alfalfa hays used in this investigation represented 8 crop years. Most of these hays were, or would have been, graded U. S. grade no. 2 as to color and leafiness, second cutting, and harvested at about the half-bloom stage. The hay fed to A45 was a mixture of alfalfa and alsike clover. The digestible protein and total digestible nutrients of all of the hays were determined by digestion experiments by using either yearling heifers, dry cows or cows in milk, except those hays used in trials 1, 3, 8 and 15. Ten-day collection periods were used for the determination of these data. The animals were fed the hays under consideration for from 10 days to several months prior to the collection periods. The digestible

TABLE 1

Description of the hays, their chemical composition and their actual or calculated coefficients of digestibility

Trial no.	Cow no.	Moisture	Ash	Protein	Ether ext.	Crude fiber	N.F.E.	Dig. proteins	T.D.N.	Description of the hays
		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	
1[a]	D12	12.6	7.19	15.8	2.18	25.4	36.8	11.7	50.7	U.S. No. 2, 2nd cut.
				74[b]	33	43	72			alf., 1936 crop
2	D12	13.1	6.65	15.0	1.80	27.2	36.3	10.2	49.7	U.S. No. 1, 1st cut.
				68	17	56	65			bud alf., 1937 crop
3	D14	13.8	7.82	16.4	1.80	28.3	31.9	11.8	48.0	U.S. No. 1, 2nd cut.
				72[b]	34	43	71			alf., 1937 crop
4	74[c]	11.9	6.88	15.0	2.77	28.6	34.9	10.2	47.2	U.S. No. 2, 2nd cut.
5	266			68	28	39	69			alf., 1938 crop
6	78									
7	239	14.2	5.94	16.6	2.18	31.0	30.1	11.5	46.1	Ungraded, 2nd cut.
				69	10	47	65			alf., 1938 crop
8	D5	10.7	6.31	14.9	2.33	27.0	38.8	11.0	52.3	U.S. No. 3, 1st cut.
				74[b]	33	43	72			alf., 1939 crop
9	A18[d]	10.9	6.76	15.9	2.59	28.1	35.8	11.8	51.7	Ungraded, 2nd cut.
10	A5			74	32	45	71			alf., 1941 crop
11	77	11.8	6.30	16.5	1.67	29.9	33.8	11.1	48.3	U.S. No. 1, 1st cut.
				67	6	50	65			bud alf., 1941 crop
12	A5	15.4	5.89	13.1	1.72	28.1	35.8	8.8	49.3	Ungraded, 2nd cut.
				67	37	60	62			alf., 1942 crop
13	A18[d]	13.0	6.43	14.6	1.74	28.6	35.6	10.5	49.7	Ungraded, 2nd cut.
14	267			72	39	47	68			alf., 1943 crop
15	A45	10.5	5.99	14.2	2.01	30.4	36.9	10.2	51.0	Ungraded, 1st cut.
				72[b]	34	43	71			alf.-alsike, 1944 crop

[a] The first line in each trial represents the chemical composition of the hay.

[b] The second line in each trial represents the coefficients of digestibility of the various hay fractions. Those marked with footnote[b] represent the calculated values, whereas all other values were obtained experimentally.

[c] Three cows (74, 266 and 78) were fed this hay.

[d] Two cows each in trials 9 and 10 and 13 and 14 were fed the same hay.

protein and total digestible nutrient contents of the other 4 hays were calculated from the chemical analyses and by the use of the coefficients of digestibility recommended by Morrison (21). The hay data are presented in table 1.

TABLE 2

The chemical composition, digestible protein and total digestible nutrient content of the corn used in each trial

Trial no.	Cow no.	Moisture	Ash	Protein	Ether ext.	Crude fiber	N.F.E.	Dig. protein	T.D.N.
		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	D12	17.2	2.71	9.94	4.09	2.00	64.1	7.7	76.7
2	D12	12.9	2.97	9.19	3.49	2.20	69.3	7.1	79.8
3	D14	12.7	2.05	10.13	4.23	1.93	69.0	7.8	81.7
4	74	13.6	4.73	8.62	3.92	2.63	66.5	6.6	77.9
5	266	12.6	3.10	9.44	4.00	3.02	67.8	7.3	80.2
6	78	12.6	3.10	9.44	4.00	3.02	67.8	7.3	80.2
7	239	13.7	2.43	9.13	2.32	3.19	69.2	7.0	78.0
8	D5	13.1	1.77	8.93	3.58	2.88	69.7	6.9	80.6
9	A18	12.5	1.92	8.94	4.36	3.01	69.3	6.9	81.8
10	A5	12.5	1.92	8.94	4.36	3.01	69.3	6.9	81.8
11	77	12.5	1.92	8.94	4.36	3.01	69.3	6.9	81.8
12	A5	14.2	2.22	9.06	3.95	2.57	68.0	7.0	79.6
13	A18	12.2	2.44	8.33	4.22	2.72	70.1	6.4	81.7
14	267	12.2	2.44	8.33	4.22	2.72	70.1	6.4	81.7
15	A45	13.4	2.65	7.88	3.86	3.01	69.2	6.1	80.0

Number 2 yellow dent corn was ground to medium fineness and used in all of the trials. The digestible protein and total digestible nutrient contents of the various batches of corn were calculated from actual chemical analyses and the use of the coefficients of digestibility recommended by Morrison (21). The corn data are presented in table 2.

Short-time experimental periods, usually 15-day periods, were used in order to minimize the effect of the natural tendency of cows to decline in milk with the

TABLE 3

The data pertaining to the stage of lactation, body weights, the average daily yield of 4 per cent fat-corrected milk, alfalfa hay and corn intakes and the total digestible nutrients received and required

Trial no.	Cow no.	Exptl. period	In milk	Body wt.	F.C.M.		Feed intake of:			T.D.N.	
					Yield	Incr.	Hay	Corn	D.P.[a]	Rec.	Req.
		(*days*)	(*days*)	(*lb.*)	(*lb.*)	(%)	(*lb.*)	(*lb.*)	(*lb.*)	(*lb.*)	(*lb.*)
1[b]	D12	15	120	1191	23.0		44.6		5.22	22.6	16.6
		33	135	1225	31.2	35.7	30.0	9.0	4.20	22.1	19.4
2	D12	15	179	1260	25.2		45.0		4.59	22.4	17.8
		12	194	1273	29.0	15.1	30.0	9.0	3.70	22.1	19.1
3	D14	9	110	1245	23.3		44.2		5.22	21.2	17.1
		15	119	1233	26.1	12.0	29.7	9.0	4.20	21.6	17.8
4	74	15	324	770	11.3		27.4		2.79	12.9	9.9
		9	339	763	12.6	11.5	11.3	9.0	1.74	12.3	10.2
5	266	15	152	1020	16.0		35.6		3.63	16.8	13.2
		15	167	999	19.4	21.3	20.0	9.0	2.70	16.6	14.1
6	78	15	261	890	8.4		24.2		2.47	11.4	9.8
		15	276	845	11.0	31.0	10.0	9.0	1.68	11.9	10.4
7	239	9	99	1143	23.4		41.2		4.74	19.0	16.4
		18	108	1116	26.8	14.5	27.0	9.0	3.74	19.4	17.3
8	D5	12	155	1067	12.1		34.4		3.78	18.0	12.2
		15	167	1065	14.0	15.7	20.0	7.5	2.72	16.5	12.8
9	A18	12	262	1214	14.4		38.8		4.58	20.1	13.9
		15	274	1189	18.3	27.1	24.9	9.0	3.56	20.2	15.1
10	A5	12	183	1155	15.6		34.1		4.02	17.6	13.9
		15	195	1134	21.3	36.5	20.0	9.0	2.98	17.7	15.7
11	77	18	144	768	16.0		24.8		2.75	12.0	11.4
		15	162	741	17.4	8.8	15.0	6.0	2.08	12.1	11.7
12	A5	15	276	1193	16.0		39.7		3.49	19.6	14.3
		21	291	1196	18.9	18.1	25.0	9.0	2.83	19.5	15.3
13	A18	24	265	1187	11.8		34.5		3.62	17.1	13.0
		30	289	1207	12.7	7.6	20.0	9.0	2.68	17.3	13.3
14	267	15	228	1238	15.5		34.9		3.66	17.3	14.5
		24	243	1200	17.8	14.8	20.0	9.0	2.68	17.3	15.0
15	A45	12	266	1006	7.0		28.7		2.93	14.6	10.2
		15	278	1003	9.6	37.1	15.7	6.0	1.97	12.8	11.0

[a] D.P. = digestible protein.

[b] The first line in each trial represents the all-alfalfa hay ration, whereas the second line represents the alfalfa-corn ration.

advance in lactation. The length of the periods when the hay-corn ration was fed varied in a few cases from 8 to 32 days. The data showing the effect of replacing a part of the total digestible nutrients in hay with an equal amount of total digestible nutrients in the form of corn are presented in table 3. The immediate effect on milk production in properly depleted cows when they are changed from an all-alfalfa hay ration to a hay-corn ration and back to an all-alfalfa hay ration again is strikingly illustrated in figure 1. The average daily milk pro-

duction of 5 typical cows (A5, A18, D12, D14 and 266) was used in the preparation of this figure.

RESULTS

The data showing the stages of lactation, body weights, the average daily yields of 4 per cent fat-corrected milk, hay and corn consumption, the total digestible nutrients received and required and the digestible protein intake are presented in table 3. When corn replaced a part of the hay, there was a marked reduction in digestible protein intake. Nine pounds of corn replaced about 15 pounds of alfalfa hay in 12 trials. In the case of cow D12 (trial 8), 7.5 lb. of corn replaced 14.4 lb. of hay, whereas in trials 11 and 15, 6 lb. of corn replaced 9.8 and 13 lb. of hay, respectively.

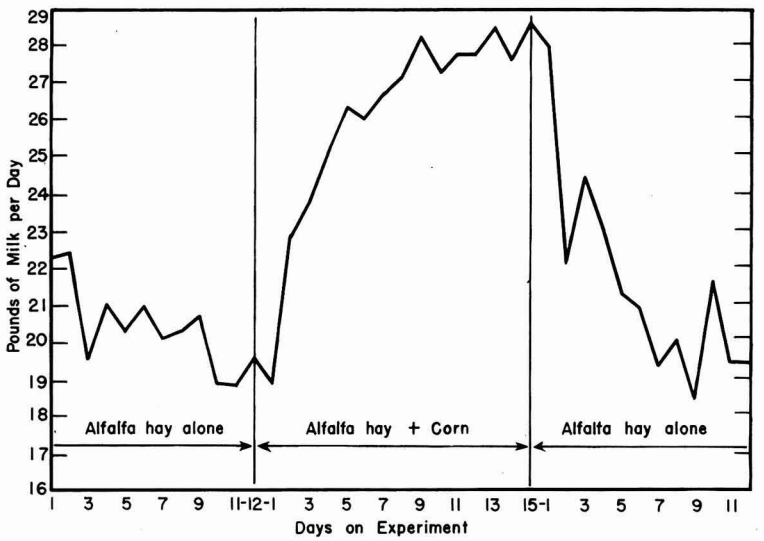

FIG. 1. The effect on milk production in properly depleted cows when changed from an all-alfalfa hay ration to an alfalfa-corn ration and back again to an all-alfalfa hay ration. (Av. for 5 cows)

The cows used in trials 5, 9, 10–14 consumed either the same amount or within plus or minus 0.2 lb. of total digestible nutrients per day during both the alfalfa hay and alfalfa-corn feeding periods. The cows used in trials 1, 2, 4, 8 and 15 consumed from 0.3 to 1.8 lb. less total digestible nutrients per day during the alfalfa-corn feeding periods than during the alfalfa hay periods. The cows used in trials 3, 6 and 7 consumed from 0.4 to 0.5 lb. more total digestible nutrients during the alfalfa-corn periods than during the all-alfalfa hay period. In all trials, however, the total digestible nutrient intake was greater than that required.

Insofar as possible, 15-day experimental periods were used in both the alfalfa-corn and all-alfalfa hay feeding periods. In the case of the cows used in trials 3, 7, 8, 9, 10 and 15, shorter periods were utilized because they had become depleted

sooner. On the other hand, cows 77 (trial 11) and A18 (trial 13) did not become entirely depleted in the usual length of time. Cow 74 (trial 4) only remained on the hay-corn ration for 9 days, since it became necessary to discontinue milking in preparation for the next calving. In the case of cow D12 (trial 2), the shorter hay-corn period was necessitated because of the limited amount of alfalfa hay cut in the bud stage. Cows D12 (trial 1), 239 (trial 7), A5 (trial 12), A18 (trial 13) and 267 (trial 14) were continued on the alfalfa-corn ration for more than 15 days.

The stage of lactation at the beginning of the alfalfa hay feeding period varied from 99 to 324 days. The mean body weights show there was a negligible loss of weight in 11 trials (maximum loss 45 lb., average 20.7 lb.) when the cows were changed from an all-alfalfa hay ration to an alfalfa-corn ration, and a gain in weight in 4 trials (maximum gain 34 lb., average 17.5 lb.). The gains or losses in weight do not appear to be significant in view of the relatively short periods employed and the reduction in dry matter intake during the alfalfa-corn feeding periods.

Since there were no significant differences in the per cent of fat in the milk between the all-alfalfa hay and alfalfa-corn feeding periods, only the average daily milk production records, on the 4 per cent fat-corrected basis, are presented. The increase in milk production varied from 0.9 to 8.2 lb. per day when part of the hay was replaced by corn on an equal total digestible nutrient basis. The increases varied from 7.6 to 37.1 per cent. In 6 trials, the increase was more than 20 per cent, whereas the increase was only 12 per cent or less in 4 trials. The wide differences in response to the change from the all-alfalfa hay ration to alfalfa and corn are attributed to variations in the hay, stage of lactation, stage of gestation, and inheritance for milk production.

DISCUSSION

The partial replacement of alfalfa hay with corn in the ration of properly depleted cows resulted in an increase in the production of 4 per cent fat-corrected milk. These results appear significant in view of the fact that 11 different hays were used, representing 8 different crop years. Although two of these hays were cut in the bud stage (trials 2 and 11), milk production increased above the all-alfalfa hay ration when corn replaced part of the hay. The greatest percentage increase in fat-corrected milk occurred in trial 15, where only 6 lb. of corn replaced 13 lb. of first cutting alfalfa-alsike clover hay. This cow had completed 278 days of lactation at the time of the change, yet she was able to produce 2.6 lb. more fat-corrected milk per day during the 15-day period than when on hay alone, or a 37.1 per cent increase. Cow 74 (trial 4) produced 1.3 lb. more fat-corrected milk per day after she was changed to an alfalfa-corn ration on the 339th day of lactation. The increased fat-corrected milk resulting from the partial replacement of the total digestible nutrients in hay with corn is in agreement with the results of Smith *et al.* (24), who reported an increase in milk production when a part of the total digestible nutrients of an all-alfalfa hay ration was replaced by either fish meal, meat meal, beet pulp, wheat bran, blood meal, pea meal or soybean meal.

The improvement in milk production which resulted from partial replacement of the total digestible nutrients of alfalfa hay with corn was not due to an increased intake of digestible protein since there was a marked reduction in digestible protein intake during each alfalfa-corn feeding period. The possibility of an amino acid deficiency appears unlikely in view of the earlier work which indicated that the ingestion of cystine as a supplement to an all-alfalfa hay ration failed to give a favorable response (14). Smith *et al.* (24) concluded that there were no indications that improved milk production resulted from improving the quality of protein in the ration.

The milk production obtained during the all-alfalfa hay feeding periods was not due to a lack of available energy, inasmuch as it previously has been shown that the addition of corn starch or corn sugar failed to increase milk production in properly depleted cows (15). These findings are supported by those of Smith *et al.* (24) who found that milk production always was less when sugar or molasses were added to the ration than with any other concentrates tested. The total digestible nutrient intake always was in excess of that required when the cows were on the all-alfalfa hay ration.

In this investigation the increased milk production which resulted from replacing a part of the hay with corn, on an equal total digestible nutrient basis, was associated with a reduction in the crude fiber intake. Kellner and Köhler (20) fed steers a maintenance ration and then superimposed various feeds on it to study changes in body weights. They concluded that the productive values of roughages varied with the crude fiber content. These investigators used the term "starch value" to denote the probable nutritive value of feeds by discounting the total digestible nutrients on the basis of their crude fiber content. In a previous publication (15), data have been presented which indicate that the level of crude fiber in the ration does not offer an adequate explanation of Kellner's hypothesis, because the replacement of 6 lb. of starch or glucose by 6 lb. of wheat or corn always resulted in an increase in milk production. These results serve to indicate that corn contains an unidentified factor(s) needed to balance the deficiencies present in an all-alfalfa hay ration. Additional evidence has been supplied by Graves *et al.* (5, 6) to show that the total digestible nutrient discount system, based entirely on crude fiber, does not apply to alfalfa hay. These investigators reported that cows produced 2.96 lb. of fat-corrected milk per lb. of total digestible nutrients intake on an all-alfalfa hay ration and 2.50 lb. of milk on an alfalfa hay-grain ration, but the cows on the hay-grain ration produced more pounds of milk per lactation period than those on alfalfa alone. The reduced efficiency of total digestible nutrient utilization by the cows on the hay-grain ration probably was due to the higher plane of nutrition. Graves (7), however, attributes the lower lactation records of the cows on alfalfa alone to their inability to consume sufficient total digestible nutrients, rather than to a deficiency in the hay. The alfalfa hays used in the above experiment were grown at Huntley, Montana, Woodward, Oklahoma, and Mandan, North Dakota, and contained 31.3, 29.2 and 31.5 per cent crude fiber, respectively. These hays contained more crude fiber than most of the hays fed in the present investigation.

Several investigators have pointed out that the total digestible nutrient content of a ration composed of alfalfa alone is not utilized efficiently for milk production except during the early stages of lactation (8, 9, 11, 12, 19, 22, 23). An increase in the digestibility of the ration when corn replaces a part of the hay is unlikely in view of the results obtained by Watson *et al.* (25) with steers and sheep. They found that the digestibility of barley was the same when it was fed in combination with timothy or alfalfa hay as when fed alone. Forbes *et al.* (2) fed steers alfalfa hay alone, corn alone, and alfalfa plus corn and concluded from this work that the digestibility of corn meal is not materially different when fed in combination with alfalfa or when fed alone. They also observed that the heat increment per pound of dry matter consumed was higher when alfalfa hay or corn was fed alone than when a combination of the two was fed. This is further evidence to indicate that the increased efficiency in milk production obtained when a part of the total digestible nutrients in an all-alfalfa hay ration is replaced with corn is due to an unidentified factor(s) in the corn, rather than due to an excess of crude fiber.

The possibility that the milk-stimulating effect produced by corn is a rumen phenomenon is suggested also by the work of Forbes *et al.* (2), who found that more methane was produced when a mixed ration of alfalfa and corn was fed than when either constituent was fed alone. Hunt *et al.* (18) reported that the addition of ground corn to the hay ration of steers resulted in an increased synthesis of riboflavin.

The immediate effect on the milk production of properly depleted cows when part of the alfalfa hay is replaced with corn, on an equal total digestible nutrient basis, is shown in figure 1. A marked increase in milk production occurs on the second day following the inclusion of corn in the ration and persists until the peak of production is reached in about 7 to 10 days. When corn is removed from the ration, a significant drop in milk production occurs on the second day and the downward trend continues for about a week or longer before production tends to level out.

SUMMARY

Twelve cows which had been depleted of their reserve milk-producing factor(s) on an all-alfalfa hay ration were used in 15 trials to study the effect on milk production after a part of the total digestible nutrients in alfalfa had been replaced with corn. Eleven different hays representing 8 crop years were used and each experimental period averaged 15 days in length.

The replacement of a part of the alfalfa hay with corn, on an equal total digestible nutrient basis, always resulted in an increased production of 4 per cent fat-corrected milk.

Milk production increased markedly during the second day following the change to the alfalfa-corn ration and persisted for 7 to 10 days before reaching a plateau. An equally sharp drop in milk production occurred on the second day following the change to an all-alfalfa hay ration and the drop continued for one week or longer before production stabilized at a lower level.

Possible explanations for the increased production are discussed.

The results of this investigation indicate that the corn grain supplied an unidentified factor(s) needed to balance alfalfa hay for milk production.

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THE YEAST IN THE SURFACE SMEAR OF BRICK CHEESE[1]

K. K. IYA[2] AND W. C. FRAZIER
Department of Agricultural Bacteriology
University of Wisconsin, Madison, Wisconsin

In the manufacture of brick cheese, the appearance of a slimy surface smear, slightly orange in color, is a prerequisite for desirable qualities in the finished cheese. This surface smear has been investigated by several workers. Langhus *et al.* (1) showed that the smear contained micrococci, *Bacterium linens* and some "yeast-like" organisms. It was felt that a study of the yeast and its probable role in the ripening of brick cheese might yield interesting results.

The samples of brick cheese either were prepared in the Department of Dairy Industry at this University or were obtained from factories located in the vicinity of Madison. Contact smears of the surface of the cheeses were made on successive days after the salting of the cheese, and the microbial types were examined. The cocci developed first within 3 days. Between the third and the eighth day after salting of the cheese, the yeasts made their appearance, increased in numbers and gradually disappeared. After about the eighth day, microscopic examination revealed large numbers of gram-positive rods which were identified as *B. linens.* In a few days the smears showed practically only *B. linens.*

The yeast was isolated in pure culture and, as a result of a study of its various characters, was identified as a *Mycoderma* species of the family *Cryptococcaceae,* according to the system of Lodder as described by Skinner *et al.* (2).

The yeast forms a dry wrinkled pellicle on liquid media in 24 hours at room temperature. It grows well at temperatures ranging from 10 to 30° C., but poorly at 37° C. The pH range for the growth of the yeast was found to be between 3.0 and 8.0. The yeast was able to tolerate sodium chloride in a concentration ranging from 0 to 15% and to utilize glucose, lactose and lactates.

In an experiment where glucose, lactose and sodium lactate were used as sources of equivalent amounts of carbon in an otherwise complete medium adjusted to pH 4.7, the growth of the yeast for 4 days at 30° C. resulted in a shift of the pH of the medium to 3.5, 3.0 and 6.3 for glucose, lactose and sodium lactate, respectively. This is significant because in brick cheese the yeast probably metabolises the lactate, causes a shift in the pH of the medium towards neutrality and thus favors the growth of *B. linens.* It was found that *B. linens* would not grow well in media having a reaction more acid than pH 5.5.

The pure culture of the yeast then was grown for about 7 days in a lactate

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[2] Government of India Scholar, Present address: Dairy Bacteriologist, Indian Dairy Research Institute, Bangalore.

broth and filtered through a Seitz filter. The filtrate, containing products of the activity of yeasts in the medium, was added in graduated amounts to a medium which by itself did not support the growth of *B. linens.* Upon inoculation and incubation of the medium at 30° C., the addition of the yeast filtrates markedly stimulated the growth of *B. linens.* This stimulation of growth was confirmed by means of turbidimetric observations with a Klett-Summerson colorimeter. Therefore the yeast in brick cheese may be considered to stimulate the growth of *B. linens,* probably by providing the bacterium with some accessory growth factors.

SUMMARY

The role of the yeast in brick cheese seems to be as follows:

1. The yeast metabolises the lactates in the cheese, causing a shift of pH towards neutrality. This favors the growth of *Bacterium linens,* which is unable to grow in an acid environment.

2. In addition, the yeast supplies *B. linens* with some essential growth factor, or factors.

ACKNOWLEDGMENT

We wish to thank Dr. W. V. Price for his helpful suggestions during the course of this work.

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ASSOCIATION ANNOUNCEMENTS

PROGRAM

FORTY-FOURTH ANNUAL MEETING

OF THE

AMERICAN DAIRY SCIENCE ASSOCIATION

UNIVERSITY OF MINNESOTA

MINNEAPOLIS AND ST. PAUL, MINNESOTA

JUNE 21–23, 1949

PROGRAM COMMITTEE

GENERAL:

P. H. TRACY, Illinois
Chairman
J. B. FITCH, Minnesota

EXTENSION:

G. HEEBINK, West Virginia
Chairman
RAY ALBRECHTSEN, New York
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MANUFACTURING:

E. M. BARKER, Minnesota
Chairman
D. V. JOSEPHSON, Pennsylvania
J. H. HETRICK, Illinois

PRODUCTION:

L. A. MOORE, Beltsville, Md.
Chairman
G. H. WISE, North Carolina
G. M. CAIRNS, Maryland

GENERAL PROGRAM

Monday, June 20, 1949

12:00 Noon — Open for Registration, Coffman Memorial Union

7:00– 9:30 — Registration and Informal Gathering, Coffman Memorial Union

Tuesday, June 21, 1949

8:00 — REGISTRATION

9:30–12:00 — OPENING SESSIONS, *Main Ballroom, Coffman Memorial Union*

J. B. FITCH, *Dairy Division, University of Minnesota, presiding*

Address of Welcome

J. L. MORRILL, *President, University of Minnesota*

Presidential Address

W. E. PETERSEN, *Dairy Division, University of Minnesota*

Cholesterol and the Problem of Aging

ANCEL KEYS, *Director of Laboratory of Physiological Hygiene, University of Minnesota*

1:30– 4:30 SECTIONAL MEETINGS

Production Section A

Genetics and Endocrine Investigations

Room 313, Zoology Bldg.

Production Section B

Calf Problems

Room 06, Botany Bldg.

Manufacturing Section

Cream, Dry Milk, Ice Cream, Sherbets

Auditorium, Museum of Natural History

Extension Section

Dairy Herd Improvement Associations

Room 320, Coffman Memorial Union

4:30 TOUR OF LAND O'LAKES CREAMERIES, INC., PLANT AND OFFICES

6:00 DINNER AND ENTERTAINMENT

Courtesy of Land O'Lakes Creameries, Inc.

Wednesday, June 22, 1949

9:00–12:00 SECTIONAL MEETINGS

Production Section A

Temperature Effects, Vitamins

Room 06, Botany Bldg.

Production Section B

Forages, Growth, Metabolism

Room 313, Zoology Bldg.

Manufacturing Section

Symposium on Milk Proteins

Auditorium, Museum of Natural History

Extension Section

Teaching Methods and Exhibits

Room 320, Coffman Memorial Union

1:00 ASSOCIATION PHOTOGRAPH

1:30– 4:00 SECTIONAL MEETINGS

Production and Extension Sections

Auditorium, Physics Bldg.

Panel Discussion—The Job of Herd Improvement

Manufacturing Section

Chemistry

Auditorium, Museum of Natural History

4:15 "BRUCELLOSIS IN MAN"

W. W. SPINK, *Professor of Medicine, University of Minnesota.* Auditorium. Physics Bldg.

5:00– 5:30 COMMITTEE AND BUSINESS MEETINGS

8:00 RECEPTION AND DANCE
Ballroom, Coffman Memorial Union

Thursday, June 23, 1949

9:00–12:00 SECTIONAL MEETINGS AND BUSINESS MEETINGS

Production Section A
Mammary Secretion, Mastitis
Room 313, Zoology Bldg.

Production Section B
Semen Techniques
Room 06, Botany Bldg.

Manufacturing Section
Chemistry, Microbiology, Standards
Auditorium, Museum of Natural History

Extension Section
4-H Club Work and Committee Reports
Room 320, Coffman Memorial Union

1:30– 3:00 SECTIONAL MEETINGS

Production Section A
Feeding and Management
Room 313, Zoology Bldg.

Production Section B
Semen Metabolism, Reproduction
Room 06, Botany Bldg.

Manufacturing Section
Dry Milk, Cheese
Auditorium, Museum of Natural History

Extension Section
Dairy Breeding
Room 320, Coffman Memorial Union

3:00– 5:00 BUSINESS MEETING OF THE ASSOCIATION
Auditorium, Museum of Natural History

7:00 ANNUAL BANQUET, INSTALLATION OF OFFICERS AND PRESENTATION OF AWARDS. *Ballroom, Coffman Memorial Union*

PROGRAM OF ENTERTAINMENT

(Principally for the Ladies)

Tuesday, June 21, 1949

1:00 *LUNCHEON, Radisson Hotel, Minneapolis.
Courtesy of Milk Dealers of the Twin Cities, Ice Cream Manufacturers, and Twin City Milk Producers Association.

4:30 TOUR, Land O'Lakes Creameries, Inc.

6:00 DINNER AND ENTERTAINMENT (Open to all registered) Courtesy of Land O'Lakes Creameries, Inc.

Wednesday, June 22, 1949

12:00 *LUNCHEON AND ENTERTAINMENT, Nicollet Hotel, Minneapolis; Entertainment by Home Service Department in Betty Crocker's Kitchens. Courtesy of General Mills, Inc.

8:00 RECEPTION AND DANCE, Coffman Memorial Union. (Open to all registered)

Thursday, June 23, 1949

1:00– 4:00 *BRIDGE AND TEA, Coffman Memorial Union.

7:00 BANQUET, INSTALLATION AND PRESENTATION OF AWARDS. Ballroom, Coffman Memorial Union. (Open to all registered)

* Open to ladies only.

PROGRAM OF MANUFACTURING SECTION

Tuesday, June 21

Afternoon Session. *Auditorium, Museum of Natural History*

1:30– 4:30 **CREAM, DRY MILK, ICE CREAM, SHERBETS.** E. M. BARKER, *Chairman.*

M1 Body of Cultured Cream. E. S. GUTHRIE, *Cornell University.*

M2 The Anti-oxidant Properties of Nordihydroguaiaretic Acid in Cream. VLADIMIR N. KRUKOVSKY, DIONISIOS A. THEOKAS AND FRANK A. WHITING, *Cornell University.*

M3 The Relation Between the Degree of Solidification of Fat in Cream and its Churning Time. J. ROBERT BRUNNER, *Michigan State College,* AND E. L. JACK, *University of California.*

M4 The Stability to Drying of Added Vitamin A to Spray Dried Milk. FLOYD C. OLSON, GEORGE W. GRUBER, ROBERT KOZLIK AND KERMIT BROWN, *Maple Island Farm, Inc.*

M5 The Effect of Variations in Acidity on the Keeping Quality of Dried Milk. GEORGE R. GREENBANK AND PHILIP A. WRIGHT, *U.S.D.A.*

M6 A Method of Measuring Ice Crystal and Air Cell Size of Ice Cream by Microscopical Examination. L. F. BLANTON AND W. S. ARBUCKLE, *North Carolina State College.*

M7 The Use of Whey in Sherbets. F. E. POTTER AND D. H. WILLIAMS, *U.S.D.A.*

M8 The Effect of Some Emulsifying Agents on the Physical-Chemical Properties of Ice Cream. J. J. SHEURING, *University of Georgia,* HARRY PYENSON AND P. H. TRACY, *University of Illinois.*

M9 Some Factors Influencing Shrinkage in Ice Cream. JOHN J. SHEURING, *University of Georgia.*

M10 The Manufacture of "Cultured" Ice Cream. W. H. E. REID, J. H. GHOLSON, C. B. AGEE AND R. M. HANCKEL, *Missouri Agricultural Experiment Station.*

M11 Utilization of Dehydrated Whey Solids in Ice Creams and Sherbets. J. H. GHOLSON, W. H. E. REID, R. J. BASNETT AND R. M. HANCKEL, *Missouri Agricultural Experiment Station.*

M12 The Relative Sweetness of Certain Corn Sweeteners in Ice Cream. L. D. HILKER, *National Dairy Research Laboratories, Inc.*

Wednesday, June 22

Morning Session. *Auditorium, Museum of Natural History*

9:00–12:00 **SYMPOSIUM ON MILK PROTEINS.** J. H. HETRICK, *Chairman.*

Important Considerations in Protein Chemistry Research. A. M. SWANSON, *University of Wisconsin.*

Crystalline Proteins from Milk Serum. H. KLOSTERGAARD AND J. D. INGLE, *Swift & Co., Chicago.*

Discussion Leader: R. McL. WHITNEY, *University of Illinois.*

Some Effects of Heat Treatment on the Serum Proteins of Milk. R. JENNESS, *University of Minnesota.*

Discussion Leader: P. G. MILLER, *Carnation Co., Milwaukee.*

Some Chemical and Physical Characteristics of Alpha and Beta Casein. E. C. HAGBERG AND A. M. SWANSON, *University of Wisconsin.*

Discussion Leader: Z. D. ROUNDY, *Armour & Co., Chicago.*

Wednesday, June 22

Afternoon Session

1:00 ASSOCIATION PHOTOGRAPH.

1:30– 4:15 **CHEMISTRY.** D. V. JOSEPHSON, *Chairman. Auditorium, Museum of Natural History.*

M13 The Sizes of the Colloidal Protein Particles of Skim Milk. T. F. FORD AND G. A. RAMSDELL, *Bureau of Dairy Industry, U.S.D.A.*

M14 Determination of Reducing Groups in Proteins and in Milk with *o*-iodosobenzoate. BRUCE LARSON AND ROBERT JENNESS, *University of Minnesota.*

M15 Isolation of Minor Organic Compounds From Heated Milk. STUART PATTON AND DAVID G. KEENEY, *Pennsylvania State College.*

M16 Milk Surfaces. II. Surface Tension Changes in Relation to Some Treatments of Milk. C. H. WHITNAH AND W. H. CHILSON, *Kansas Agricultural Experiment Station.*

M17 Turbidity as a Means for Determining the Efficiency of Homogenization. U. S. ASHWORTH, *State College of Washington.*

M18 The Instability of Ascorbic Acid in Water, with Added Copper or Hydrogen Peroxide or Both. R. W. BELL AND T. J. MUCHA, *Bureau of Dairy Industry, U.S.D.A.*

M19 Deferment of an Oxidized Flavor in Frozen Milk by Ascorbic Acid Fortification and by Hydrogen Peroxide Oxidation of the Ascorbic Acid of the Fresh Milk. R. W. BELL AND T. J. MUCHA, *Bureau of Dairy Industry, U.S.D.A.*

M20 A Re-evaluation of the Hortvet Formula and Freezing Point Value of Milk in Estimating the Percentage of Added Water. W. A. KRIENKE AND L. R. ARRINGTON, *University of Florida.*

M21 Electrometric Titration of Milk and Dairy Products in the Determination of Titratable Acidity. W. A. KRIENKE, *University of Florida.*

M22 Preliminary Observations of the Effects of Ladino Pasture and Hay Feeding on Tocopherol Content of the Fat and Stability of Milk. VLADIMIR N. KRUKOVSKY, J. K. LOOSLI AND DIONISIOS A. THEOKAS, *Cornell University.*

M23 Effects of External Temperature and Pasturage on the Degree of Unsaturation of Milk Fat. E. E. BARTLEY, E. W. BIRD, C. Y. CANNON AND J. H. ZALETEL, *Iowa State College.*

M24 Separation of Fatty Acids by Displacement Chromatography and its Application to Analysis of Butter Fat. RALPH T. HOLMAN AND LENNART HAGDAHL, *Texas A. and M. College.*

M25 Some Observations on Fat Fractions from Butter Oil. ARTHUR T. MUSSETT, STUART PATTON AND CHESTER D. DAHLE, *Pennsylvania State College.*

4:15– 5:00 **GENERAL SESSION.** *Auditorium, Physics Bldg. Brucellosis in Man,* W. W. SPINK, *Professor of Medicine, University of Minnesota.*

5:00– 5:30 **SECTION BUSINESS MEETING.** *Auditorium, Museum of Natural History.*

Thursday, June 23

Morning Session. *Auditorium, Museum of Natural History*

9:00–11:00 **CHEMISTRY, MICROBIOLOGY, STANDARDS.** J. H. HETRICK, *Chairman.*

M26 The Steam Distillation of Stale-flavor Component from State Butteroil. R. MCL. WHITNEY, KATHERINE PAULSON AND P. H. TRACY, *University of Illinois.*

M27 The Extraction of Stale Butteroil from Stale Dried Whole Milk by Organic Solvents. R. MCL. WHITNEY AND P. H. TRACY, *University of Illinois.*

M28 Sanitary Standardization of Equipment Used in the Dairy Industry. E. H. PARFITT, *Evaporated Milk Association.*

M29 Nutrition of the Lactic Group of Streptococci and its Relation to Bacteriophage Multiplication. E. B. COLLINS, F. E. NELSON AND C. E. PARMELEE, *Iowa Agricultural Experiment Station.*

M30 Thermal Death Time Studies of Coliform Bacteria in Milk. J. C. OLSON, JR., H. MACY AND H. O. HALVORSON, *University of Minnesota.*

M31 Studies on Acid Production, Loss of Bacteriophage and Resistance of a Bacteriophage-sensitive Culture of *Streptococcus lactis.* H. F. FORD AND F. J. BABEL, *Purdue University.*

M32 Variations Encountered in the Grading of Raw Milk with the Methylene Blue and Resazurin Reduction Tests. R. K. LEWTON, D. M. MARKLAND AND F. J. BABEL, *Purdue University.*

M33 Standards for Grades of Milk for Use in Manufactured Dairy Products. C. J. BABCOCK AND H. J. EMERY, *Manufactured Dairy Products Division, U.S.D.A.*

M34 The Effect of Certain Metallic Ions on Germicidal Activity of Quaternary Ammonium Germicides. W. S. MUELLER AND D. B. SEELEY, *University of Massachusetts.*

11:00–12:00 **BUSINESS MEETING.**

Thursday, June 23

Afternoon Session. *Auditorium, Museum of Natural History*

1:30– 3:00 **DRY MILK, CHEESE.** D. V. JOSEPHSON, *Chairman.*

M35 Optimum Consumer Preference for Dry Milk in Bread. E. L. JACK AND (MRS.) V. M. HAYNES, *University of California.*

M36 The Utilization of Roller and Spray Dried Sweet Cream Buttermilk in Bread Making. J. V. REGER, W. B. COMBS, S. T. COULTER AND R. B. KOCH, *University of Minnesota.*

M37 The Relation of Surface Growth to the Ripening of Minnesota Blue Cheese. H. A. MORRIS, W. B. COMBS AND S. T. COULTER, *University of Minnesota.*

M38 The Manufacture of Blue Cheese from Pasteurized Homogenized Milk. I. I. PETERS AND F. E. NELSON, *Iowa Agricultural Experiment Station.*

M39 The Determination of Free Tryptophane in Cheese. ARTHUR B. EREKSON, *Lakeshire-Marty Company, Plymouth, Wisconsin.*

M40 Filter Paper Chromatography as a Means to Determine the Amino Acids and Amines Developed in Cheddar Cheese During Ripening. F. V. KOSIKOWSKY, *Cornell University.*

M41 Manufacture of Cottage Cheese from Reconstituted Non-Fat Dry Milk Solids. C. E. PARMELEE AND W. S. ROSENBERGER, *Iowa Agricultural Experiment Station.*

3:00– 5:00 **BUSINESS MEETING OF THE ASSOCIATION.** *Auditorium, Museum of Natural History.*

PROGRAM OF PRODUCTION SECTION

Tuesday, June 21

Afternoon Session

1:30– 4:30 Section A, **GENETICS AND ENDOCRINE INVESTIGATIONS.** L. A. MOORE *Chairman.*
Room 313, Zoology Bldg.

P1 Differences in Production, Type, Size and Breeding Efficiency of Cow Families. KENNETH A. TABLER, W. J. TYLER AND GEORGE HYATT, JR., *West Virginia University.*

P2 Prolonged Gestation of Genetic Origin in Cattle. S. W. MEAD, P. W. GREGORY AND W. M. REGAN, *University of California.*

P3 Estimation of Changes in Herd Environment. C. R. HENDERSON, *Cornell University.*

P4 The Number of Proved Sons Necessary to Evaluate the Transmitting Ability of a Sire. W. E. WASHBON AND W. J. TYLER, *West Virginia University.*

P5 Calf Mortality, Sex Ratio and Incidence of Twinning in Two University of Minnesota Herds. KENNETH MILLER AND L. O. GILMORE, *Minnesota Agricultural Experiment Station.*

P6 Observations on Mammary Gland Development of Dairy Heifers Induced by Hormone Injections. J. F. SYKES, T. R. WRENN AND P. C. UNDERWOOD, *Bureau of Dairy Industry, U.S.D.A.*

P7 Effect of Temperature and Drying on Male Hormone in Cow Manure. C. W. TURNER, *Missouri Agricultural Experiment Station.*

P8 Effect of Mild Hyperthyroidism on Milk Production in Dairy Cattle. C. W. TURNER, *Missouri Agricultural Experiment Station.*

P9 Effects and Economy under Tennessee Conditions of Thyroprotein Feeding during Lactation Decline. ERIC W. SWANSON, *University of Tennessee.*

P10 Size of Thyroid in Cows from Southern States. W. W. SWETT AND C. A. MATTHEWS, *Bureau of Dairy Industry, U.S.D.A.*

P11 Factors Affecting Heart Rates of Dairy Cows. J. W. THOMAS, *Bureau of Dairy Industry, U.S.D.A.*

1:30– 4:30 Section B, **CALF PROBLEMS.** G. M. CAIRNS, *Chairman. Room 06, Botany Bldg.*

P12 Milk Substitutes for Young Dairy Calves. H. D. WALLACE, J. K. LOOSLI AND K. L. TURK, *Cornell University.*

P13 Milk Replacements in the Rations of Dairy Calves. J. B. WILLIAMS AND C. B. KNODT, *Pennsylvania State College.*

P14 Diurnal Variations in Concentrations of Fat in Blood Plasma of Calves Fed Various Types of Oils. H. B. BARKER AND N. L. JACOBSON, *Iowa State College.*

P15 The Hydrogen Ion Concentration and Dry Matter of the Feces of Young Dairy Calves Raised on a Limited Whole Milk-Dry Starter Method. R. E. JOHNSON, H. D. EATON, J. H. KRAMER, E. L. JUNGHERR, W. N. PLASTRIDGE AND L. NEZVESKY, *University of Connecticut and Storrs Agricultural Experiment Station.*

P16 The Influence of Pasture and Rumen Inoculation on the Establishment of Certain Microorganisms in the Rumens of Young Dairy Calves. W. D. POUNDEN AND J. W. HIBBS, *Ohio Agricultural Experiment Station.*

P17 The Influence of Pasture and Early Rumen Development on the Changes in the Plasma Carotenoids, Vitamin A and Ascorbic Acid and the Liver Storage of Carotenoids and Vitamin A of Young Dairy Calves. J. W. HIBBS AND W. D. POUNDEN, *Ohio Agricultural Experiment Station.*

P18 Carotene Requirements for Young Dairy Calves. R. F. ELLIOTT, *Cornell University.*

P19 The Plasma Levels of Carotene and Vitamin A in Calves from Dams Milked Prepartum and in Calves from Dams Milked Postpartum. H. D. EATON, A. A. SPIELMAN, R. E. JOHNSON AND L. D. MATTERSON, *University of Connecticut and Storrs Agricultural Experiment Station.*

P20 Effect of Type of Dispersion on Rate of Absorption of Carotene and Vitamin A by Dairy Calves. G. H. WISE, N. L. JACOBSON, R. S. ALLEN AND S. P. YANG, *Iowa State College.*

P21 Studies on the Site of Absorption and Conversion of Carotene to Vitamin A in the Dairy Calf. R. F. ELLIOTT, *Cornell University.*

P22 Calf Losses in a Dairy Herd Consisting of Five Breeds. E. E. ORMISTON, *University of Illinois.*

Wednesday, June 22

Morning Session

9:00–12:00 Section A, **TEMPERATURE EFFECTS, VITAMINS.** L. A. MOORE, *Chairman.*
Room 06, Botany Bldg.

P23 The Influence of Variations in Environmental Temperature and Thyroid Status on Sexual Development in the Male Mouse. M. MAQSOOD AND E. P. REINEKE, *Michigan State College.*

P24 Factors Affecting Heat Tolerance of Dairy Cattle. R. E. MCDOWELL AND R. A. HILDER, *Bureau of Dairy Industry, U.S.D.A.*

P25 The Comparative Heat Tolerance of Red Sindhi X Jersey and Other Breeds of Dairy Calves. R. A. HILDER AND R. E. MCDOWELL, *Bureau of Dairy Industry, U.S.D.A.*

P26 Reactions of Dairy Cows to Higher Temperatures. SAMUEL BRODY, *Missouri Agricultural Experiment Station.*

P27 The Effect of Increasing Environmental Temperatures on the Composition of Milk. J. W. COBBLE AND A. C. RAGSDALE, *University of Missouri.*

P28 The Influence of Temperature on the Carotenoid and Vitamin A Content of Milk Fat. O. T. STALLCUP AND A. C. RAGSDALE, *University of Missouri.*

P29 The Carotene Requirements of Guernsey Cattle for Reproduction. A. H. KUHLMAN AND W. D. GALLUP, *Oklahoma A. and M. College.*

P30 Vitamin A Absorption Studies in Ruminants. R. P. NIEDERMEIER, VEARL R. SMITH AND L. H. SCHULTZ, *University of Wisconsin.*

P31 Relation Between the Carotene in the Feed and the Vitamin A Potency of Butter. H. G. WISEMAN AND J. B. SHEPHERD, *Bureau of Dairy Industry, U.S.D.A.*

P32 Further Studies on the Relation of Soybeans to the Vitamin A Requirements of Dairy Cattle. M. F. ELLMORE AND J. C. SHAW, *University of Maryland.*

P33 Role and Sources of B_{12} in the Normal Mammal. A. M. HARTMAN, L. P. DRYDEN AND C. A. CARY, *Bureau of Dairy Industry, U.S.D.A.*

P34 The Vitamin D Content of Roughages. G. C. WALLIS, C. A. SMITH AND R. H. FISHMAN, *Standard Brands, New York, N. Y., and Agricultural Experiment Stations of Florida, Illinois, Kansas, Michigan, New York, North Carolina, South Dakota, Texas and Washington, and the California State Polytechnic College.*

9:00–12:00 Section B, **FORAGES, GROWTH, METABOLISM.** G. M. CAIRNS, *Chairman.*
Room 313, Zoology Bldg.

P35 The Effect of the Proportion of Roughage in the Ration on the Growth of Dairy Heifers. K. E. HARSHBARGER AND G. W. SALISBURY, *University of Illinois.*

P36 Preliminary Report on the Influence of Soil Fertility on the Health, Reproduction and Milk Production of Dairy Cows. C. W. DUNCAN, K. M. DUNN, R. E. ELY, S. T. DEXTER AND C. E. MILLAR, *Michigan Agricultural Experiment Station.*

P37 Conservation of Nutrients and Feeding Value of Wilted Silage, Barn-Cured Hay and Dehydrated Hay. R. E. ELY, L. G. SCHOENLEBER, J. B. SHEPHERD, H. G.

WISEMAN, C. G. MELIN, W. H. HOSTERMAN AND R. E. WAGNER, *Bureau of Dairy Industry, Bureau of Plant Industry, Soils, and Agricultural Engineering, and Production and Marketing Administration, U.S.D.A.*

P38 Observations on Time Required for Dairy Cows to Eat Grain, Silage and Hay. K. E. HARSHBARGER, *University of Illinois.*

P39 How Hay Feeding to Cows on Pasture Affected Milk Production and Body Weight. DWIGHT M. SEATH, *University of Kentucky.*

P40 A Method for Estimating the Feed-Replacement Value of Pasture Forage. W. B. NEVENS, R. W. TOUCHBERRY AND J. A. PRESCOTT, JR., *University of Illinois.*

P41 Distribution of Intravenously Injected Radioactive Phosphorous (P32) in the Body of the Dairy Cow. N. P. RALSTON, MAX KLEIBER, A. H. SMITH AND A. L. BLACK, *University of California.*

P42 The Effects of Lactose Feeding on Lactase Production. JESSIE FISCHER, T. S. SUTTON, J. L. LAWRENCE, H. H. WEISER AND G. L. STAHLY, *Ohio State University.*

P43 Blood Sugar Studies in Relation to Ketosis in Ruminants. L. H. SCHULTZ, VEARL R. SMITH AND H. A. LARDY, *University of Wisconsin.*

P44 Biochemical and Histo-Pathological Studies of Fasting Ketosis and Spontaneous Ketosis of Cows. J. C. SHAW, P. V. SAARINEN, B. C. HADJIOLOS AND E. C. LEFFEL, *University of Maryland.*

P45 Standards for Growth in Weight of Jersey Heifers. C. A. MATTHEWS AND M. H. FOHRMAN, *Bureau of Dairy Industry, U.S.D.A.*

P46 The Value of Wood Molasses for Growth of Dairy Heifers. T. H. BLOSSER, G. W. SCOTT, R. E. ERB AND A. O. SHAW, *State College of Washington.*

Wednesday, June 22

Afternoon Session. *Auditorium, Physics Bldg.*

1:00 ASSOCIATION PHOTOGRAPH.

1:30– 3:15 **JOINT MEETING OF EXTENSION AND PRODUCTION SECTIONS.**

L. A. MOORE AND G. HEEBINK, *Co-Chairmen.*

PANEL DISCUSSION—The Job of Herd Improvement. JOE TAYLOR, *Pennsylvania State College, Leader.*

1. Allowing for the Effect of Environment on Production. E. E. HEIZER, *University of Wisconsin.*

2. Estimating the Breeding Value of Young Bulls.
   J. L. LUSH, *Iowa State College.*
3. Should a Bull be Linebred or Out bred?
   G. A. BOWLING, *Farm Manager, formerly from West Virginia University.*
4. What about Indexes in the Selection of Bulls?
   V. A. RICE, *University of Massachusetts.*
5. Results from Crossbreeding.
   MILTON FOHRMAN, *Bureau of Dairy Industry, U.S.D.A.*
6. Reasonable Production Increase to be Expected from Culling.
   FRANK ASTROTH, *Jersey Breeder, St. Paul, Minnesota.*

3:15– 4:15 **JOINT COMMITTEE REPORTS.**

Breeds Relations Committee. H. A. HERMAN, *Chairman.*
Dairy Cattle Health Committee. W. E. PETERSEN, *Chairman.*
Dairy Cattle Breeding Committee. E. J. PERRY, *Chairman.*
Type Classification Committee. J. W. LINN, *Chairman.*

4:15– 5:00 **GENERAL SESSION.**

Brucellosis in Man. W. W. SPINK, *Professor of Medicine, University of Minnesota.*

5:00– 5:30 **COMMITTEE MEETINGS**

Thursday, June 23

Morning Session

9:00–11:00 Section A, **MAMMARY SECRETION, MASTITIS.**
L. A. MOORE, *Chairman.*
Room 313, Zoology Bldg.

P47 Effect of Various Milking Procedures, Prepartum and Postpartum, on Composition of Mammary Secretions. D. B. PARRISH, F. C. FOUNTAINE, G. H. WISE, F. W. ATKESON AND J. S. HUGHES, *Kansas Agricultural Experiment Station.*

P48 Some Effects of Prepartum Milking on the Performance of Cows and Calves. R. A. ACKERMAN, GEORGE HYATT, JR. AND A. H. VAN LANDINGHAM, *West Virginia University.*

P49 The Effect of Prepartum Milking on the Ascorbic Acid and Riboflavin Content of Colostrum at Parturition. A. H. VAN LANDINGHAM, C. A. FLANDERS AND R. A. ACKERMAN, *West Virginia University.*

P50 Effectiveness of Penicillin Infusions in Eliminating Mastitis Infections in the Bureau of Dairy Industry Herd. W. W. SWETT, L. A. BURKEY, CECELIA R.

BUCKNER AND P. C. UNDERWOOD, *Bureau of Dairy Industry, U.S.D.A.*

P51 The Incidence and Relative Severity of Infections of Different Organisms in Mastitis. LLOYD A. BURKEY AND CECELIA R. BUCKNER, *Bureau of Dairy Industry, U.S.D.A.*

P52 A Study of the Reliability of Various Diagnostic Tests and the Efficiency of Certain Therapeutic Measures in the Control of Mastitis. C. P. MERILAN, H. A. HERMAN, J. E. EDMONDSON, K. L. TALLMAN AND O. S. CRISLER, *University of Missouri.*

P53 Preliminary Observations on the Biochemical and Serological Characteristics of Coliform Organisms Isolated From Cases of Acute Mastitis. J. C. OLSON, JR., I. A. SCHIPPER AND M. E. SCHMITZ, *University of Minnesota.*

P54 Comparison of the Incidence and Severity of Mammary Edema of Cows Fed Roughages Alone or Roughages Plus Grain during the Dry Period. F. C. FOUNTAINE, D. B. PARRISH AND F. W. ATKESON, *Kansas Agricultural Experiment Station.*

9:00–11:00 Section B, **SEMEN TECHNIQUES.** G. M. CAIRNS, *Chairman.*

Room 06, Botany Bldg.

P55 Diluting Bull Semen on the Basis of Numbers of Spermatozoa Rather than by Volume. CECIL BRANTON, M. H. NEWSOM AND T. E. PATRICK, *Louisiana State University.*

P56 Penicillin and Sulfanilamide in Semen Dilutors and Their Effect on Fertility of Semen from Relatively Fertile Bulls. JOHN P. MIXNER, *New Jersey Agricultural Experiment Station.*

P57 A Comparison of Penicillin, Streptomycin and Sulfanilamide for Improving the Fertility of Semen from Relatively Infertile Bulls. JOHN O. ALMQUIST, *Pennsylvania State College.*

P58 Fertility of Bull Semen Diluted from 1:100 to 1:300. E. L. WILLETT, *American Foundation for the Study of Genetics.*

P59 Buffered Whole Egg as a Nutrient Extender for Bovine Spermatozoa. H. O. DUNN AND R. W. BRATTON, *Cornell University.*

P60 The Fertility of Bovine Semen Cooled with and without the Addition of Citrate-Sulfanilamide-Yolk Ex-

tender. R. H. FOOTE AND R. W. BRATTON, *Cornell University.*

P61 Relation of the Eosin-Aniline Blue Staining Method to the Quality of Bull Semen. H. E. SHAFFER AND J. O. ALMQUIST, *Pennsylvania State College.*

P62 The Effect of Frequency of Collection Upon Semen Production and Fertility of Dairy Bulls used in Artificial Breeding. T. E. PATRICK, CECIL BRANTON AND M. H. NEWSOM, *Louisiana State University.*

11:00–12:00 **PRODUCTION SECTION BUSINESS MEETING.**
Room 06, Botany Bldg.

Thursday, June 23

Afternoon Session

1:30– 3:00 Section A, **FEEDING AND MANAGEMENT.** L. A. MOORE, *Chairman.*
Room 313, Zoology Bldg.

P63 Clipping as an Aid to Control of Cattle Lice. R. B. PRICE, JR., W. C. PRIGGE, N. N. ALLEN AND R. J. DICKE, *University of Wisconsin.*

P64 The Effect of Methods of Milking, Methods of Cooling the Milk and Types of Barns on the Total Bacteria Count and Coliform Count. C. C. FLORA, P. M. REAVES AND C. W. HOLDAWAY, *Virginia Agricultural Experiment Station.*

P65 Some Observations on Recovery in Dairy Production in Western Europe. W. H. RIDDELL, *University of Vermont.*

P66 Feeding Value of Dehydrated Sweet Potatoes Fed Wet as Compared with Corn-Soybean Silage for Lactating Cows. L. L. RUSOFF, B. J. BURCH, JR., J. B. FRYE, JR., AND G. D. MILLER, *Louisiana State University.*

P67 Effect of Excess Concentrate Feed Consumption on Milk Producton of Dairy Cows in Hawaii. L. A. HENKE, *Hawaii Agricultural Experiment Station.*

P68 Influence of Various Udder Treatments Upon the Let-Down of Milk. C. E. KNOOP AND C. F. MONROE, *Ohio Agricultural Experiment Station.*

P69 A Comparison of Milk Production Between the Prepartum Milked Halves and the Non-prepartum Milked Halves of Bovine Udders. M. L. DAWDY AND C. B. KNODT, *Pennsylvania State College.*

1:30– 3:00 Section B, **SEMEN METABOLISM, REPRODUCTION.** G. M. CAIRNS, *Chairman.*
Room 06, Botany Bldg.

P70 The Effect of in Vitro Treatments with Testosterone on the Oxygen Consumption of Ejaculated Spermatozoa. F. N. BAKER, A. B. SCHULTZE AND H. P. DAVIS, *University of Nebraska.*

P71 Complementary Effect of Acetylcholine and Thyroxine on O_2 Consumption of Bovine Semen. A. B. SCHULTZE, *University of Nebraska.*

P72 Recovery of the Fertilized Ovum from the Living Cow. ARTHUR E. DRACY, *South Dakota State College,* AND W. E. PETERSEN, *University of Minnesota.*

P73 Factors Affecting the Interval Between Parturition and Subsequent Estrus in Dairy Cattle. J. H. EDMONDSON, *University of Missouri.*

P74 Comparison of pH Values of in Vivo and in Vitro Determinations on Bovine Vaginal-Cervical Mucus. D. B. ROARK AND H. A. HERMAN, *University of Missouri.*

P75 The Interrelationship of Age and Season on Bull Fertility. T. M. LUDWICK, D. S. RUDRAIAH, JAMES ROSENBERGER AND FORDYCE ELY, *Ohio Agricultural Experiment Station.*

3:00– 5:00 **BUSINESS MEETING OF THE ASSOCIATION.** *Auditorium, Museum of Natural History.*

PROGRAM OF EXTENSION SECTION

Tuseday, June 21

Afternoon Session. *Room 320, Coffman Memorial Union.*

1:30– 4:30 **Opening Business Section and Dairy Herd Improvement Associations.** G. HEEBINK, *Chairman.*

E1 Suggested Revisions of the DHIA Herd Book. J. F. KENDRICK, *Bureau of Dairy Industry, U.S.D.A.*

E2 Comparison of DHIA Computing Tables. C. R. GEARHART, *Pennsylvania State College.*

E3 Progress Report on Use of I.B.M. Machines in Processing DHIA Records. H. C. GILMORE, *Pennsylvania State College.*

E4 Use of I.B.M. Equipment for more Efficient Processing of BDI 718 Reports. RAYMOND ALBRECTSEN, *Cornell University.*

E5 Centering Date Versus Calendar Month for Computing Production Records. ROGER MORRISON AND R. E. ERB, *Washington State College.*

Wednesday, June 22

Morning Session. *Room 320, Coffman Memorial Union.*

9:00–12:00 **Teaching Methods and Exhibits.** C. W. REAVES, *Chairman.*

E6 Extension Education on Milking Machine Operation. I. E. PARKIN, *Pennsylvania State College.*

E7 Development of a Successful Integrated Dairy Program. E. C. SCHEIDENHELM, *Rutgers University.*

E8 The Michigan Program of Brucellosis Control in Cattle. R. E. HORWOOD, *Michigan State College.*

Explanation and Discussion of Exhibits. HILTON BOYNTON, *University of New Hampshire, in charge.*

Wednesday, June 22

Afternoon Session

1:00 ASSOCIATION PHOTOGRAPH

1:30– 4:15 **Joint Meeting of Extension and Production Sections.** See Production Section Program. *Auditorium, Physics Bldg.*

4:15– 5:00 **General Session**

Brucellosis in Man. W. W. SPINK, *Professor of Medicine, University of Minnesota. Auditorium, Physics Bldg.*

Thursday, June 23

Morning Session. *Room 320, Coffman Memorial Union*

9:00–12:00 **4-H Club Work, Committee Reports and Business Meeting.** G. HEEBINK, *Chairman.*

E9 4-H Show Programs as Developed in Mississippi. L. A. HIGGINS, *Mississippi State College.*

E10 Training 4-H Dairy Project Leaders. E. T. ITSCHNER, M. J. REGAN AND W. H. CLONINGER, *University of Missouri.*

Committee Reports

Business Meeting

Thursday, June 23

Afternoon Session. *Room 320, Coffman Memorial Union.*

1:30– 3:00 **Dairy Breeding.** G. HEEBINK, *Chairman.*

E11 Analysis of Production Records of the Daughters of Sires Used in the New York Artificial Insemination Program. RAYMOND ALBRECTSEN, *Cornell University.*

E12 A Different Slant on Sire Selection. W. E. WASHBON, *West Virginia University.*

3:00– 5:00 **Business Meeting of the Association.** *Auditorium, Museum of Natural History.*

VOLUME XXXII MAY, 1949 NUMBER 5

JOURNAL OF DAIRY SCIENCE

ABSTRACTS OF LITERATURE

Prepared in cooperation with the
International Association of Ice Cream Manufacturers
and the Milk Industry Foundation

BOOK REVIEWS

273. Milk Industry Foundation laboratory manual. Methods of analysis of milk and its products. 2nd ed. Milk Industry Foundation, 1001 Fifteenth St., N. W., Washington 5, D. C. 629 pp. $15.00. 1949.

This is the second edition of the manual first published in 1933 by the International Association of Milk Dealers. Certain tests have been repeated in the new edition with present accepted modifications. Many new tests have been added in line with recent advances in research and technology. While emphasis is placed upon milk tests, methods are included for almost every dairy product and for certain non-dairy products as well. The form of presentation of subject matter is the same as in the first edition.

The new edition is divided into 8 parts: the milk laboratory; microbiological control of dairy products; chemical control methods for dairy products; physical control methods for dairy products; miscellaneous and special tests of dairy products; microbiological, chemical and physical tests for non-dairy products; preparation of media and reagents; and appendix. Over 175 different tests are described in sufficient detail to permit their performance in the laboratory with little or no additional reference work. Original sources of information are cited liberally. Of particular value is the suggested schedule of routine laboratory procedure, describing the sampling and frequency of testing. This manual should provide an excellent handbook for the dairy plant laboratory technician, the governmental regulatory laboratory and the teacher.

D. J. Hankinson

274. Pregnancy diagnosis tests: a review. A. T. COWIE. 283 pp. 15 shillings. Joint Publication No. 13. Commonwealth Bureau of Animal Breeding and Genetics, Dairy Science, and Animal Health, Penglais, Aberystwyth, Great Britain. 1948.

This book with nearly 2,000 references is an excellent compilation of the literature on various methods of pregnancy diagnosis in women and domestic animals. The first part of the book deals with clinical methods of diagnosis in domestic animals; clinical methods for women purposely are omitted. Four chapters are devoted to tests dependent upon the presence in body fluids of gonadotropins, estrogens, progestogens and pregnandiol, and other hormones. Two more chapters deal with tests involving enzymic and other biochemical investigations of body fluids and tissues. Chapters concerning tests based on physiological and immunological phenomena and physical properties of body fluids and tissues make up the latter part of the book. The author has placed his evaluation on the methods for the different species concerned. By necessity the references discussed are treated briefly. This book should prove to be of value to practitioners and investigators in the field of human and animal reproduction as well as to many others in related fields.

N. L. VanDemark

275. The chemistry and manufacture of Indian Dairy Products. K. S. RANGAPPA AND K. T. ACHAYA. 189 pp. $3.00. The Bangalore Press, Bangalore, India. 1948.

The first part of the book deals with the general composition of the Indian milks (from cow, buffalo and goat), breeds of animals and the bacteriological aspects of production and storage. A brief reference has been made to some of the local milk products. Suitable comparative data of the European conditions have been presented. The preparation of butter from the cultured milk has been treated in the second part. Of special interest is the third part, comprising almost half of the book, dealing with the production and the chemical aspects of Ghee, a heat-treated, clarified butterfat with remarkable keeping qualities under warm storage conditions.

The authors have drawn heavily from the Indian workers in the field and the extensive references to the original papers enhance the value of the book. The printing also is satisfactory. The authors deserve to be complimented for a clear and critical presentation of their material.

A. T. Dudani

276. Odors. Physiology and control. CAREY P. MCCORD, The Industrial Health Conservancy Labs., and William N. Witheridge, General Motors Corp., Detroit. McGraw-Hill Book Co., Inc., New York, N. Y. 1949.

This is the first full-length technical book to appear in the United States that deals completely with the subject of odors, particularly those odors which are classified as offensive. It is a summary of the latest knowledge of the perception, measurement, classification, control and elimination of odors and an appraisal of the significance of odors in relation to health, emotional life, economics and related legal problems.

The physiology, chemistry and psychology of odors are given complete consideration. Then classification, measurement and detection with various methods of control and abatement follow. Finally, how to make an odor survey and legal aspects of odor nuisances complete the coverage. One learns that "Osmics" is the name of the field of science concerned with the sense of smell and that the thousands of materials (including milk and milk products) that lead to the sensation of odor are termed "osmyls". Some of the osmyls encountered in the dairy industry cannot be designated in the category of "pleasant". This book should be a shelf companion to Crocker's *Flavor,* McGraw-Hill. 1945. L. M. Dorsey

BUTTER

O. F. HUNZIKER, SECTION EDITOR

277. Pasteurizing and cooling cream and controlling butter defects. E. J. FERGUSON. Can. Dairy Ice Cream J., **27,** 9: 90-92. Sept., 1948.

The practice of cooling quickly, when a surface cooler is used, to 90° F. (where the fat begins to solidify), followed by slower cooling, is the first step toward control of body and texture defects in butter. The correct churning temperature is that which will churn cream exhaustively in 45-50 min., developing granules between the sizes of peas and walnuts for cream testing between 35 and 40% butterfat. Cold washing of the butter granules at about 5 to 10° F. below churning temperature is the most important step in the control of body and texture defects. The butter should be stored at 40° F.

H. Pyenson

278. Aluminum foil for packaging print butter. A. H. WHITE. Can. Dairy Ice Cream J., **27,** 10: 27-31. Oct., 1948.

Aluminum foil wraps for print butter as compared to. parchment give greater protection to flavor quality, prevent the absorption of other food odors and flavors and eliminate oxidative defects due to light exposure. They minimize loss of weight due to evaporation of moisture from butter surfaces and thus maintain uniform color. The aluminum foil wraps can be used in automatic packaging equipment and make an attractive tightly-wrapped package.

H. Pyenson

279. Spezifisches Gewicht und Luftgehalt der Butter. (Specific gravity and air content of butter). English Summary. M. E. SCHULZ. Die Milchwissenschaft, **3,** 7: 196-201. July, 1948.

Incorporation of air into butter during manufacture results in larger volume, lower specific gravity, seams and dull, lighter color (in Alpha butter).

A rapid method for the determination of the specific gravity of butter consists in immersing 3 to 4 cm. plugs of butter from a trier into water-alcohol mixtures ranging in specific gravity from 0.85 to 0.95. A minimum of 3 plugs per sample should be examined. Most samples of Alpha butter examined were free of air, whereas churn butter contained from 3 to 5% air by volume and Fritz butter 5 to 10%. I. Peters

280. Die Eiweisstoffe der Butter. (Proteinaceous substances in butter). English summary. R. NESENI. Die Milchwissenschaft, **3,** 7: 190-193. July, 1948.

Butter samples from Sudeten German dairies were analyzed for (a) total protein, (b) casein, (c) albumin and (d) residual nitrogen by Almen's tannic acid reagent. The values obtained on 63 samples of "Trade Mark" butter varied in *a* from 0.39 to 0.831% (av. 0.518%), in *b* from 0.332 to 0.769% (av. 0.477%), and in *c* from 0.011 to 0.042% (av. 0.024%). The values obtained on 46 samples of "Excellent" butter varied in *a* from 0.166 to 1.31% (av. 0.554%), in *b* from 0.121 to 1.02% (av. 0.488%), and in *c* from 0.013 to 0.055% (av. 0.026%). Analysis of the 109 butter samples after holding for 3 mo. at 8 to 9° C. did not result in a shift of values between the individual protein fractions.

I. Peters

Also see abs. no. 275, 325, 326, 334, 341, 389, 413.

CHEESE

A. C. DAHLBERG, SECTION EDITOR

281. Control of the moisture content and "body-firmness" of cheddar cheese. H. R. WHITEHEAD, Dairy Research Institute, Palmerston North, New Zealand. J. Dairy Research, **15,** 3: 387-397. May, 1948.

Cheesemaking experiments were carried out to investigate the moisture-retaining characteristics of curd made from milks of varying fat and casein content. Milk fat helps to retain moisture in a cheese curd. The higher the proportion of fat present the more drastic the treatment required in the cheese vat to reduce the moisture content of the finished cheese to the desired level. Curd formed from milk of a low-casein content (from Friesian cows) retains moisture in the cheesemaking process more tenaciously than curd from milk of a high-casein content (from Jersey cows). The two effects tend to neutralize each other, but the "casein effect" is usually more powerful than the "fat effect". It is not possible to conclude from the evidence available at present whether the "casein effect" is quantitative only, more moisture having to be removed from a low-casein curd, or whether there also is a qualitative difference between the caseins in Jersey and Friesian milk with an associated difference in moisture-retaining capacity. E. L. Thomas

282. Flavor development in Cheddar cheese made from pasteurized milk. K. V. Kosikowsky and A. C. Dahlberg. Can. Dairy Ice Cream J., **27,** 10: 70, 74. Oct., 1948.

A popular article based upon J. Dairy Sci., 31: 275-284; 285-292; 293-303; 305-314. 1948.

283. The problem of bitter flavor in Cheddar cheese. E. G. Hood and C. A. Gibson. Can. Dairy Ice Cream J., **27,** 11: 45-47. Nov., 1948.

Contributing factors in causing bitterness in Cheddar cheese are acidity, temperature and salt content. The two main factors are pasteurization and lipase activity. Bitterness is intensified by higher pasteurization temperatures and higher storage temperatures. H. Pyenson

284. A comparison of the yields of Cheddar cheese. O. R. Irvine, L. R. Bryant, D. C. Hill and W. H. Sproule. Can. Dairy Ice Cream J., 27, 11: 49-51. Nov., 1948.

A comparison was made of the yields of cheese/100 lb. of milk from raw milk, from milk pasteurized at 143° F. for 30 min. and from milk pasteurized at 161° F. for 16 sec. The influence of variations in moisture content of the cheese was eliminated by calculating yields on the basis of a 35% moisture content. The mean yields secured on 9 comparative trials were as follows: raw milk, 9.84; holder pasteurized, 10.02: and high short-time pasteurized, 10.01. The high temperature method retained a higher proportion of the butterfat in the cheese than the raw milk. Holder pasteurized milk gave a mean rate of retention intermediate between the other two. The mean fat content of the whey was significantly lower for the vats of high short-time pasteurized milk than for either raw or holder pasteurized milk. H. Pyenson

285. Cutting large cheese for retail sale. Owen R. Irvine. Can. Dairy Ice Cream J., **27,** 12: 27–29. Dec., 1948.

In Canada a large 15-in. Cheddar is a standard size cheese for both export and domestic trade. A hydraulic cutter fitted with a special frame is used for cutting large cheese into 18 wedge-shaped pieces. A wire bow is used to slice off a layer of 18 prints. The wedge-shaped prints then have the point trimmed off and the weight checked and then are wrapped in transparent film. Ten 1-lb. prints are boxed so that the wedges form a rectangle. H. Pyenson

286. Future possibilities for the cheese industry. E. W. Gaumnitz. Can. Dairy Ice Cream J., **27,** 9: 54–58. Sept., 1948.

Some of the fators noted in the cheese industry are as follows: (a) production of all cheese has increased steadily, (b) cheese now is produced in practically every state, (c) the government purchases 400 million lb. of cheese annually on the basis of grade, (d) manufacturing methods have been inproved generally, (e) extensive use of cheese by the armed forces popularized cheese, (f) the position of cheese was enhanced by putting it in the category of meat, (g) the reduction of imports helped the development of competing domestic varieties, (h) consumer-type packages for American types of cheese have been developed, (i) more varieties of cheese of better quality have been put in packages more acceptable to consumers, (j) the per capita consumption of cheese has increased steadily, particularly in the last few years.

Some of the problems that have become apparent in the past few years are: (a) making of cheese from pasteurized milk (b) more stringent regulations with reference to waste disposal, (c) increased attention to extraneous matter and (d) more efficient utilization of whey.

H. Pyenson

287. Storage of cottage cheese. H. S. Willard, Ohio State Univ., Columbus. Milk Plant Monthly, **38,** 3: 87, 92. Mar., 1949.

Several methods of manufacturing and storing cottage cheese are discussed. Advantages and disadvantages of the different processes are listed.

J. A. Meiser, Jr.

Also see abs. no. 297, 301, 307, 308, 330, 333, 349, 389.

CONDENSED AND DRIED MILKS; BY-PRODUCTS

F. J. DOAN, SECTION EDITOR

288. The bacteriological quality of British spray-dried milk powder. CONSTANCE HIGGINBOTTOM, Hannah Dairy Research Institute, Kirkhill, Ayr, Scotland. J. Dairy Research, **15,** 3: 277–279. May, 1948.

Plate counts on weekly samples of spray-dried milk obtained from 8 plants in Great Britain during the years 1942 and 1943 are presented. A definite improvement in the bacteriological quality of the milk powder was noted in 1943 after the introduction of a preheating temp. of 190° F. Prior to this time a preheating temp. of 165° F. had been used in all spray-drying plants included in this report. E. L. Thomas

289. Keeping quality of dried milk and milk products. P. H. TRACY.. Cherry-Burrell Circle, pp. 3–5, 22. Mar.–April, 1949.

Present knowledge concerning dried whole milk is summarized in some detail with a number of references to the literature. Dried whey also is discussed. F. E. Nelson

290. Deterioration on storage of dried skim milk. Part I. Introduction. KATHLEEN M. HENRY, S. K. KON, C. H. LEA AND J. C. D. WHITE. **Part II. Preparation, packing and storage of the experimental powders.** C. H. LEA AND J. C. D. WHITE. **Part III. Physical, chemical and palatability changes in the stored powders.** C. H. LEA AND J. C. D. WHITE. **Part IV. Changes in the biological value of the proteins.** KATHLEEN M. HENRY AND S. K. KON. **Part V. Microbiological assay of "essential" amino acids.** KATHLEEN M. HENRY, S. K. KON, C. H. LEA AND J. C. D. WHITE. **Part VI. General discussion and appendix.** KATHLEEN M. HENRY, S. K. KON, National Institute for Research in Dairying, Reading, England, C. H. LEA, Low Temperature Station for Research in Biochemistry and Biophysics, Cambridge, England, AND J. C. D. WHITE, Hannah Dairy Research Institute, Kirkhill, Ayr, Scotland. J. Dairy Research, **15,** 3: 292–363. May, 1948.

This is a detailed report of the results of a large-scale experiment conducted by the three cooperating research institutes to inquire fully into the changes occurring during storage of dried skim milk.

Little physical or chemical change was observed in the powders with moisture contents of 3 and 5%, except in palatability and gas exchange at the higher storage temperatures. The high moisture powder (7.6%) rapidly became unpalatable, discolored and insoluble. Its pH, free amino-nitrogen and soluble lactose content fell, whereas the amount of sugar attached to the protein and the reducing power towards ferricyanide increased. Oxygen was absorbed and CO_2 produced. It was concluded that the major cause of deterioration in powder of high moisture content, particularly at high storage temp., is a reaction involving the free amino-groups of the milk protein, which consist mainly of the *eta*-amino-groups of the lysine residues. The primary reaction appears to be between the protein amino-groups and the potential aldehyde group of reducing sugar. The reaction takes place in at least two stages, the primary combination resulting in neither discoloration nor loss of solubility, which follows only as a result of secondary changes, which are not understood fully. The temperature coefficient of the formation (and degradation) of the protein-sugar complex is high (at least 6), and moisture contents which can be tolerated under moderate temperatures for long periods will be unsatisfactory at high temperatures. Physical and chemical properties which depended essentially on the protein-sugar reaction were influenced only slightly by the presence of oxygen.

The protein-sugar reaction results in "heated" or "caramelized" flavors in the gas-packed powders and "stale" and "gluey" flavors in the air-packed powders. Evidence was obtained of an oxidative reaction, independent of the protein-sugar change, which produces an off-flavor in powders stored for long periods at moisture contents too low for the protein-sugar reaction to occur. It is believed that the small amount of fat present is involved. The above factors indicate a decided advantage for gas-packing under all conditions.

Crystallization of lactose, which occurred only in the powder of highest moisture (7.6%), increases the activity of the residual water in the sealed container and further accelerates deterioration.

The biological value of the proteins of dried skim milk of 7.6% moisture content decreased progressively during storage in air at 37° C. from a value of 86.9 for the first 8 d. to 65.9 after 85 d. True digestibility of this powder did not alter after 1 mo. of storage, but a significant decrease of 5–6% occurred by the end of 2 mo., with little change thereafter.

At the lower storage temperature of 28.5° C. the biological value and true digestibility of the protein at the end of 6 mo. was comparable to those of a sample stored for 1 mo. at 37° C., indicating a six-fold difference in the rate of change.

Powder with a 5% moisture content showed an unchanged biological value of its proteins after 6 mo. storage at 37° C., though the true digestibility of the proteins decreased significantly by 4%. Dried skim milks of lower moisture content were not examined, as chemical tests showed they suffered little deterioration under any conditions of storage.

Microbiological tests of fresh and stored dried skim milk showed a definite apparent loss of lysine in deteriorated powder, the loss being greater when measured after enzymic than after acid hydrolysis. The maximum deficiency of lysine was about 40% of the original content of this "essential" amino acid. A slight loss of histidine also was probable, and of arginine and methionine possible, but the reproducibility of the methods was not sufficient to establish these with certainty. Restoration of the approximate original biological value of the proteins in a sample stored for 60 d. at 37° C. in nitrogen was obtained by the addition of 1.25% lysine. An increase in the true digestibility of the proteins and in protein efficiency also was observed, but the values fell short of those obtained for the control milk. The addition of histidine as well as lysine caused a further slight improvement in the protein efficiency of a sample of deteriorated milk which had been stored for 60 d. at 37° C. in air, but arginine was without effect. The authors emphasize that it seems likely that under all conditions of storage skim milk powder will become unpalatable before it suffers any appreciable loss in the nutritive value of its proteins.

A discussion is presented in which the conclusions reached from the various approaches to the problem are considered in relation to one another.

E. L. Thomas

291. The manufacture of powdered cream. P. H. Tracy. Can. Dairy Ice Cream J., **27,** 11: 52–53. Nov., 1948.

As with fluid cream, reconstituted cream standardized to 30–34% butterfat whipped by aeration produced a better whipped product than that containing less butterfat. The addition of added m.s.n.f. was beneficial up to approximately 8%. Emulsifying agents such as sorbitan monostearate aid in obtaining overrun, good body and texture, and dry appearance of the product whipped by aeration. There were no noticeable differences in whipping properties of the reconstituted creams sprayed from various size nozzles. High spray pressures were detrimental to the whipping ability of the reconstituted cream. Inert gasses delayed oxidized flavor development. The addition of anti-oxidants like N.D.G.A., gallic acid and Viobin to powdered cream, especially when nitrogen packed, increased the shelf life of the powder.

H. Pyenson

292. Concentrated milk and the ice cream industry. D. B. Goodwillie. Can. Dairy Ice Cream J., **28,** 1: 27, 29, 72. Jan., 1949.

The concentrated milks discussed are plain condensed milk, dry whole milk, dry skim milk, dry buttermilk, dry ice cream mix and dry cream for whipping.

H. Pyenson

293. Problems of experimental condensing and spray drying. H. Shipstead and R. L. Perry, Univ. of California, Davis. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 90–101. 1948.

A laboratory spray drier and a small milk-condensing unit are described. Drawings of the units are shown and the results of two trials with the drier are presented.

H. B. Naylor

294. Untersuchungsmethoden für Milone. (Methods for analysis of Milone.) English summary. K. Kumetat. Die Milchwissenschaft, **3,** 7: 193–196 July, 1948.

Analysis of the alcoholic whey beverage "Milone" resulted in values as follows: specific gravity, 1.0047; alcohol, 0.82% by volume; total acidity (expressed as lactic acid), 0.63% volatile acids (expressed as acetic acid), 0.083%; ash, 0.31%; dry matter, 1.25%; lactose, 0.18% and protein, 0.19%. Analytical methods are given.

I. Peters

Also see abs. no. 304, 305, 316, 319, 329, 399.

DAIRY BACTERIOLOGY

P. R. ELLIKER, SECTION EDITOR

295. Inhibitory strains of lactic streptococci and their significance in the selection of cultures for starter. Margery Hoyle and Agnes A. Nichols, Univ. of Reading, Reading, England. J. Dairy Research, **15,** 3: 398–408. May, 1948.

From 56 "wild" strains isolated from sour milk for use as starter strains, 19 (34%) were found to be inhibitory. Since the inhibitory strains came from eight samples of milk it is likely that some of the strains may have been identical. Fifty-nine (27%) inhibitory strains from 220 "cultivated" strains of *Streptococcus cremoris* were obtained out of a large collection of starters. Several of these inhibitory strains also may have been similar since they were obtained from only 13 starters. All of the inhibitory strains from starter were *S. cremoris* while those from "wild" sources were classified as *Streptococcus lactis,* although several of the latter gave atypical reactions to some differential tests.

The importance of testing individual strains of lactic streptococci for inhibitory properties is emphasized, especially when strains are prepared separately to be mixed later. The importance of this fact in connection with slow acid development in cheesemaking is considered. Methods are described for determining the concentration of inhibitory substance produced and the effect of these inhibitory strains on a wide selection of lactic streptococci. E. L. Thomas

296. The identity of streptococci from starter and of streptococci, suitable for use as starter, isolated from sour milk. AGNES A. NICHOLS AND MARGERY HOYLE, National Institute for Research in Dairying, Reading, England. J. Dairy Research, **15,** 3: 409–416. May, 1948.

277 strains of lactic streptococci isolated from commercial starters and 72 strains from souring milk, suitable for cheesemaking, were identified. All the starter strains examined were *Streptococcus cremoris* and those (with two possible exceptions) from the sour milk were *Streptococcus lactis.* Since the strains from each source were so similar, the information obtained did not help in the selection of the strains within each group most suitable for starter. Action in litmus milk, hydrolysis of arginine, and ability to grow in litmus milk at 40° C. (104° F.) usually will be sufficient to differentiate clearly between *S. lactis* and *S. cremoris.* E. L. Thomas

297. The problem of bacteriophage in relation to cheese starters. C. C. PROUTY. Can. Dairy Ice Cream J., **27,** 9: 46–48. Sept., 1948.

Bacteriophage is the major cause of slow starter. Bacteriophage is a virus living as a parasite upon the bacterial cell. Bacteriophage are not destroyed until a temperature of 158° F. and an exposure period of 15–30 min. is obtained. They also are more resistant than bacteria to drying, storage and action of acid and alkalies. Bacteriophage can be destroyed by 500 p.p.m. chlorine concentration in 1 min., and by hypochlorite mists over a temperature range of 30–80° F. if the room has over 50% humidity and the hypochlorite has a concentration as little as 0.02 to 0.003 p.p.m. Generally a bacteriophage strain will be active against one specific strain of lactic acid bacteria. With the appearance of slow starter in a cheese factory, a new starter carrying a different or several different strains is placed in use. Starter rotation may help to control bacteriophage by avoiding the building up of a high concentration of any one bacteriophage strain. Resistant strains of lactic acid bacteria can be developed from a bacteriophage-susceptible strain by prolonged incubation of the culture.

The initial source of bacteriophage in a cheese factory is difficult to determine. Once it is established in the cheese factory, it will develop rapidly in the cheese vats as it survives pasteurization. The whey separator and whey storage vats should be located in a separate room from the cheese vats, as the whey may seed succeeding vats of milk with bacteriophage. In New Zealand, workers advocate the use of a separate building in which to propagate the cheese starter for daily use to prevent contamination from bacteriophage. H. Pyenson

298. Studies in the bacteriology of milk. I. The streptococci of milk. Y. ABD-EL-MALEK AND T. GIBSON, College of Agriculture, Edinburgh, Scotland. J. Dairy Research, **15,** 3: 233–248. May, 1948.

This is the first of a series of papers in which the authors report upon investigations designed to provide a clearer picture of the composition of the bacterial populations in different types of milk.

The present paper deals with the frequency of occurrence of individual species of streptococci in raw and pasteurized milks of varying purity. Samples were examined in the raw state and also after laboratory pasteurization at 63° C. (145.4° F.) for 30 min. Some of the pasteurized samples were held for further observation at various temperatures between 10 and 22° C. until a taint and other signs of bacterial action had appeared. Details of methods employed for the identification of species are given.

Twenty-two out of 23 samples of raw milk yielded streptococci. Of the 22 positive samples, *Streptococcus kefir* was detected in 19 samples, *Streptococcus lactis* in 17, mastitis streptococci in 16, *Streptococcus cremoris* in 10, *Streptococcus faecalis* in 7, *Streptococcus citrovorus* in 3, and *Streptococcus bovis* in 2 samples.

Thirty-three out of 54 samples of fresh pasteurized milk yielded streptococci. *Streptococcus thermophilus* was detected in 28 of the samples, *S. bovis* in 25, *S. faecalis* in 6, and *S. kefir* in 5. Pasteurized milk held at 10–22° C. until it became tainted yielded *S. kefir* and *S. faecalis* at the lower temperatures and, at the higher temperatures, *S. bovis* and *S. thermophilus.*

The authors report that a notable feature of the results is the prevalence of *S. kefir.* This organism was isolated from all classes of raw milk with greater frequency than *S. lactis* and although it suffered considerable destruction during pasteurization, it frequently became the dominant species in pasteurized milk stored at 10–22° C.

The streptococci occurring in raw and pasteurized milk were placed in five main groups by test-

ing for the hydrolysis of arginine, growth at 45° C. and at 8–12° C., survival in milk at 63° C. for 30 min. (measured by a semi-quantitative plating method), action on litmus milk, and ability to form CO_2 from glucose (tested by a cultural method). The five groups thus distinguished were: (1) organisms of bovine mastitis; (2) *S. bovis* and *S. thermophilus;* (3) *S. lactis* and *S. cremoris;* (4) *S. faecalis* and its varieties and (5) heterofermentative streptococci (*S. kefir* and *S. citrovorus* predominating). E. L. Thomas

299. Studies in the bacteriology of milk. II. The staphylococci and micrococci of milk. Y. ABD-EL-MALEK AND T. GIBSON, College of Agriculture, Edinburgh, Scotland. J. Dairy Research, **15,** 3: 249–260. May, 1948.

A total of 598 cultures of staphylococci and micrococci from milk and dairy equipment were studied in detail. These were isolated as follows: 248 from the cow's udder (milk drawn aseptically), 76 from raw milk, 242 from pasteurized milk and 32 from pasteurized rinsings of dairy equipment. For purposes of comparison, 201 additional cultures from other known sources also were examined. Details of the laboratory methods used are given, as well as a critical discussion of the limitations of the various criteria for identifying species.

As a result of the present study, the authors have devised a classification of representatives of the *Staphylococcus-Micrococcus* complex occurring in milk. According to their general character the strains could be arranged in a virtually continuous series. At one extreme is placed the pathogenic staphyloccus and at the other a thermoduric saprophyte. The series consists of three main groups as follows:

"(1) The staphylococcus group in which the organisms are sugar fermenters and relatively sensitive to heat. They are, mainly at least, parasites of the animal body. Four subgroups are distinguishable. In three ammonia is formed from arginine, and in two acetoin is formed from glucose. A test for acetoin production defines those mannitol fermenters which do not produce coagulase.

"(2) An intermediate group in which the organisms are obligate aerobes and do not produce acid from sugars.

"(3) The dairy micrococci, a group of thermoduric sugar fermenters which occur frequently on dairy equipment and in pasteurized milk. The group comprises two species conforming to *Micrococcus luteus* Cohn *emend.* Lehmann and Neumann, and *Micrococcus varians* (Dyar) Migula." E. L. Thomas

300. The microbacteria. I. Morphological and physiological characteristics. R. N. DOETSCH AND M. J. PELCZAR, JR., Univ. of Maryland, College Park. J. Bact., **56,** 1: 37–49. July, 1948.

The history of the classification of the members of the genus is reviewed. Eighteen cultures were studied to observe microscopic, cultural and physiologic characteristics. These included five original isolations made from milk following laboratory pasteurization. Thermal resistance, while valuable for isolation purposes, was not a satisfactory characteristic for classification. A key is presented to describe three species: (1) *Microbacterium* sp., (2) *M. lacticum* and (3) *M. flavum.* D. P. Glick

301. Bacteria in farmer's milk which survive pasteurization and subsequently grow during cheese making. I. ERICHSEN AND N. S. GOLDING, State College of Washington, Pullman. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 110–116. 1948.

Thirty-seven samples of raw milk from different producers were studied to determine the effect of incubation temperature on plate counts made before and after laboratory pasteurization. Standard methods were followed with the exception that cabbage extract was added to the standard agar. The incubation temperatures studied were 30 and 37° C. Incubation temperature had a marked influence on raw milk counts, and on pasteurization efficiency calculated from counts on laboratory pasteurized samples.

The ability of pure cultures isolated from pasteurized milk plates incubated at 30 and at 37° C. to grow in milk incubated at temperatures and times comparable to those used in cheesemaking was determined. About 25% of the 106 cultures tested showed considerable growth under cheese-making conditions. H. B. Naylor

302. Studies on heat resistance. I. Increasing resistance to heat of bacterial spores by selection. FRANKLIN L. DAVIS, JR., AND O. B. WILLIAMS, Univ. of Texas, Austin. J. Bact., **56,** 5: 555–559. Nov., 1948.

Using spores of *Bacillus globigii,* it is shown that there is a graded resistance to heat among the spores of a population. By selecting the survivors of heated spore suspensions, an increase in resistance was observed. D. P. Glick

303. Studies on heat resistance. II. Comparison of resistance to heat with resistance to disinfectants. FRANKLIN L. DAVIS, JR., ORVILLE WYSS AND O. B. WILLIAMS, Univ. of Texas, Austin. J. Bact., **56,** 5: 561–567. Nov., 1948.

When spores of a culture of *Bacillus globigii* and of a heat-resistant variant derived from the parent culture were plated in parallel in agar media containing various amounts of gentian violet, mercuric chloride or streptomycin, both strains were inhibited similarly by increasing concentrations of the bacteriostatic agents. However, the spores of the heat-resistant strain exhibited greater resistance to the killing action of iodine and of phenol. D. P. Glick

304. **Dye-reduction tests in the bacteriological examination of dried milk.** CONSTANCE HIGGINBOTTOM, Hannah Dairy Research Institute, Kirkhill, Ayr, Scotland. J. Dairy Research, **15,** 3: 280–284. May, 1948.

Results from both the methylene blue-reduction and the resazurin-reduction tests on reconstituted spray-dried milk showed very poor correlation with plate counts at either 37 or 30° C. and with keeping quality. E. L. Thomas

305. **Bacterial growth in reconstituted spray-dried milk.** CONSTANCE HIGGINBOTTOM, Hannah Dairy Research Institute, Kirkhill, Ayr, Scotland. J. Dairy Research, **15,** 3: 285–291. May, 1948.

Over 200 samples of spray-dried milks from 8 British plants were examined for total and spore counts, numbers of beta-haemolytic colonies, molds, yeasts and coliform bacteria. Results are reported for the freshly reconstituted products and also after aging the reconstituted milk for 24 hr. at 15.5° C. and at 22° C. Predominating organisms present in a random selection of samples are described. The relation of the flora of reconstituted milk to its food-poisoning potentialities is discussed briefly. E. L. Thomas

306. **Carbon assimilation tests for the classification of yeasts.** L. U. WICKERHAM AND K. A. BURTON, Northern Regional Research Laboratory, Peoria, Illinois. J. Bact., **56,** 3: 363–371. Sept., 1948.

This is an extension of the senior author's earlier work on fermentation tests and nitrogen assimilation tests. The basic medium is synthetic; it contains vitamins in pure form instead of yeast extract or other crude vitamin carriers. Seventy carbon compounds have been tested on 100 strains of yeasts, representing 22 genera, for preliminary classification of the compounds. These are presented in nine categories of usefulness. The advantages of assimilation tests are emphasized in comparison with the less satisfactory fermentation tests. D. P. Glick

307. **Physiological reasons for the dominance of *Penicillium roqueforti* in blue veined cheese.** N. S. GOLDING AND D. D. MILLER, State College of Washington, Pullman. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 122–129. 1948.

Cultures of *Penicillium roqueforti, Penicillium expansum* and *Oospora lactis,* cultured on malt agar at 55° F., were compared as to ability to grow in atmospheres of different CO_2 and O_2 content. It was found that *P. roqueforti* was not inhibited by CO_2 until a concentration of over 30% was reached. The other cultures were inhibited measurably at the 10% level. On the other hand, *P. roqueforti* was inhibited to a greater extent than the other cultures when the O_2 content was less than 4%. There was no growth of *P. roqueforti* at O_2 levels below 0.8%, whereas *P. expansum* showed growth at the 0.3% level and *O. lactis* grew at even lower concentrations.

Since the ranges of CO_2 and O_2 concentrations in blue veined cheese are 21.14 to 40.95% and 2.42 to 7.00%, respectively, it was concluded that the reason for the predominance of *P. roqueforti* in blue cheese is due to the high CO_2 content and not to the low O_2 content. H. B. Naylor

308. **The control of mold.** D. D. MILLER. Can. Dairy Ice Cream J., **27,** 9: 60–64. Sept., 1948.

A very low concentration of carbon dioxide may stimulate rather than inhibit mold growth, particularly at a storage temperature of 70–80° F. High concentrations inhibit mold growth especially at low storage temperatures. Probably the best method to inhibit mold growth by use of gas at cool temperatures is to reduce the O_2 present to a minimum and then to add a fairly high concentration of CO_2. In the vacuum canning of cheese, the small amount of O_2 in the can, the CO_2 formed by fermentation in ripening, the conversion of the O_2 in the can to CO_2 by aerobic growth of molds and other organisms all tend to prevent mold growth. The use of CO_2 in the inhibition of molds may be applied to the canning of cheese, and cheese and butter rooms properly built to allow the addition and retention of a given concentration of CO_2. H. Pyenson

309. Bacteriological changes during the fermentation of steamed potatoes for silage. J. L. ETCHELLS AND I. D. JONES. J. Agr. Research, **78,** 1 and 2: 19–31. Jan. 1 and 15, 1949.

Thermophilic, facultative anaerobes were the predominating microorganisms during the fermentation of hot-ensiled steamed potatoes (*Solanum tuberosum*) and were responsible for the developed acidity and resultant preservation of the silage. These bacteria are considered to be

non-gas-producing, acid-forming, spore-bearing rods, which are facultative with respect to oxygen and temperature requirements. These organisms may be classified, according to Bergey *et al.*, as thermophiles belonging in group X of the genus *Bacillus*. H. Pyenson

Also see abs. no. 288, 290, 372, 407.

DAIRY CHEMISTRY

H. H. SOMMER, SECTION EDITOR

310. Investigations on the composition of South African milk. IV. The influence of monthly variations in air temperature and rainfall on the composition of milk. S. BAKALOR, Agricultural Research Institute, Pretoria. Farming in S. Africa, **23,** 265: 271–282. April, 1948.

The relationship of air temperature and amount of rainfall to the fat and solids-not-fat content of milk was determined for various areas in South Africa. There was no correlation between mean fat content of milk and air temperature for the same month, but there was an increase in fat content as winter approached and a decrease in fat content as summer approached.

The amount of rainfall had no effect on fat content, but the amount of solids-not-fat increased with an increase in rainfall. There was no apparent relationship between air temperature and solids-not-fat content of milk. F. C. Fountaine

311. Investigations on the composition of South African milk. V. (a) The relationships between the various constituents of milk. S. BAKALOR, Agricultural Research Institute, Pretoria. Farming in S. Africa, **23,** 266: 345–354, 356. May, 1948.

Data were taken from analyses for fat, protein, ash, lactose, T. S. and solids-not-fat of 1,608 industrial samples of milk supplied by producers, plus T. S., S. N. F. and fat on 1,200 batches of whole milk. Annual averages of fat and S. N. F. of milk supplied to condenseries over a period of 15–16 yr. also were used. There was no definite relationship between S. N. F. and fat and ash and fat on individual samples, but a definite positive relationship existed between fat and S. N. F. when annual averages were used.

Increased fat % was accompanied by increased protein % and decreased lactose %. There was a variation in the S. N. F. content of groups of milk with fat % constant, the ash content being the most variable between fat-constant samples. There also was a seasonal change in the S. N. F. content of milk, independent of changes in fat content. S. N. F. and lactose were highest in summer; S. N. F. and protein were highest in late summer and autumn; S. N. F., protein and lactose were lowest in late winter and early spring. There was a positive relationship between protein and fat and a negative relationship between lactose and fat. F. C. Fountaine

312. Investigation on the composition of South African milk. V. (b) The ratios of the percentages of other constituents to the percentage fat in milk. S. BAKALOR, Agricultural Research Institute, Pretoria. Farming in S. Africa, **23,** 267: 415–422. June, 1948.

As the % fat increases, a definite narrowing of the ratio of S. N. F., ash, protein and lactose to fat occurs. In all but one area the ratio of S. N. F. to fat was widest in the spring and summer months. The importance of changes in ratios of milk constituents to the industry is discussed. F. C. Fountaine

313. Undersokelser over melkens aciditet. (Studies concerning milk acidity). English summary. H. DOVLE. Meieriposten, **37:** 415–419. 1948.

Daily milk samples were obtained from 80 cows. The mean pH was 6.65, with the range from 6.45–6.83, and 90% of the samples were in the range from 6.60–6.74. The mean titratable acidity was 7.10° SH, the range 5.50–8.15° SH, and 74.2% of the samples were in the interval 6.75–7.70° SH. Disease caused marked changes in pH and titratable acidity. Titratable acidity could not be calculated from pH and vice versa. O. M. Ystgaard

314. Observations on change of buffer indices of milk with changes of temperature. L. S. VODAK AND N. P. TARASSUK, Univ. of California, Davis. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 102–109. 1948.

Fresh milk samples were heated to temperatures ranging from 42.5 to 93° C. and held for 30 min. The samples then were cooled rapidly to 4.5° C. and stored at that temperature. Samples of the unheated milk cooled to the same temperature were used as controls. At zero time and after 2, 4, 8, 12 and 24 hr., electrometric titrations were made on aliquots of each sample. 0.1 *N* HCl was used to titrate to pH 4.0, and 0.1 *N* NaOH was used in titrating to pH 8.5. Titration curves were plotted and the buffer indices were computed for eight pH values.

The results showed that buffer indices increased at most pH values when unheated milk was cooled and help at 4.5° C. Heating decreased the buffer indices, the greatest decreases being observed at the highest temperature. However, the changes produced by heating were reversible, as shown by the fact that storage of the

heated samples at 4.5° C. for from 2 to 24 hr. resulted in buffer indices which were nearly identical with those of the control samples.

H. B. Naylor

315. Improved dairy indicator solution. L. R. Bryant. Can. Dairy Ice Cream J., **27,** 8: 31, 48. Aug., 1948.

Dairy indicator solution that has better keeping qualities than phenolphthalein in an alcoholic solution is made by dissolving 1 g. of dry phenolphthalein in 60 ml. of cellosolve (ethylene glycol mono-ethyl ether) or methyl cellosolve and then diluting with 40 ml. of water. This solution retains its proper concentration over a longer period of time than does an alcoholic solution of phenolphthalein. H. Pyenson

316. Ion exchange applications in milk products. H. E. Otting, M & R Dietetic Labs., Inc., Columbus, Ohio. Ind. Eng. Chem., **41,** 3: 457–459. Mar., 1949.

This paper is one of six which made up a symposium on the application of ion exchange in different industries. Calcium first was removed from milk in 1930 by placing it in contact with greensand. The resulting milk exhibited soft-curd properties. Years of research have resulted in the present process and the use of a hydrated synthetic sodium aluminum silicate. One ft.^{3} of this ion exchange material will treat 125 gal. of milk per cycle and it now can be used daily for more than a year with little replacement. The process, which dairy plant employees can be trained to carry out, follows: Wash the base-exchange material (upflow) with water at 100° F., to remove residual milk. Circulate (upflow) a wetting agent to remove fat, protein and phosphorus and rinse with water. Pass acidified and buffered sodium chloride (5%) downflow and follow with a water rinse. Circulate downflow a solution of sodium hydroxide and sodium aluminate and wash with water.

Soluble caseinates of improved keeping quality can be made by this process. Development of sandiness in ice cream mixes which contain as much as 15% milk solids-not-fat can be retarded if 3% or more of these solids are ion-exchange-treated solids. The heat stability of evaporated milk can be improved sufficiently to eliminate the need for stabilizing salts if 0.5–2% of the original milk is treated by the mineral-ion exchange process. B. H. Webb

317. Undersokelser over noen varianter av Kjeldahls metode til bastemmelse av protein i melk og melkeprodukter. (Investigations of some modifications of the Kjeldahl method for the determination of protein in milk and milk products.) H. Dovle. Meieriposten, 37: 473–477. 1948.

Heating almost to the boiling point and slow boiling, after raising the boiling point by addition of potassium sulfate (Gunning) were the heating conditions tested. Lower values always were obtained when the digestion was ended immediately after the liquid looked clear. Mountain milk caused trouble even when boiled as much as 1.5 hr. after the liquid looked clear.

Flasks containing 500 ml. were preferred because this size secured better acid condensation and the flasks could be used conveniently as distillation flasks; 750 ml. flasks also were found adequate. If steam distillation were used, 100–300 ml. flasks were adequate.

The recommended procedure for the determination of nitrogen in milk and milk products is as follows: (a) Add 5–8 ml. of milk/Kjeldahl flask; (b) add approx. 1 g. crystalline $CuSO_4$ (or 0.3–0.5 g. CuO); (c) add H_2SO_4 (3 × the milk volume if gas heating is used or 4 × the milk volume if electrical heating is used); (d) heat slowly until the water has evaporated, then raise the temperature to obtain slow boiling; (e) cool the flasks after 0.5 hr.; (f) add crystalline K_2SO_4 in the amount of 1/2–2/3 as many g. as the no. of ml. of H_2SO_4 added; (g) continue the heating process (slow boiling); (h) cool after approx. 2.5 hr. when the sample turns green; (i) add water. (Precipitation takes place at first, but enough water is added to dissolve the precipitate.) Distillation, etc., are carried out as usual. O. M. Ystgaard

318. Determination of the free amino-nitrogen of casein and of fresh and deteriorated milk protein by the Van Slyke method. C. H. Lea. Univ. of Cambridge, Cambridge, England. J. Dairy Research, **15,** 3: 364–368. May, 1948.

The reaction of casein, fresh milk protein and deteriorated milk protein with nitrous acid was followed at 20° C. for 4 hr. in the manometric apparatus of Van Slyke. Simplified procedures are suggested whereby the method can be utilized for investigation of the deterioration of the protein of skim milk powder during storage.

For the investigation of deteriorated spray-dried skim milk powder, the powder being brown in color and of very poor solubility, in the present study, it was first suspended in water, dialysed at 0° C. for 5 d. and freeze-dried. One hundred mg. of the product, which dissolved quite readily in the acetic acid in the reaction chamber, were used for each determination. Diphenyl ether proved inadequate as a defoaming agent but secondary octyl (capryl) alcohol proved satisfactory. Commercial samples of capryl alcohol were

found to vary greatly in purity. The use of one drop of a redistilled fraction boiling within 1° C. of the correct figure was used as standard procedure. For routine examination of deteriorated milk powders, a reaction time of 30 min. was adopted as a standard, the values (mg. free amino N/g. protein N) so obtained being corrected by the addition of 2 units. Since some samples of milk protein appear to reach the linear portion of the reaction/time curve appreciably earlier than others, an error of as much as ± 1 unit may be introduced by this approximation. E. L. Thomas

319. Separation of proteins from milk products. A. LEVITON. (Assigned to the people of the U. S.). U. S. Patent 2,460,891. 1 claim. Feb. 8, 1949. Official Gaz. U. S. Pat. Office, **619**, 2: 431. 1949.

Dried skim milk powder is separated into a protein fraction and a lactose fraction by precipitation of the former by mixing the powder with a 40–62% (by wt.) methanol-water soln. at −16° C. and filtering immediately. R. Whitaker

320. Reststickstoffgehalt in normaler Kuhmilch. (The residual nitrogen content in normal cow's milk). English summary. R. NESENI AND H. KÖRPRICH. Die Milchwissenschaft, **3**, 7: 186–189. July, 1948.

The milk of 11 healthy cows was examined for residual nitrogen content, using Almen's reagent, every 14 d. during the period between September 15, 1943, and July 21, 1944. The extreme range of values fluctuated from 13 to 40 mg. %, with the average being between 27 (± 4.55) and 32 (± 4.8) mg. %. Higher values were obtained at the beginning and end of the lactation period than during the in-between period. Green feed as well as some concentrates tended to increase the residual nitrogen values in milk, whereas dry feeds reduced it. Values above 40 mg. % can be regarded as abnormal and may be considered as symptoms of pathological conditions in the animal of a sub-clinical nature. I. Peters

321. Process to produce a stabilized protein-formaldehyde dispersion. L. L. MCKINNEY. (Assigned to the people of the U. S.). U. S. Patent, 2,461,070. 6 claims. Feb. 8, 1949. Official Gaz. U. S. Pat. Office, **619**, 2: 475. 1949.

Casein is allowed to react with an alkylene oxide in an alkaline medium before hardening with formaldehyde. R. Whitaker

322. The reaction between milk protein and reducing sugar in the "dry" state. C. H. LEA, University of Cambridge, Cambridge, England. J. Dairy Research, **15**, 3: 369–376. May, 1948.

Unheated, fresh milk was separated and dialysed at 0° C. in the presence of a little toluene against repeated changes of distilled water for a total period of 7 d. The solids content was determined and the requisite quantities of glucose, lactose, sucrose and mixtures of these sugars were added to portions of the fluid which then were freeze dried. After equilibration over sulfuric acid to the required moisture content, samples were stored at 37° C. and 55% relative humidity. At intervals samples were examined for free amino and total nitrogen, solubility of the protein and color.

The reducing sugars combined with free amino-groups of the protein, apparently in a 1:1 ratio. The reaction did not proceed to completion, probably owing to difficulty of access of the reactive groups to one another. Only when the sugar-amino reaction occurred did discoloration ensue. Glucose reacted more rapidly with the protein than did lactose, and the complex formed became discolored and insoluble in both cold and hot water much more rapidly. Sucrose and lactose both greatly delayed the onset of glucose-induced insolubility, lactose being the more efficient of the two. They did not prevent discoloration.

The protein alone became insoluble in cold but not in hot water after prolonged storage, but did not discolor. This change was prevented by sucrose. The behavior of lactose was inconsistent, loss of solubility being accelerated in one experiment and retarded in another. It is suggested that the effect of sugars on the development of insolubility in proteins includes (a) acceleration by reason of the reducing group-amino reaction and (b) retardation under the influence of relatively high concentrations of carbohydrate, particularly of disaccharide. Glucose behaves predominantly according to mechanism *a*, sucrose entirely according to mechanism *b* and lactose according to both. E. L. Thomas

323. The effect of varied concentrations of nonfat dry milk solids on the rate of whey protein denaturation by heat. G. J. KRUEGER, U. S. ASHWORTH AND H. A. BENDIXEN, State College of Washington, Pullman. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 82–89. 1948.

Using nonfat dry milk solids spray dried from separated milk which had not been given a preheat treatment, a study was made of the effect of temp. on the extent of whey protein denaturation in reconstituted samples varying in milk

solids concentration. Samples reconstituted at the rate of 1, 5, 10, 16, 20, 25 and 30 g. of powder per 100 ml. water were heated to temperatures of 70, 75, 77, 80 and 85° C. and held for 30 min. The undenatured whey protein was determined in each case by saturating the sample with NaCl, filtering off the precipitate and measuring the turbidity of an aliquot of the filtrate after acidification with HCl. At temperatures of 77° C. and below, the extent of whey protein denaturation decreased as the milk solids content was increased. However, at 80 and 85° C., samples containing low levels of milk solids showed abnormally low levels of denatured whey proteins; the authors indicate that this may have been due to the presence of acid-coagulable breakdown products of casein in the filtrates.

H. B. Naylor

324. Manufacture of artificial protein filaments. R. H. K. THOMPSON. (Assigned to Imperial Chemical Industries, Ltd.). U. S. Patent 2,460,372. 12 claims. Feb. 1, 1949. Official Gaz. U. S. Pat. Office, **619,** 1: 131. 1949.

A casein solution containing a vegetable globulin is spun as a filament into a formaldehyde bath, then dried at at least 80° C. under tension, followed by contact with boiling water while in the relaxed condition. R. Whitaker

325. The properties of New Zealand butters and butterfats. I. Iodine, Reichert and saponification values and softening points of monthly samples of butterfats from nine commercial factories over four years. G. A. COX AND F. H. MCDOWALL, Dairy Research Institute, Palmerston North, New Zealand. J. Dairy Research, **15,** 3: 377–386. May, 1948.

The trend of variation of any one property throughout the season was remarkably uniform, both for different factories in the one season and for any one property in the four seasons. Weighted monthly average iodine values, Reichert values, saponification values and softening points for the butterfat from all factories over 4 yr. were 36.7 (33.8–40.2), 30.4 (25.5–32.3), 229 (225.5–232.7) and 33.1 (32.2–33.7), respectively. The minimum iodine value occurred in midsummer, i.e., at the season of the year when maximum values are reported for northern hemisphere butters. The iodine values for South Island butterfats diverged markedly from those for the North Island butterfats during the winter, i.e., at the time when turnips are fed to cows in the South. In spite of the lower iodine values, the softening points of the South Island butterfats were lower throughout the year. An explanation of the latter observation must await a study of the detailed fatty acid composition of the butterfats at the different periods of the season. E. L. Thomas

326. Onderzoek naar de factoren die de samenstelling van het melk vet beinvloeden. (Investigation into the factors influencing the composition of milk fat.) English, French and German summaries. W. ADRIANI, A. F. TAMSMA, M. P. VOGEL AND J. GROOT. Laboratorium de Cooperatieve Fabriek van Melkproducten, Bedum, Holland. Vakgroep Boterindustrie. The Hague, Holland. 182 pp. + 24 graphs. 1945.

It has been found in practice in Holland that during the pasture period the composition of the milk fats often was such that even with the best manufacturing process the butter still remained too soft, and so the composition of the milk fat was primarily decisive for the consistency of summer butter. There was a large difference in this respect between different parts of Holland, making further study desirable.

As a criterion for the composition of the milk fat, the refractive index was chosen and ample proof given that it may be considered a good indicator.

In the first place, experiments were conducted with cows grazing in the same pasture and the following factors found to show correlation with the composition of the fat: age of the cow, fat production, fat percentage of the milk, ponderosity (live weight divided by 10 × fat production in 24 hr.), carotene content of the milk fat, stage of lactation, gestation, quantity of food, illness of the cow, nature of the food.

The influence of different factors was calculated by statistical methods, with their internal correlations and partial correlation, and regression coefficients. Thus the differences in refraction of the milk fat existing at a given moment between different cows in the same pasture, largely could be explained and also the course of the average refraction as the grazing period advanced.

The main factors for healthy cows receiving no extra food were age of the cow, fat percentage of the milk and ponderosity, while the carotene content of the milk fat was only an important factor in the beginning of the grazing period and the influence of the lactation stage was merely an indirect one.

In the second place, experiments were carried out with groups of cows of several farmers in the same area, all the cows being on pasture without extra fodder. Beyond the mentioned factors, from these experiments there appeared two other important factors, the soil and the degree of poorness of the pasture.

In the third place, experiments also were made with groups of cows in different provinces of the Netherlands, all the cows being on pasture with-

out extra fodder. It then appeared that apart from ponderosity of the cow and fat percentage of the milk, four other factors, all relating to the composition of the grass, were of importance, namely: percentage of crude protein, percentage of starch-like substances, calcium percentage and chlorine percentage. In all these cases the influence of different factors was calculated as in the first experiments, so that the differences in composition of the milk fat largely could be explained on a quantitative basis.

It thus appeared that the differences in refraction of the milk fat may be reduced to a number of factors. It has been shown clearly that it is wrong to look only to a single factor; one has to bear in mind all factors that have proved to be important, and the differences are to be ascribed to different factors at different times. Many suggestions for further investigations were given and a new method was worked out to determine the amount of fat in grass in a simple way. The figures now available on the percentage of fat in grass did not give the impression that this factor is as important as often was thought. A. F. Tamsma

327. Factors affecting the stability of milk fat and fat soluble vitamins. V. N. KRUKOVSKY. Can. Dairy Ice Cream J., **27,** 10: 90. Oct., 1948.

See J. Dairy Sci., 31: 961–972. 1948.

328. The Sanders-Sager test. ANONYMOUS, Milk Plant Monthly, **38,** 2: 36–38. Feb., 1948.

The Sanders-Sager test used for detecting under-pasteurization of dairy products is based on the fact that all raw milk contains an enzyme, phosphatase, that is destroyed by proper pasteurization. The test can be used on all dairy products, detecting the presence of 1 lb. of raw milk in 2,000 lb. of properly pasteurized milk. It is more sensitive in the case of raw cream, due to the increased concentration of the enzyme in the raw product.

This article outlines the complete procedure for conducting this test, including a pictorial reproduction of the prescribed procedure.

J. A. Meiser, Jr.

329. The Babcock fat test of reconstituted milk. G. M. TROUT, J. R. BRUNNER, AND P. S. LUCAS, Michigan State College, East Lansing. Milk Plant Monthly, **38,** 2: 52–59. Feb., 1949.

Due to the increased sale of dry milk for reconstituting purposes, a comparison of the results obtained when testing reconstituted milk for fat by the Babcock and Mojonnier methods was made. The whole milk powder was reconstituted in distilled water using a Waring food blender and then stored at 40° F. for 24 hr. prior to testing.

The results obtained by the Babcock test averaged 0.25% below those obtained by the Mojonnier method. The resulting fat columns frequently were dark and contained char bearing a remarkable resemblence to those columns obtained when testing homogenized milk by the Babcock method. J. A. Meiser, Jr.

330. Problems involved in ashing cottage cheese for calcium and phosphorus determination. H. B. CLEMONS AND E. A. WINKLER, Univ. of California, Davis. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 117–118. 1948.

Difficulty was encountered in ashing unsalted cottage cheese curd by the A. O. A. C. method. By adding 5 ml. of a 0.6% Ca acetate solution to 10 g. of curd, a satisfactory white ash was obtained. The authors point out that in addition to facilitating the ashing of the curd, added Ca acetate makes possible a more complete recovery of Ca and P from cottage cheese curd. By ashing a sample of Ca acetate solution, a blank value for added Ca was obtained. It was suggested that ashing at 600° C. instead of 500° C. might give better results on this type of curd.

H. B. Naylor

331. Viscositätsmessungen an hochprozentigem Rahm. (Viscosity measurements of high fat cream.) English summary. W. MOHR AND J. WELLM. Die Milchwissenschaft, **3,** 7: 181–185. July, 1948.

The viscosity of cream with 60% fat or more rises rapidly in the temperature range of from 40 to 60° C. A 40% cream at 50° C. had a viscosity of from 5 to 5.38 cp., whereas 80% cream at 50° C. had a viscosity of from 3320 to 6720 cp. Viscosity values for other fat percentages and at 40, 50 and 60° C. are given.

The rapid rise in viscosity in high fat cream is due to the structual properties of the cream. In a cream with over 74% fat by volume, the fat globules are deformed, even though they are packed with the minimum of voids. The deformation of fat globules in cream with over 70% fat is to be considered in the formation of butter since it represents a hitherto unknown intermediary step. I. Peters

332. First annual review of analytical chemistry. Food. B. L. OSER, Food Research Labs., Inc., Long Island City, N. Y. Anal. Chem., **21,** 2: 216–227. Feb., 1949.

The food section is one of 11 reviews of the applications of analytical developments to different

chemical industries. Food analysis is considered under the following headings: moisture, carbohydrates, proteins and amino acids, vitamins, inorganic elements, decomposition and contamination, disinfectants, preservatives and insecticides. There are 395 references almost entirely to publications of the last 8 yr. B. H. Webb

Also see abs. no. 280, 290.

DAIRY ENGINEERING

A. W. FARRALL, SECTION EDITOR

333. Centrifuge for the separation of serum from cheese constituents. G. J. Strezynski. (Assigned to DeLaval Separator Co.) U. S. Patent 2,461,129. 6 claims. Feb. 8, 1949. Official Gaz. U. S. Pat. Office, **619,** 2: 490. 1949.

Structural details are given of a separator bowl designed specifically for continuously removing whey from coagulated milk products as a step in the manufacture of soft unripened types of cheese. R. Whitaker

334. Method of producing butter by cooling cream of high concentration. H. O. Lindgren. (Assigned to Aktiebaloget Separator Corp., Sweden.) U. S. Patent 2,461,117. 3 claims. Feb. 8, 1949. Official Gaz. U. S. Pat. Office, **619,** 2: 487. 1949.

Cream containing 81 to 82% fat is obtained by passing 25 to 30% cream through a separator. Without coming in contact with air it passes to a mixer which incorporates salt, coloring materials and flavoring and then to a cooling device which effects a phase reversal, converting the cream into butter. R. Whitaker

335. Measurement of holding time of H. T. S. T. pasteurizers. Wm. Jordan and R. F. Holland. Can. Dairy Ice Cream J., **27,** 10: 76. Oct, 1948.

See abs. no. 232, p. A51.

336. Electronic pasteurization. David LeRoi. Milk Ind., **29,** 6: 56–58. Dec., 1948.

A system was evolved whereby the milk falls freely through a large tube placed between two electrodes. When the electrodes are joined to the alternating circuit, the temperature of the tube becomes intense, and the milk passing through it is raised to a temperature of 205° F. in 0.067 sec. Milk which had passed through the tube had no trace of a cooked flavor. The bacteria count was considerably less than the 1% obtained with ordinary pasteurization and the vitamin and other nutritional losses are no more than for normal pasteurization. The milk is cooled quickly by injecting it into a vacuum chamber. The initial temperature is reduced to 35° F. in 0.2 sec. The electronic pasteurization of milk is still in the laboratory stage. H. Pyenson

337. Homogenizer. A. M. Kinney and A. N. Jergens. U. S. Patent 2,452,661. 16 claims. Nov. 2, 1948. Official Gaz. U. S. Pat. Office, **616,** 1: 150. 1948.

The novel feature of this homogenizer is the homogenizing valve, which consists of 2 flat coil springs which are compressed and released alternately by a reciprocating rod. The product under pressure enters the center of one spring, flows through the spaces between the coils and then through a passage to the outside of the second spring, thence through the coils of the second spring to the interior from whence it is discharged. The reciprocating rod passes through the second spring and is attached to a cylinder between the two longitudinal aligned springs. The homogenizing action takes place as the product passes through the vibrating springs. R. Whitaker

338. Planning, construction and maintenance of modern dairy plants. B. A. Boucher. Can. Dairy Ice Cream J., **27,** 10: 37–38. Oct., 1948.

In planning new plants and the remodeling of older plants, a complete staff of engineers and architects specializing in creamery plant design can be of considerable assistance to the dairy industry. It is important to plan for future expansion and to arrange the plant equipment so that the product is processed in a continuous flow. The author recommends the installation of the lowered sawtooth roof over all processing areas to provide an abundance of natural light and to assist in the control of moisture. The walls should be of tile or smooth cement plaster. The floors should be constructed either of tile for long life or of concrete for shorter life. Acid-resisting compounds for joints and acid-resisting sealer should be used. The floor should be sloped and have adequate drains. Plant maintenance and sanitation should be borne in mind when planning the plant layout. H. Pyenson

339. Milk plant layout. H. L. Mitten, Jr., Ohio State Univ., Columbus. Milk Plant Monthly, **38,** 3: 73–74. Mar., 1949.

Factors to be considered in plant layout are: (a) location, (b) type of building, (c) size, (d) arrangement of rooms, (e) location of equipment and (f) building construction.

Certain rules essential to calculating size are as follows: (a) fluid milk plants require 1 to 2 ft.^{2} of floor space per gal. of milk handled daily; (b) refrigerated storage rooms require 1 ft.^{2} for

each 5.25 gal. of milk handled daily; (c) floor space for processing rooms should be determined by the formula $A = a/0.2$, where A = the floor area and a = area occupied by the processing equipment after a proposed operations expansion; (e) bottle-washing rooms should be sufficiently large to accommodate all necessary equipment and still provide bottle storage space equal to that of the refrigerated milk storage room; (f) dry storage space must be 25% of the total floor area; (g) equipment shall be separated by 2 to 3 ft.; (h) ceilings must be at least 12 ft. high. J. A. Meiser, Jr.

340. High efficiency plant. G. R. JOHNSON, Pace Associates, Chicago, Ill. Milk Dealer, **38,** 5: 38, 72. Feb., 1949.

An efficient, attractive plant combines economical operation with good appearance, both derived from treating processing requirements, architectural design and engineering as one complete problem. Amplified further it would include: (a) functional planning based on analysis of production to determine specific space and equipment needs, (b) building plant and form most ideally suited to exacting requirements of plant operation, equipment layout and site conditions, (c) construction materials selected for specific uses consistent with economy and ease of maintenance, (d) simplicity of design and structure, keeping initial and maintenance costs at a minimum and (e) appearance, which with simple forms dramatizes use and enchances advertising value. C. J. Babcock

341. Important improvements necessary for creameries. C. A. KERR. Can. Dairy Ice Cream J., **27,** 8: 50. Aug., 1948.

A few of the more important improvements necessary in creameries are: (a) temperature control, (b) can washing and steaming, (c) dry creameries in the winter months and (d) improvements in creamery surroundings.

H. Pyenson

342. Practical ammonia refrigeration for ice cream plants. CLYDE H. MINSTER, Greenbrier Dairy Products Co., Beckley, W. Va. Ice Cream Rev., **32,** 7: 94–102. Feb., 1949.

The operating cost of a refrigeration system in an ice cream plant is influenced primarily by the amount of power required to produce the necessary tons of refrigeration. To obtain maximum capacity from ammonia compressors with the lowest possible power cost, the following suggestions are made: (a) Operate the compressor at the highest possible suction pressure and still maintain the temperature desired. (b) Use an evaporator of such capacity that the temperature differential between the ammonia temperature and the temperature of the cooling medium will not exceed 5° F. (c) Use suction lines of such size that the velocity of the gas as it travels back to the compressor will not exceed 4,000 ft./min., thereby avoiding wide differences in suction pressure between the evaporator and compressor. (d) Avoid excessive head pressures which in turn will increase the power cost. (e) Use two-stage compression in ice cream plants where there is a variation in the temperatures which must be maintained. In this system, a booster compressor is connected to the low temperature evaporator and the discharge from the booster is in turn piped to an intermediate cooler for removal of super heat. The discharge from the cooler is pumped directly to the suction side of the second stage compressor. The booster compressor designed for low-pressure, high-speed operation can raise the pressure of the ammonia gas from 0 to 35 lb. with a minimum of power. The second stage compressor operating at 35 lb. suction pressure will in turn have its capacity increased tremendously accompanied by a marked reduction in the power cost per ton of refrigeration produced. W. J. Caulfield

343. The bugs in refrigeration and how to cure them. LEROY WILLIAMSON. Can. Dairy Ice Cream J., 27, 11: 78–82. Nov., 1948.

The article discusses the refrigeration system, which includes the evaporating part (low side), the compressor, the condenser-receiver and the refrigeration supply. Other subjects taken up are suction line, frost line, power element of valve, float valves, blowers, coils, brine cooling, ammonia leakage and excessive oil usage. H. Pyenson

344. Mechanical can washing. C. B. Shogren, Klenzade Products, Inc., Beloit, Wis. Milk Plant Monthly, **38,** 3: 76–77. Mar., 1949.

Rules that should be observed in operating a straightline can washer are: (a) keep washer free of lime and milkstone encrustations; (b) keep washer in proper mechanical condition; (c) provide at least 30 to 40 lb. of water pressure in the pre-rinse section; (d) recharge the washer with the proper concentration of washing compound daily; (e) maintain overflow between 0.5 and 1 pt./can; (f) insure that sterile rinse pipes and jets are clean and free of lime deposits.

J. A. Meiser, Jr.

345. A study of milk can washing. P. H. TRACY. Can. Dairy Ice Cream J., **27,** 9: 86–88, 94. Sept., 1948.

The physical condition of the milk can is not particularly significant bacteriologically except when open seams are present. Washing solutions hot enough (160° F.) to kill the bacteria are important factors in successful can washing. Washing compounds that can withstand high temperatures must be used. Even in a dry can there is apparently enough moisture to support bacterial growth. Washed cans should be kept uncovered and in a dry atmosphere during storage.

H. Pyenson

346. Packaged automatic boilers. WILLIAM PALM. Can. Dairy Ice Cream J., **27,** 8: 52–54, 78. Aug., 1948.

By the use of oil or gas fuels it has become possible to arrange for full automatic control of the steam boiler plant. The packaged steam boiler generator was built as one complete unit with boiler, burner and automatic controls all fully assembled, insulated, jacketed, wired, adjusted and tested at the factory. The package boiler is built to operate independently of stack draft. A package type boiler will start cold and be at full operating pressure in 30 min. H. Pyenson

DAIRY PLANT MANAGEMENT AND ECONOMICS

L. C. THOMSEN, SECTION EDITOR

347. Efficiency in plant operation. E. J. FERGUSON. Can. Dairy Ice Cream J., **27,** 9: 74–76. Sept., 1948.

Efficiency in dairy plant operation suggests: (a) careful selection of plant personnel, (b) a program of job instruction and training, (c) systematizing of plant maintenance work, (d) a well-planned and -scheduled quality control program, (e) a thoroughly scheduled and detailed program of plant clean-up work, (f) proper scheduling of all work in plant operations, (g) careful standardization of product and (h) elimination of wasteful practices. H. Pyenson

348. Price and profit. FRED MERISH. Milk Plant Monthly, **38,** 2: 66–68. Feb., 1949.

Transition from a sellers' to a buyers' market may result in materially lowering a plant's margin on sales. To prevent operating at a loss, plant managers must increase sales and up volume or rely on decreases in the cost of goods sold to counterbalance the price drop.

J. A. Meiser, Jr.

349. Potentialities in efficiency in cheese factory operation. D. M. IRVINE. Can. Dairy Ice Cream J., **27,** 9: 78–84. Sept., 1948.

Increased efficiency in cheese factory operation is needed. The commercially profitable manufacture of whey might justify the paying for milk on a total solids basis. If the cheese makers are to obtain an adequate supply of the best quality milk, they must expect to meet competitive prices. Labor constitutes an important item of processing costs, consequently the output per individual must be greater. The more arduous features of the cheesemaking operations must be reduced or eliminated. More cheese was produced per man 40 yr. ago than today. Efficiency can be increased by good roads, improved hauling equipment and mechanized vehicles. In this way the manufacture of cheese can be concentrated in fewer plants. The by-product whey can be utilized better in larger plants. The equipment that will help to increase efficiency is the high temperature short time pasteurizer for cheese-making. Cheese presses are fairly unsanitary and lack temperature control. Standardization of packaging will help to increase efficiency in cheese factory operation. H. Pyenson

350. Labor's responsibility in the future development of the dairy industry. AUGUST BURNIER, Dairy Employees Union, Chicago, Ill. Milk Dealer, **38,** 4: 44, 86–87. Jan., 1949.

The importatnce of the different groups to the dairy industry from the employer's standpoint is given as follows: (1) The customer—without consumers, no jobs for anyone; (2) the stockholder—no invested capital, no business; (3) the farmer, production of milk before labor; (4) the employees of the dairy industry. The author agrees that the consumer is of first importance but believes that labor should have priority over the other groups. The following program then is set forth from the labor standpoint: (1) Wages increased in line with current living costs; (2) establishment of sound retirement or pension plans; (3) separation pay to cushion the shock of unexpected lay-off; (4) the working out, on a mutually cooperative basis, of some means of preventing speed-ups and increases in the work load which are harmful to the health of the worker and which reduce the wage-earning span of his life. C. J. Babcock

351. Bonus plan spurs routemen's sales efforts. ROSS YOUNG. Milk Plant Monthly, **38,** 2: 76–77. Feb., 1949.

To foster sales to old customers as well as new, the following plan was adopted: Using the previous month's sales records for the base period, routemen received $1.00 for increased sales totalling up to 5 points, $1.25 for 6 to 10 points and $1.75 for all points over 11.

In an effort to insure routemen returning every

possible bottle, a weekly bonus of $5.00 was given to the man who returned the most bottles in relation to those he delivered. This plan accounted for a 30% increase in bottle returns.
J. A. Meiser, Jr.

352. Annual bonus system builds sales all year. Ross YOUNG. Milk Plant Monthly, **38,** 2: 54–55. Feb., 1949.

An incentive sales plan whereby routemen received $1.50 for every quart over a minimum of 400 qt. increase for the year and 50 cents per qt. for sales over 800 qt. has done much to promote increased sales. This bonus is supplemented by three cash awards of $1,500, $1,000 and $500 for the top three men at the end of the year.

Educational displays showing negligence such as worn-out gears, tires and engines that were damaged beyond repair by improper care were very effective in improving driving habits of the routemen. J. A. Meiser, Jr.

353. Training milk salesmen. ROSS SIDEY. Can. Dairy Ice Cream J., **28,** 1: 30, 74. Jan., 1949.

The basis of sales training policy should be to impress on the men that conditions prevailing during the war no longer exist. Good dependable service as the customer wants it should be given. The average customer wants: (a) regular and punctual service, (b) accuracy and honesty, (c) a pleasant route salesman with a clean and good appearance, (d) a salesman who knows something about the products he sells and (e) an intelligent answer to questions. H. Pyenson

354. Adding 600 new customers in four months. Ross YOUNG. Milk Plant Monthly, **38,** 3: 80–81. Mar., 1949.

For increases of 8 to 15, 24 to 31 and over 32 new customers per month, milk routemen receive a bonus of 50 cents, $1.50 and $2.00, respectively. At the end of a 2-mo. period an additional bonus of 25 cents, 75 cents and $1.00 is paid for all new customers totaling up to 16, 32 and 48. Also, prizes of $15, $10 and $5 are awarded to the three highest-scoring routemen at the end of the first 2-mo. period. J. A. Meiser, Jr.

355. Retail milk delivery—three days per week. J. M. LAWRENCE. Can. Dairy Ice Cream J., **28,** 1: 60, 64. Jan., 1949.

The advantages of 3-day over E.O.D. delivery are a 6-d. plant operation, no relief men are required for the odd day and the housewife gets her milk on the same days of the week. The 3-d.-a-week delivery also improves plant operation by eliminating overproduction, reduces routes by about one-third, increases employee benefits and increases milk consumption. The disadvantages of 3-d.-a-week delivery are that the consumer has difficulty carrying enough milk over the 3-d. weekend and split accounts are made by the consumer getting milk from two dairies to have delivery 6 d. a week. H. Pyenson

356. Is your return on investment adequate? A. C. KIECHLIN, Public Accountant. Ice Cream Rev., **32,** 7: 44–50. Feb., 1949.

Too much attention has been focused on profit on sales and not enough on the return on invested capital by the ice cream industry. The ultimate yardstick of the profitableness of any business enterprise is the return on invested capital, whereas profit on sales is of secondary consideration.

When return on invested capital is low or falls below the return that could be obtained through outside investments it is an indication that something is wrong with the management of the business. Over-capitalization, over-expansion, high credit losses or failure to promote sales effectively are frequent causes of low return on invested capital.

Management should make systematic and periodic checks to determine whether the return on invested capital is adequate. The return on invested capital should be maintained at well above the return that could be obtained on safe outside investments, otherwise there is no point in operating the business. Return on net worth of a business is the most important factor determining the market value of the business and constitutes the true measure of the success of the management. W. J. Caulfield

357. The truth about profits. L. SPENCER, Cornell Univ., Ithaca, N. Y. Am. Milk Rev., **11,** 2: 2–4, 6, 42–44. Feb., 1949.

A study of six milk companies in the New York-New Jersey metropolitan area during the 7 yr. 1941–1947 revealed the following distribution of costs and profits: 57.6% for product, 20.9% for selling and delivery expense, 13.4% for receiving, processing and freight, 4.1% for bottles and supplies and 1.7% for other expenses, leaving 1.0% for profits. The spread between sales and product cost was accounted for as follows: 53.5% for salaries and wages, excluding officers' salaries, 10.3% for bottles and containers, 10.0% for property expense, 9.1% for freight and hauling, 7.0% for other supplies and services, 3.1% for payroll taxes, etc., 2.5% for milk handling charges, 1.0% for officers' salaries and 3.5% for other expenses. During the 7 years notable changes occurred. Dollar sales increased 70%, cost of product increased 88% and expenses of operation increased

45%. Wage rates increased 31 to 75%, with employees in country plants receiving largest increases.

Large companies failed to return a normal rate on investment even in so-called prosperous years. Possible reasons listed were increased store distribution and decreased home delivery, greater difficulty in dealing with labor and political criticism of larger companies. A decrease in spread is possible only if labor efficiency is improved or distribution services are reduced further.

D. J. Hankinson

358. Cost of production in establishing milk prices. C. W. PIERCE. Can. Dairy Ice Cream J., 27, 8: 41–47. Aug., 1948.

Cost of production varies widely among individual farmers. The unsolvable problem arises whether to use the average cost, the cost for the most efficient producers, or a cost which would apply to all but the most inefficient producers. In computing cost per hundred weight it is impossible to determine exactly the cost of the several items that do not represent cash expenditures. It is relatively easy to measure changes in main item production costs from one period to another. Changes in costs, rather than any estimated cost/100 lb. of milk, should be used as one of the guides to the proper level of milk prices. The most inefficient producers should be eliminated from the computation of cost of production.

H. Pyenson

359. Production cost problems in the manufacture of ice cream. H. W. SCHUELKE, Central Dairy Prod. Co., Oklahoma City. Southern Dairy Products J., **45,** 1: 33, 42, 43, 46, 47. Jan., 1949.

Since the war the cost of ice cream has increased tremendously and with the resulting advance in prices to the consumer there has come a decrease in volume. The future of the business under these conditions depends more than ever upon the skill of the accountant and the operating manager. All indirect labor costs must be justified by profitable results. The work of all departments must be coordinated so that the product may be delivered to the customer at a profit and at a price at which he will continue to buy in a satisfactory volume. O'Neal Johnson of the International Association of Ice Cream Manufacturers is introducing an efficient cost system for the purpose.

Chief attention should be given to obselete and inadequate accounting systems, inefficient personnel, excessive distribution systems and unbalanced inventories. Elimination of the practice of supplying the customers with equipment and subsidies would allow a decrease in the price of ice cream to the consumer. Either a reduction in costs or an increase in volume is essential to future success. The companies that have well-trained men who are alert financially and capable of adjusting to the future will be successful.

F. W. Bennett

360. A producers' incentive plan. MELVIN MAXWELL, Idlewild Dairy, Scottsbluff, Nebr. Milk Plant Monthly, **38,** 2: 60–61. Feb., 1949.

This plan establishes a bonus year starting December 17 and ending 52 wk. later. Utilizing a base period covering the last 13 wk. of the bonus year, base amounts for each producer are determined by averaging his three lowest weeks of production during the base period. Each producer then is paid a bonus of 50 cents per hundred at the end of the year, in addition to his weekly check, for all milk he produces up to his base amount.

J. A. Meiser, Jr.

361. Your advertising problems. Part IV. W. FRANK WELCH, Pres., The AD-VER-TIS-ER, Inc., Fort Wayne, Ind. Southern Dairy Products J., **45,** 2: 66, 67, 74, 75. Feb., 1949.

Outdoor posters are essentially a prestige medium and have a distinctly different function from that of newspaper and radio advertising. The latter are more flexible as to timeliness and and designed to get more immediate sales reaction. Direct mail advertising is highly specialized and may be too expensive except for a brief and specific campaign. It is regarded generally as a supplement to the routine advertising program. Selecting the proper advertising medium requires the matching of the purpose against the advantages of the different advertising media. A combination of several media usually is more effective than only one, provided the budget is adequate for a reasonably full use of more than one medium. If funds are not available for an effective combination of media, the money should be directed into one channel.

The advice of salesmen of the respective kinds of advertising should be helpful. Employment of a reliable agent or agency which is thoroughly acquainted with advertising methods may be advantageous if the budget warrants such an expenditure.

F. W. Bennett

362. The consumer and dairy product prices. BLAKE A. CAMPBELL. Can. Dairy Ice Cream J., **27,** 12: 58–62. Dec., 1948.

Prices in the United States advanced faster in 1946 and the first part of 1947 than they did in Canada. During the past year wholesale prices and the cost of living have increased more in Canada than they have in the U. S. Since 1939, personal incomes, adjusted for changes in the cost of living index, have increased 72% in

Canada as compared with 58% in the U. S. A study of retail prices in 20 food commodities in Canada and the U. S. for July, 1948, showed that in most cases prices in the U. S. were higher than in Canada. If Canada had to pay U. S. prices for dairy products, it would cost the average family $45 a year more for dairy products.
H. Pyenson

363. Press relations and publicity for your dairy. DAN VALENTINE. Milk Plant Monthly, **38,** 3: 47–48, 50. Mar., 1949.

Press releases must be newsworthy, localized, concise, non-commercial and timely. When written on a printed press release form, they create a sound publicity program for the dairy plant. J. A. Meiser, Jr.

FEEDS AND FEEDING

W. A. KING, SECTION EDITOR

364. Preparation and storage of carotene concentrates. H. L. MITCHELL, W. G. SCHRENK, AND H. H. KING, Kansas Agr. Expt. Sta., Manhattan. Ind. Eng. Chem., **41,** 3: 570–572. Mar., 1949.

Carotene concentrates are of interest because of the continued shortage and high cost of fish oils. Solid carotene concentrates would be easy to incorporate in rations of farm animals. The effectiveness of several finely ground solids as carriers of carotene were investigated. The less highly refined carriers resulted in more stable concentrates. The loss of carotene after 5 mo. storage at 25° C. with different carriers was: soybean and cottonseed meal, 68 and 60%, respectively; casein, ground sorghum grain and sorghum bran, 72–81%; glucose and sorghum starch, 100%. The antioxidant action of cottonseed meal was increased appreciably by the addition of 2% lactic acid. B. H. Webb

365. Forage crop management for higher yields. Part III. C. M. HARRISON, Michigan State College, East Lansing. Hoard's Dairyman, **93,** 2: 859. Nov., 1948.

The conclusions drawn from this study were: (a) forage mixtures vary as to productiveness in terms of hay or grazing with livestock; (b) mixtures containing alfalfa are more productive than straight grass or red clover grass mixtures and, likewise, they are superior as green manure when measured in terms of added corn following in the rotation; (c) pasturing any mixture will result in a greater green manure benefit than removing the forage as hay or hay and pasture; (d) pasturing apparently results in the removal of less mineral nutrients from the soil, making it easier to reestablish a good forage field with less fertilizer than is the case where the forage is removed from the field. J. B. Frye, Jr.

366. Pasture control. With special reference to the border area. J. H. PRELLER, College of Agriculture, Potchefstroom. Farming in S. Africa, **23,** 264: 191–199. March, 1948.

The effects of fertilizer and systems of management on yield of South African pastures are described. F. C. Fountaine

367. Estimation of digestibility of grazed pasture from feces nitrogen. R. J. LANCASTER. Nature, **163,** 4139: 330. 1949.

Based on pastures located in England, United States, South Africa and New Zealand, data are presented to show that the nutritive value of the herbage can be calculated from the nitrogen content of the feces of sheep grazed on the pasture.
R. Whitaker

368. Grazing without fields. DAVID LEROI. Milk Ind., **29,** 2: 48–49. Aug., 1948.

Hydroponics, or the growing of field crops in liquid culture media without soil, now has passed the experimental stage and a technic has been perfected to yield crops which compare more than favorably with normal soil agriculture. It is possible to raise healthy crops without soil. Specially constructed cabinets have been developed for the raising of cattle pasture. By this method, in 11 d. the first sowing has attained a growth of 10 in. An 80-tray cabinet yields 200 lb. of grass daily. H. Pyenson

Also see abs. no. 309.

GENETICS AND BREEDING

N. L. VAN DEMARK, SECTION EDITOR

369. The inheritance of red, roan and white coat colour in dairy shorthorn cattle. I. C. JONES, Univ. of Liverpool. J. Genetics, **48:** 155–163. 1947.

Old theories and exceptions are reviewed and 856 records from a carefully-kept private herd are tabulated by type of matings. The two-gene explanation of Ibsen (1933) is substantiated with respect to homozygous dominant red and incompletely dominant white. The unusually low number of exceptions, i. e., 11, is considered to be due to the great care of the herdsman. Only one case of error in diagnosing the color was found in later checking the exceptions with the animal or a photograph. To explain the exceptions that it was possible to check, it was suggested that one of the three animals in each case, i.e., calf, sire or dam, that were phenotypically

red were genotypically roan but so extreme in the series that they could not be distinguished. The various grades of roaning are implied to be due possibly to differences in internal temperatures during prenatal growth. Further explanation of these exceptions was considered unsafe.

L. O. Gilmore

370. The Bucks County quintuplets. ROBERT COOK. J. Heredity, **39:** 347–348. 1948.

A report is made on a set of quintuplet heifer calves born in Pennsylvania. On the basis of color marking the set is assumed to be composed of one pair of monozygotic twins and one set of monozygotic triplets, hence resulting from two fertilized eggs.

After referring to the literature on the frequency of occurrence of multiple births of different orders, the frequency for the occurrence of quintuplets is estimated at not less than one in 3–5 million births. L. O. Gilmore

371. The role of major genes in the evolution of economic characters. R. L. KNIGHT, Empire Cotton Growing Corp. and Sudan Govt. J. Genetics, **48:** 370–387. 1948.

It is considered that preadaption (cf., response to existing selection pressure) is common in economic characters. Such characters involving major differences typically will be found to be controlled by one or a few major genes. Different plants are listed for which economic characters are controlled wholly or in part by major genes. For breeding purposes, attempts should be made to reduce complex characters to the action of the individual genes responsible to expedite analysis. L. O. Gilmore

372. Corynebacterium pyogenes in bull semen. J. R. HANCOCK AND W. R. KELLEY. Vet. Record, **60,** 51: 669–670. Feb., 1949.

All samples of bull semen received in the authors' laboratory from December, 1945, to March, 1947, were routinely examined for the presence of *C. pyogenes.* Semen samples were submitted for examination because of breeding difficulties in the herds in which the bulls were maintained, and were collected by the artificial vagina method with precautions to prevent contamination. A total of 170 semen samples from 70 bulls in 40 different herds was studied and *C. pyogenes* was isolated from 25 bulls in 16 of the herds studied. The organism could not be recovered from sheath swabs in known carrier bulls, which indicates it is in the genital tract above the sheath. No difference was detectable between positive and negative bulls as regards semen examination, and in 3 herds with both positive and negative bulls, no difference was noted in the conception rate. However, herds in which positive bulls were used had a high incidence of genital infection in females, and cultural examinations of vaginal discharges showed *C. pyogenes* present in most cases. The authors suggest that bulls known to produce semen with this organism in it be withheld from service.

R. P. Niedermeier

Also see abs. no. 274.

HERD MANAGEMENT

H. A. HERMAN, SECTION EDITOR

373. Painless dehorning. F. S. BARLOW. Hoard's Dairyman, **94,** 3: 105. Feb. 10, 1949.

A local anesthetic (not named) is injected halfway between the eyes and the horns 20 min. before dehorning. The head is disinfected at the base of one horn and drawn to one side by a nose lead for the dehorning operation. Practically no pain is experienced by this method. This method is being used by Dr. Harold E. Amstutz, College of Veterinary Medicine, Ohio State Univ. J. B. Frye, Jr.

374. Suspension hanger. F. W. STANKE AND L. F. BENDER. (Assigned to Universal Milking Machine Co.). U. S. Patent 2,460,856. 4 claims. Feb. 8, 1949. Official Gaz. U. S. Pat. Office, **619,** 2: 422. 1949.

A band, passing over the cow's back, supports the milk receiver of a milking machine in such a manner that it is permitted to swing beneath the cow's stomach. The swinging movement of the milk receiver, caused by the pulsations of the flexible milk tubes attached to the teat cups, imparts a tugging action alternately to different portions of the teats. R. Whitaker

375. Reinforce farm manure. C. J. CHAPMAN, Univ. of Wisconsin, Madison. Hoard's Dairyman, **94,** 2: 205. Jan., 1949.

Spreading of superphosphate in loose run barns, sheds or box stalls at intervals of every 4 or 5 d. or weekly at the rate of 1 lb./animal/d. is recommended. Reinforcing animal manures with superphosphate not only increases the value and the effectiveness of the manure by actually bringing up the phosphate content but also helps to prevent losses of valuable nitrogen which may get away in the form of volatile ammonia.

J. B. Frye, Jr.

ICE CREAM

C. D. DAHLE, SECTION EDITOR

376. Ice cream stabilizers. P. H. TRACY. Can. Dairy Ice Cream J., **27,** 10: 34–36. Oct., 1948.

A number of satisfactory ice cream stabilizers have been developed within recent years for use under various conditions. The more important ones are gelatin, dariloid, Irish moss, locust bean, sodium carboxymethyl cellulose (C. M. C.), ground psyllium seed husks, karaya gum, oat gum, pectin, quince seed and mechanical mixtures of two or more of the above products together with corn sugar as a carrier. Whipping aids or emulsifiers in conjunction with regular ice cream stabilizers help whipping and air incorporation and give the ice cream a drier appearance.

H. Pyenson

377. Nature and properties of some new ice cream emulsifiers. J. S. GOULD AND N. P. TARASSUK, Univ. of California, Davis. Proc. 29th Ann. Meeting, Western Div., Am. Dairy Sci. Assoc. Pp. 119–121. 1948.

Using the emulsifier "Tween 60" and the stabilizer "SherVel," it was found that 0.10% of emulsifier was optimum in mixes frozen in batch freezers, but that 0.15 to 0.20% was required to obtain improved body and texture when a continuous freezer was used. The emulsifier had no effect on the susceptibility of ice cream to heat shock. It tended to slow the melt-down and in some instances caused a curdy appearing melt-down. A given emulsifier may not give identical results with all stabilizers. H. B. Naylor

378. Consumers preference tests for imitation and pure flavors in ice cream. P. S. LUCAS. Can. Dairy Ice Cream J., **27,** 11: 92–94. Nov., 1948.

See abs. no. 119, p. A26.

379. An analysis of concentrated citrus oils. DAVID E. LAKRITZ, Florasynth Laboratories, Inc. Ice Cream Field, **53,** 2: 32. Feb., 1949.

The author classifies concentrated citrus oils as follows: (a) "Concentrated" citrus oils—oils from which a portion of the terpenes has been removed. (b) Terpeneless citrus oils—oils from which the major portion of terpenes has been removed. (c) Sesquiterpeneless citrus oils—oils from which the major portions of both terpenes and sesquiterpenes have been removed.

It is pointed out that most essential oils are composed of (a) mixtures of hydrocarbons, principally terpenes, sesquiterpenes and polyterpenes, (b) oxygenated compounds including acids, alcohols, esters, lactones, aldehydes, ketones, phenols and ethers and (c) non-volatile material consisting chiefly of waxes and resins.

The author briefly describes the four principal methods of concentrating citrus oils, namely, (a) vacuum distillation, (b) steam distillation, (c) alcohol distillation and (d) extraction.

The removal of terpenes (unsaturated hydrocarbons) increases the stability of the remaining oil. It is claimed that such oils are especially useful for flavoring gelatin dessert and are recommended for use in ices and sherbets.

Although the oxygenated components of citrus oils comprise the major portion of their flavoring, terpenes contribute towards flavor and sesquiterpenes and waxes have some fixative action. It is, therefore, recommended that where stability and solubility of oils are not too important that less concentrated and even unconcentrated oils be used. W. C. Cole

380. Flavoring materials used in ice cream. CARL KOERVER, Pioneer Ice Cream Company (The Borden Co.), Brooklyn, N. Y. Am. Milk Rev., **11,** 1: 36–40, 48. Jan., 1949; Can. Dairy Ice Cream J., **27,** 10: 78–88. Oct., 1948.

See abs. no. 39, p. A7.

381. Diced cream. ANONYMOUS. Ice Cream Rev., **32,** 7: 39, 87. Feb., 1949.

See abs. no. 254, p. A54.

382. Sealtest presents — ice cream eclairs. ANONYMOUS. Ice Cream Trade J., **45,** 2: 46. Feb., 1949.

The eclair is an oblong-shaped bar about 5 in. long, consisting of a layer of cake, a layer of fudge and a layer of ice cream, covered with a chocolate coating and 4 dabs of whipped cream. Special equipment makes automatic mass production possible. Dealers pay 45 cents for 4 bars which retail for 60 cents, providing a gross margin of 25% of the selling price.

W. H. Martin

383. The trend in ice cream packages. C. H. SCHAFFER. Can. Dairy Ice Cream J., **27,** 8: 65–66, 70. Aug., 1948.

Package ice cream should not be looked upon as inevitably replacing bulk, but rather for its value in adding to the total sales. One ice cream item should not be pushed to the exclusion of others. Ice cream should be sold in packages most acceptable to the public; package attractively, price properly and let the public be the judge of what they wish to buy. H. Pyenson

383a. Bulk ice cream container. H B. TILLERY. U. S. Patents 2,459,727 and 2,459,728. 2 claims. Jan. 18, 1949. Official Gaz. U. S. Pat. Office, **618,** 3: 942. 1949.

Details are given regarding the construction of a carton for ice cream which may be shipped flat, readily assembled to provide a box having a piston-like bottom that can be pressed out to

eject the contents. The assembled carton is so constructed that air may circulate freely beneath the bottom. R. Whitaker

384. 1948 gallonage. ANONYMOUS. Ice Cream Trade J., **45,** 2: 44. Feb., 1949.

Ice cream production in the United States declined 10% in 1948. U.S.D.A. Bureau of Agricultural Economics estimates indicate a production of 568,735,000 gal., which is still 13% more than the 1942–1946 av. and 88% ahead of the av. for 1939, 1940 and 1941. Leading states were Pa., N. Y., Calif., Ill. and Ohio. After experiencing monthly drops in production since March, the production trend turned up in November and December. W. H. Martin

385. Your ice cream cabinet—its relation to your sales and profits. A. C. DOAK, Frigidaire Div., General Motors Corp. Southern Dairy Products J., **45,** 2: 26, 28, 41. Feb., 1949.

The location of the cabinet is important in increasing sales. Usually the most effective location is in line of store traffic, near the cash register or used as a dividing counter. Location near bakery goods, the use of attractive advertising and the display of a full line of flavors also are suggested. A neat, orderly arrangement of packages plainly marked to facilitate rapid and courteous service increases the rate of turn-over. An extremely clean cabinet, inside and out, will stimulate buying. Frequent refinishing or polishing is recommended.

High operational and service costs can reduce profits greatly. The use of manufacturer's instructions is helpful in this respect. Frost should be removed when it equals the thickness of a pencil. Allow ample room around the compressor for air circulation. Avoid battering the cabinet. Lubricate regularly as needed. Inspection by a service man every 3 mo. is economical. In case of failure of the compressor to function, examine it for easily-corrected causes of trouble but call the service man when corrective measures are not understood. F. W. Bennett

386. Things to consider when manufacturing ice cream of excellent quality. G. H. WILSTER. Can. Dairy Ice Cream J., **27,** 9: 38–42. Sept., 1948.

Requirements for the manufacture of ice cream of excellent quality include (a) a sanitary plant, (b) dairy products low in bacterial content, (c) fruit, flavors, sweeteners, stabilizer, egg and colors of fine quality, (d) modern, clean, well-kept equipment, (e) correct mix standardization, mixing homogenization and freezing, (f) efficient hardening and (g) maintenance of fresh stocks of ice cream. H. Pyenson

387. The pursuit of quality in the manufacture of ice cream. C. W. ENGLAND, High's Dairy Products Co., Washington, D. C., and Baltimore, Md. Southern Dairy Products J., **45,** 2: 102–104, 106, 110–113. Feb., 1949.

Some of the essentials for quality are good raw materials, clean and sterile equipment, proper balance of ingredients, equipment in good operating condition, careful processing, quick hardening and uniformly low storage temperatures. An educational program for the employees who supervise or do the actual work will promote quality. Demonstrations especially increase the understanding of the employees.

Plant sampling of the materials and products during the manufacture may eliminate many defective lots. The sampling also should extend to the retail cabinets of the dealers, including comparisons with competitive brands during which identifications of the samples are removed. A complete laboratory analysis of each sample often reveals some valuable facts.

Uniformity as well as level of quality is important. This involves the proper standards and uniformity in titratable acidity, kinds and amount of stabilizer, complete solution of the stabilizer, kind and amount of sugar, the grade of flavoring, dumping and use of returns, control of viscosity, exact weighing of ingredients, checking and standardizing the finished mix, maximum pasteurization temperature with cooked flavor, homogenization which produces small unclumped fat globules and mix free from curdling, fast freezing, overrun control, prompt hardening, proper cleaning and sterilizing procedure for equipment, good housekeeping and careful handling until the ice cream reaches the consumer. F. W. Bennett

Also see abs. no. 292, 316, 342, 356, 359, 389, 411.

MILK AND CREAM

P. H. TRACY, SECTION EDITOR

388. Flavors in milk. J. A. NEWLANDER, Univ. of Vermont and State Agricultural College, Burlington. Milk Plant Monthly, **38,** 3: 42, 44–45. Mar., 1949.

The five common off-flavors described are feed, oxidized, high acid, rancid and cooked. Causes and prevention of these defects are discussed. J. A. Meiser, Jr.

389. Low temperature storage of dairy products. W. S. ARBUCKLE, North Carolina State College, Raleigh. Quick Frozen Foods, **11,** 7: 92–93. Feb., 1949.

Answers to questions concerning proper freezer storage temperatures for milk and milk products arising in connection with home freezer storage

cabinets and frozen foods locker plants are given. Dairy products must be protected against flavor deterioration and impairment of body and texture. Retail packages of butter and ice cream should be wrapped with protective materials such as pliofilm or aluminum foil of freezing weight. Butter so protected will keep well for long periods at 0° F. Ice cream likewise may be kept 6 weeks or longer. Holding ice cream at constant temperature is essential to avoid detrimental effects on body and texture. Cream containing 40% butterfat will hold satisfactorily for 3.5 mo. If 10% sugar is added before freezing, there will be less tendency to oil off when the cream is thawed. Whipped cream has not been frozen successfully. Milk, either whole or skim, concentrated or unconcentrated, requires a lower temperature (-15° F.) for storage than home freezer cabinets or lockers maintain. While cottage cheese can be frozen, the result is not satisfactory. L. M. Dorsey

390. An efficient electric milk pasteurizer for home use. A. V. MOORE, Texas Agr. Expt. Sta., College Station. Am. Milk Rev., **11,** 1: 54–55. Jan., 1949.

Tests for bacteria, phosphatase activity, coliform bacteria, flavor and cream volume were made on milk pasteurized in the "Safgard" home pasteurizer. Tests made on five trials indicated satisfactory reduction in bacteria numbers and complete freedom from coliform bacteria. Phosphatase tests were negative in all trials. Heated flavor was not reported in any of the pasteurized samples. Cream volume apparently was not affected adversely, since data show increases in cream volume following pasteurization in some trials and decreases in other trials. D. J. Hankinson

391. Fat-free vitamin-fortified milk. K. G. WECKEL, Univ. of Wisconsin, Madison. Milk Dealer, **38,** 4: 47–48, 80–84. Jan., 1949.

The following reasons are given that fat-free milk should be processed for retail sales: (1) Many consumers believe they cannot afford to pay prevailing prices for bottled whole milk; (2) there is a probability that fat-free milk at a lower price may be sold when whole milk cannot; (3) many people are not consuming any whole milk or are consuming it in quantities far less than desirable; (4) many people are evidently conscious of the very good nutritional value of fat-free milk.

The following groups especially would be interested in this product: (1) individuals who are overweight, (2) individuals in whom fat digestion is carried out poorly or incompletely because of enzyme deficiency, (3) individuals in the upper age group when it is necessary to consume less of the rich foods that tax digestion facilities and (4) individuals on restricted diets because of health conditions.

The article is summarized as follows: "There is a market for fat-free milk. This market is above and beyond that now being ministered by the dairy industry. The product is easily processed, and on the basis of experience, is quite acceptable to consumers. The nutritional quality can be enhanced to equal that of milk, excluding its butterfat, by the simple expedient of adding vitamins A and D. The vitamin-fortified milk has been approved by the American Medical Milk Commission and is being introduced in a significant number of dairies throughout the country." C. J. Babcock

392. Promoting non-fat fortified milk. ANONYMOUS. Milk Dealer, **38,** 5: 42, 78. Feb., 1949.

The Supplee-Wills-Jones Milk Co. of Philadelphia, Pa., has ben marketing Sealtest Fortified Fat-free Milk since August and they are pleased with the reaction to the product on the part of the medical profession and consumers. Indications are that it has not been replacing sales of whole milk, as about 95% of the sales seem to be additional sales. The product contains less than 0.1% butterfat. It is pasteurized at 185° F. and fortified with 2,000 units of vitamin A and 400 units of vitamin D. The product is marketed at 4 cents under regular market milk, or 1 cent above the previous price for regular skim milk, and reaction to the price has been excellent.

Abbotts Dairies in Philadelphia introduced a non-fat soft curd milk with added vitamins A and D last July. Each quart contains 2,000 units of vitamin A and 400 units of vitamin D. They have applied for patent protection on the soft-curd feature, as their process is new in the field of skim milk. The product is marketed at 1 cent a quart less than standard or so-called "B" milk and 5 cents a quart less than homogenized "A" milk.

A fat-free fortified certified milk is being distributed in a midwestetrn city. It sells at the same price as regular pasteurized milk. This distributor believes that it would be a mistake to sell fat-free milk at a considerably lower price than regular milk. This belief is based on the fact that in those markets where buttermilk is sold cheap, it is kicked all over the map.

Each of the above distributors has promoted the sale of fat-free milk with the backing of the medical profession. C. J. Babcock

393. Uniform inspection of milk supply. L. T. TOMPKINS. Can. Dairy Ice Cream J., **27,** 8: 68–70. Aug., 1948.

The score card used by the Mass. Milk Regulation Board is divided into five parts: (a) "A"

or *excellent* classification, (b) "B" or *good* classification, (c) "C" or *fair* classification; (d) "D" or *poor* classification and (e) "F" or *unsatisfactory* classification. The card is graduated to five classifications for each of the headings to be classified. Such a score card requires a lot of experience, close coordination and careful study of each unit scored. H. Pyenson

394. Studies on the bacteriological flora and keeping quality of pasteurized liquid cream. E. L. CROSSLEY, April and Barrett Ltd., Yeovil, Somerset. J. Dairy Research, **15,** 3: 261–276. May, 1948.

The special conditions of the cream trade in Britain are discussed. Bacteriological control of cream processing was studied over a period of 10 yr. at a large country depot engaged in cream distribution on a nation-wide basis. Sources of bacterial contamination and means of reducing infection to a minimum are discussed in detail.

A 24-hr. grading test as a means of forecasting the probable keeping quality of pasteurized cream was evolved. The test consisted essentially of inoculating 10 ml. of sterilized milk containing 0.01% bromcresol purple with 1 ml. of cream, incubating the tubes at 30 ± 1° C. and examining them after 16–17 hr. and again at 24–25 hr. to grade 4 in which case either definite acid or acid and clot were observable after 16 hr. and both acid and clot after 24 hr.

Data from 2558 samples of heat-treated cream are presented to show the relationship between the grading test, coliform test, colony count and keeping quality. A decline from grade 1 to grade 4 was accompanied by a pronounced reduction in the mean keeping quality, amounting to a difference of roughly 10 hr. between each grade. In general, there was a greater correlation between keeping quality and the coliform test than with mean colony counts at 37° C.

E. L. Thomas

395. How to produce and deliver high-quality cream. E. M. BARKER, Rochester Dairy Cooperative. Am. Milk Rev., **11,** 2: 21, 22, 24, 62. Feb., 1949.

Cream of uniform high quality may be produced if (a) milk is graded closely at the intake for flavor and odor, (b) effective sediment-control is maintained, (c) bacteria counts are made of producers' milk with arrangements for follow-up of unsatisfactory milk, (d) clean cans are returned to the farmer, (e) milk is cooled to 40° F. when received if it is to be stored before separating (f) air incorporation is minimized, (g) copper-free equipment is used, (h) equipment is cleaned and sterilized properly, (i) proper pumps are used, (j) equipment of sanitary design is used, (k) clean, sterile cans are used for storage and shipment and (l) cars are scheduled and iced properly. D. J. Hankinson

396. Fat variations in milk. Part one—Farm factors. J. A. GOULD AND R. E. STOUT, Univ. of Maryland, College Park. Milk Plant Monthly, **38,** 2: 32–35, 44–45. Feb., 1949.

Despite continued efforts to provide harmonious producer-plant relationships, misunderstanding as to the cause of fat variations in milk frequently arises. Basically the causes of fat variations may be divided into: (a) farm factors and (b) dairy plant factors.

The daily weights and corresponding fat tests of milk received at dairy plants do vary because of (a) breed and individual variations, (b) stage of lactation, (c) season of the year and temperature, (d) interval between milking, (e) exercise, (f) herd management and (g) such miscellaneous factors as disease, age of cow and oestrum period.

The comparison of D. H. I. A. tests with plant tests also has accounted for much misunderstanding. However, it must be remembered that there are numerous reasons why the D. H. I. A. tests do not agree with plant tests: (a) plant tests usually are composite tests or periodic spot tests whereas the D. H. I. A. tests cover only a 1-day period (b) usually the manner of milking is changed considerably the day the D. H. I. A. tests are conducted and (c) all the milk tested on the farm actually may not reach the plant due to home usage, spillage, feeding, etc.

J. A. Meiser, Jr.

397. Fat variations in milk. Part two. Dairy plant factors. I. A. GOULD AND R. E. STOUT, Univ. of Maryland, College Park. Milk Plant Monthly, **38,** 3: 36–41. Mar., 1949.

Those dairy plant procedures influencing fat variations in milk are: (a) dumping the milk, (b) weigh tank sampling, (c) care and preparation of samples and (d) testing. Proper design and agitation have done much to eliminate errors due to weightank sampling. Where fresh samples serve as a basis of payment, at least five samples should be taken per month, including at least one Sunday or holiday sample. Time-composite samples must be taken proportionately using the proper concentration of an approved germicidal agent, placed in closed containers and stored in a dark room at 45° F. for a period of time not exceeding 2 wk. Testing must be done according to the recommended procedures for the Babcock test.

J. A. Meiser, Jr.

Also see abs. no. 273, 310, 311, 312, 313, 314, 328, 329, 336, 337, 339, 340, 344, 345, 348, 351, 352, 353, 354, 355, 357, 358, 360, 403.

MILK SECRETION

V. R. SMITH, SECTION EDITOR

398. Acetate as a possible precursor of ruminant milk fat, particularly the short chain fatty acids. S. J. FOLLEY AND T. H. FRENCH. Nature, **163,** 4135: 174. 1949.

In vitro experiments with mammary gland slices indicate that the short fatty acids (C_4–C_{14}) found in the milk of ruminants are synthesized from acetate, rather than formed from carbohydrates, as in the case with non-ruminant animals. Considerable quantities of acetate are formed in the rumen and absorbed into the blood.

R. Whitaker

NUTRITIVE VALUE OF DAIRY PRODUCTS

R. JENNESS, SECTION EDITOR

399. Consideration in the utilization of solids not fat in dairy industry. H. H. SOMMER. Can. Dairy Ice Cream J., **27,** 9: 42–45. Sept., 1948.

The skim milk solids must be valued more so that the milk fat may be valued less and still leave the price of milk at a level that will stimulate production. The dairy industry cannot compete with other food fats if the milk fat has to carry the major part of the cost of producing milk. With all the outlets for skim milk and condensed and dried skim milk products, approximately 20 billion lb. of skim milk had no market in 1946. A market for skim milk must be found for human food uses without resorting to filled products like filled milk, filled cream, filled ice cream and filled cheese and oleomargarine. We should encourage the greater use of cottage cheese, and skim milk powder and the production of high-testing milk as there are less solids not fat in high-testing milk.

H. Pyenson

400. Dairy foods and the adequate diet. H. A. RUEHE, Univ. of Illinois, Urbana. Milk Plant Monthly, **38,** 2: 36–37. Feb., 1949.

A discussion of the nutritional importance of carbohydrates, fats and proteins in the human diet is presented. Listing vital nutritional information on the various dairy products, he points out the need for consumer education; this would create a better market for dairy products and also foster nutritional welfare work among the consuming public. J. A. Meiser, Jr.

401. Nutrition research in the dairy industry. ETHEL AUSTIN MARTIN. Can. Dairy Ice Cream J., **27,** 8: 33–37, 72. Aug., 1948.

Dairy industry research studies must be planned to yield new constructive nutrition data which furnish a steady stream of fresh, pertinent facts about dairy products and nutrition information of the type needed to correct and clarify misinformation about dairy products. Approximately 50 industry-supported nutrition research studies now are underway or recently completed in 25 universities and colleges. The projects concerning the individual nutrients in dairy products consist of studies on the fats, proteins, minerals, lactose and the vitamins, riboflavin and niacin. Projects dealing with dairy products as whole foods include infant feeding, milk in breads, milk in dental caries prevention, ice cream in the diet, therapeutic diets and dairy products that supplement the diet of children to improve their nutritional well-being.

Nutrition research, to be effective, must be well-supported, well-planned, purposeful, in line with other nutrition research which is conducted and also keyed to the needs of the industry.

H. Pyenson

402. Dietary needs of special age groups. HELEN OLDHAM, Univ. of Chicago, Chicago, Ill. Milk Dealer, **38,** 5: 45–46, 118–122. Feb., 1949.

Following a discussion of minimal and optimal requirements as well as recommended dietary allowances, the dietary needs of individuals over 50 are discussed. Available data show that individuals in this age group consume from 300 to 500 less calories per d. than the average young adult. However, there is evidence that the protein and Ca requirements of the individual over 50 are at least as great and possibly exceed those of the average young adult. The data are not in full agreement as to the vitamin requirement but indicate that an intake of approx. 2,000 mg. ascorbic acid, 20 to 90 mg. thiamine and 475 mg. niacin per d. is beneficial. Reasons elderly people fail to get adequate amounts of nutrients are discussed; the use of non-fat dry milk solids and fluid skim milk is suggested as at least a partial remedy. C. J. Babcock

403. Interpreting assay reports on your vitamin D milk. BARBARA L. CARSON. Ohio Agr. Expt. Station, Wooster, O. Milk Dealer, **38,** 5: 41, 114–116. Feb., 1949.

The commonly-used "line test", involving the measurement of the width of the healed area in the bones of the front legs of rachitic rats when such rats have been fed vitamin D, is described in simple terms and its application to assay of vitamin D milk discussed. C. J. Babcock

404. Ice cream—a nutritious food. A. C. DAHLBERG, Cornell Univ., Ithaca, N. Y. Ice Cream Rev., **32,** 7: 34, 76–82. Feb., 1949.

See abs. no. 256, J. Dairy Sci., **31,** 7: A99. 1948.

405. The effect of autoclaving with dextrose on the nutritive value of casein. E. E. McINROY, H. K. MURER AND R. THIESSEN, JR., General Foods Corp., Hoboken, N. J. Arch. Biochem., **20,** 2: 256–260. Feb., 1949 .

When crude casein was mixed with 0.5 g. of water and 1 g. anhydrous dextrose for every g. of protein and autoclaved 2 hr. at 250° F., its growth-promoting qualities were destroyed for weanling albino rats. This treatment produced a rubbery, dark brown material containing no detectable free amino groups. A similar treatment of casein in the absence of dextrose only slightly impaired its nutritional properties. When the moist mixture of casein and dextrose was air-dried at room temperature, no apparent effect on the growth-promoting qualities of the casein was observed; the biological value of this mixture was comparable to that of the untreated casein control. H. J. Peppler

406. Amino acid and unsaturated fatty acid requirements of Clostridium sporogenes. G. M. SHULL, R. W. THOMA AND W. H. PETERSON. Univ. of Wisconsin, Madison. Arch. Biochem., **20,** 2: 227–241. Feb., 1949.

Vaccenic acid was found to be as active as oleic acid in replacing biotin for *Clostridium sporogenes* (ATC 10,000) grown in a chemically-defined medium. A synthetic preparation of *trans*-vaccenic acid produced only 0.25 of the growth stimulation exhibited by synthetic *cis*-vaccenic acid. Natural vaccenic acid is considered to be of the *trans*-type. H. J. Peppler

407. Microorganisms in the cecal contents of rats fed various carbohydrates and fats. H. NATH, V. R. BARKI, W. B. SARLES AND C. A. ELVEHJEM, Univ. of Wisconsin, Madison. J. Bact., **56,** 6: 783–793. Dec., 1948.

Observations were made on the cecal flora of rats fed sucrose, lactose or dextrin, and butterfat or corn oil. In all cases lactic organisms dominated. Lactose induced much higher plate counts than did sucrose or dextrin. Lactose-fed animals also had greater total cecal contents. Lactose tends to maintain a high coliform population as well as large numbers of aciduric bacteria. Dextrin also stimulates coliforms. Counts of all types of organisms were low in the ceca of animals fed sucrose.

No significant differences in numbers of different kinds of bacteria per g. of cecal contents were observed whether butterfat or corn oil was fed. However, butterfat-fed rats had heavier cecal contents and, therefore, greater total numbers of cecal microorganisms. Coliform organisms are decreased by increasing fat in the diet but lactic organisms are affected little. The ratio of aerobic to anaerobic plate counts was highest on the dextrin diet, lowest with lactose.

D. P. Glick

Also see abs. no. 290.

PHYSIOLOGY AND ENDOCRINOLOGY

R. P. REECE, SECTION EDITOR

408. Reactions to hot atmospheres of Jersey cows in milk. R. F. RIEK AND D. H. K. LEE, University of Queensland, Brisbane, Australia. J. Dairy Research, **15,** 3: 219–226. May, 1948.

Four grade Jersey cows were subjected to various combinations of dry-bulb temperatures from 85 to 110° F. and of absolute humidity from 6 to grains of moisture per ft.^{3} The animals were admitted twice a wk. for 10 wk. to the air conditioned room in which the desired temperatures and humidity had been produced. They remained in the room for 7 hr. or until the rectal temp. reached 107° F. Animals were tied so as to permit them to lie down or stand at will. Water at atmospheric temp. was offered on all occasions 3.5 hr. after admission.

Rectal temp. rose to higher values with less ready establishment of equilibrium the hotter the condition, but exceeded 107° F. only in the hottest atmosphere studied (110° F., absolute humidity 16 gr./ft.^{3}). Respiratory rate was affected similarly. In both cases, humidity had a marked effect as well as temp., an increment of 0.4 gr./ft.^{3} (approx. 4%) in humidity having the same effect as 1° F. rise in air temp. The highest av. respiratory rate was 200/min. Pulse rate was essentially unaffected by rise in temp. but tended to rise somewhat with humidity. Evaporative loss was increased markedly by temperature, but much less so by humidity. Neither milk nor butterfat production was essentially affected by the exposures. Blood calcium and phosphate levels fell but the erythrocyte count was unchanged. Behavior changes included some licking, panting, salivation, mild agitation, cessation of rumination and refusal of water. E. L. Thomas

409. Reactions of Jersey calves to hot atmospheres. R. F. RIEK AND D. H. K. LEE, Univ. of Queensland, Brisbane, Australia. J. Dairy Research, **15,** 3: 227–232. May, 1948.

Four grade Jersey calves, 8 wk. old, three female and one male, the progeny of cows used in

a similar investigation (abs. no. 408) were subjected to the same combinations of dry-bulb temperature and humidity as the cows. The calves were fed twice a d. with about 0.75 gal. milk each. When the animals were not in the room, lucerne chaff and a concentrate mixture of bran, pollard and maize meal were allowed *ad lib.*

Rectal temperatures rose rapidly to a higher level than was shown by cows under similar conditions but maintained a steady equilibrium thereafter, except under the most severe conditions. Respiratory rate responses resembled those of rectal temperature, the differences from those of cows being even more striking. Humidity had relatively less effect upon the rectal temperature and respiratory rate responses of calves than of cows. Pulse rate and tidal respiratory volumes were relatively unaffected, but minute respiratory volumes rose. Evaporative loss per unit body weight resembled that of cows (markedly increased by temp.) but humidity had less effect on the calves. Behavior changes resembled those of cows but weakness of the hind limbs was observed at rectal temp. about 106° F. Blood calcium, phosphate, sugar and erythrocyte levels were not essentially affected.

Possible explanations for the lower thermal tolerance of calves, as compared with cows, are considered. These include a suggested lower efficiency of sweat glands and a smaller thermal conductance through the superficial tissues in calves. E. L. Thomas

SANITATION AND CLEANSING

K. G. WECKEL, SECTION EDITOR

410. Quaternaries vs. chlorine in bacteria control. E. M. Foster, Univ. of Wisconsin, Madison. J. Milk Food Technol., **12,** 1: 13–18. Jan.–Feb., 1949.

The use of quaternaries in the dairy industry has been advocated because these compounds have advantages over chlorine. The author has suggested a few of these characteristics, such as prolonged bacteriostatic action. The presence of organic matter does not interfere seriously with their action as compared to chlorine, and produces less irritation than chlorine when used as a rinse solution for udders before milking. However, quaternaries are more expensive than chlorine and usually act more slowly. They are less effective germicides in the absence of organic matter and other unfavorable conditions such as hardness of water, pH and temperature, which further restrict their effectiveness.

H. H. Weiser

411. Sanitation in manufacturing and retailing ice cream. A. E. Berry. Can. Dairy Ice Cream *J.*, **27,** 8: 27–30, 48. Aug., 1948.

Sanitation must include cleanliness and safety against disease. The author speaks primarily about those conditions which prevail in the Province of Ontario. The article discusses the following points: (a) origin of contamination; (b) personnel and handling; (c) utensils; (d) sterilization; (e) methods of sterilization; (f) recent regulations; (g) medical examination of personnel; (h) containers; (i) scoops; (j) cones; (k) a sanitary code for the ice cream industry.

H. Pyenson

412. Detergency. J. C. L. Resuggan. Milk Ind., **29,** 6: 44–48. Dec., 1948 and **29,** 7: 39–43. Jan., 1949.

These articles deal with a discussion of detergents, their nature and use, substances found in them and their importance to the dairymen.

H. Pyenson

413. Quaternary ammonium compounds for creamery churns. A. G. Leggatt. Can. Dairy Ice Cream J., **27,** 12: 32–35, 74. Dec., 1948.

The remarkable affinity of wood for this type of sterilizer makes it difficult to recommend strengths of solution to use for satisfactory sanitization. There appears to be a danger of conditioning the microflora of a churn until it becomes preponderantly gram-negative in character and many organisms of this type have been shown to be associated with flavor defects in butter. The effect of continued absorption should be investigated from the standpoint of stickiness and contamination of the cream by the leaching of the compound. Apparently the generally accepted methods used for evaluating the germicidal efficiencies of disinfectants should not be used for these compounds. H. Pyenson

414. Control of rodents and insects in dairy plants. E. M. Searls. Can. Dairy Ice Cream J., **27,** 10: 72–73. Oct., 1948.

Rat and mouse trapping should be done systematically. The old style clap-traps have been found most successful to date. Ten rat traps and ten mouse traps are enough for the average-sized plant. Bait the traps with something the rats like but can't get; peanut butter, bacon rind, cheese, smoked fish, raw meat, raw fish, vegetables, bananas and other fruits are all good baits. All traps should be baited and set out the same evening. Rodent-proof barriers must be placed in all the openings.

D.D.T. in the proper form seems to answer all the requirements for a good insecticide. A

5% D.D.T. in odorless kerosene has been found the most satisfactory form for use in a dairy plant as a residual spray. H. Pyenson

MISCELLANEOUS

415. Undercoating protects truck bodies. TED KNIGHT. Milk Plant Monthly, **38,** 2: 74–75. Feb., 1949.

Coating the undercarriage and body interiors of delivery trucks increases the life of the unit by preventing corrosion due to the salt air and lactic acid, and insulates the unit against summer heat. The thickness of the coat applied ranges from 0.125 to 0.1875 in. For added motor protection and quick-starting during cold weather, application of a 0.125 in. coating to valve covers, valve push rod covers and oil pans has been most effective. J. A. Meiser, Jr.

416. Food poisoning. K. R. STEVENS. Can. Dairy Ice Cream J., **27,** 8: 102–104. Aug., 1948.

Characteristic symptoms of the various kinds of food poisoning, causes of the poisoning and how they may be prevented are summarized. The food poisonings mentioned are ptomaines, *Salmonella,* staphylococcal, botulism and chemical food poisoning caused by arsenic, lead, cadmium, fluoride, methyl chloride and tin.

H. Pyenson

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