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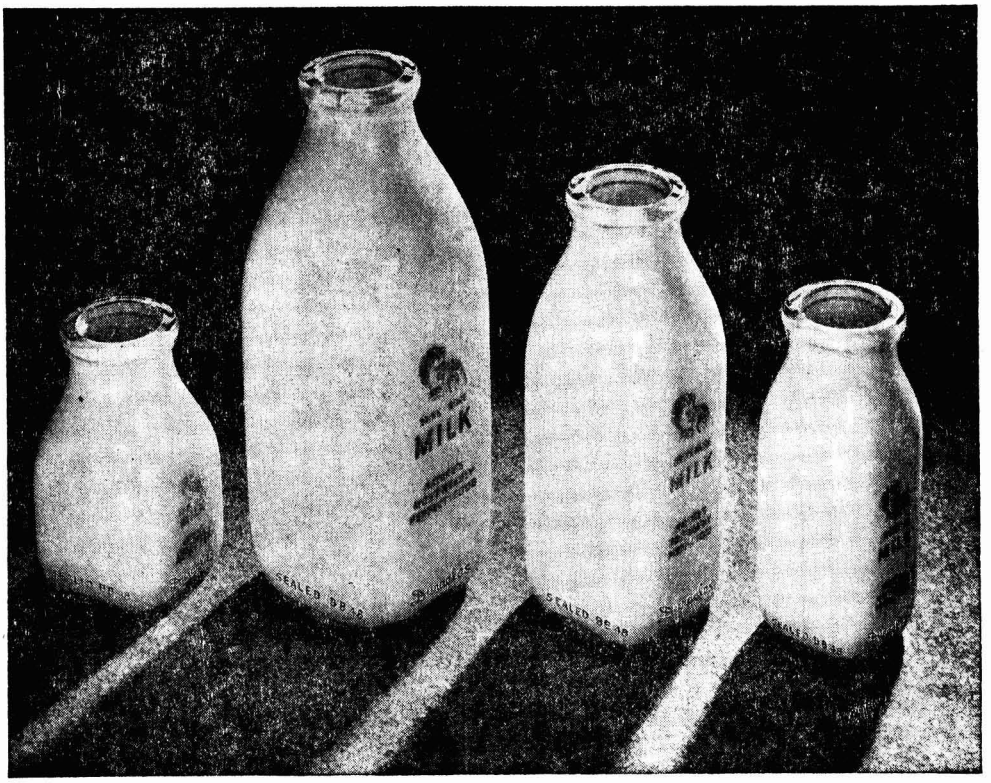

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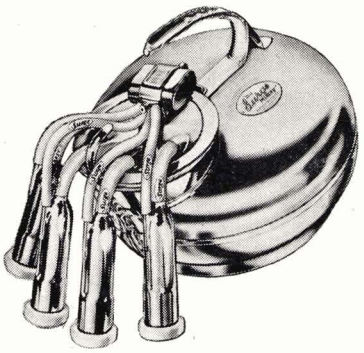

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THE ACID DEGREE, FREE VOLATILE FATTY ACIDS, AND THE FLAVOR SCORE OF SALTED COMMERCIAL BUTTERS[1]

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It is well known that butter deteriorates during long storage as a result of oxidative or hydrolytic processes with a subsequent formation of various chemical substances. The extent of the deterioration is governed by such factors as the past history of the butter and the conditions of storage. A number of chemical changes occur in butter as a result of storage. An interesting example of these changes is found in the work of Browne (2) who noted that a sample of butter exposed to the air at room temperature for a period of about 25 years markedly increased in the content of free acids and total volatile acids and decreased in the unsaturated insoluble acid content.

Various attempts have been made to use the acid degree and the free volatile acidity of butterfat as a means of following the quality change in butter. Ferris, Redfield, and North (3) found that after keeping sweet cream butter in cold storage 5 to 6 months there was a lowering in the score of one point, while the free volatile fatty acid value was about doubled. After 6 to 7 months the butter was removed from cold storage and kept at 15° C. for 2 weeks, causing a drop in score but no increase in volatile acids. Bendixen (1), working with the acid number of fresh butter before and after storage, noted that an increase in the acid ratio (fat acidity : butter acidity) during a week at 21° C. and during 1 month at 0 to 5° C. seemed to be closely related to poor keeping quality, especially in the case of sweet cream butter. In an extensive study dealing with butter, Fouts (4) reported that most samples of unsalted butter increased in acid number of the fat during holding for 6 days at 21° C.

The relationship, however, between the acid degree, free volatile acidity, and the quality of commercial butters covering the normal flavor score has never been clearly established. Fouts (4), using butter obtained for the most part from a student scoring contest and generally scoring 90 or over,

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[1] The authors are indebted to Mrs. Lois Phelps and Mrs. Shirley Weiss for making some of the analyses.

could find little or no correlation between the acid degree and score of salted commercial butter. On the other hand, Knaysi and Guthrie (11) developed a colorimetric method for determining quality of commercial butter based on the principle that an indirect relationship existed between quality of commercial butters and concentration of free fatty acids. Guthrie (8) later stated that values obtained on a large number of butters by this method and by the method involving titration of the fatty acids correlated closely with each other, and both agreed with the flavor scores in the great majority of cases.

The possible existence of a relationship between free volatile fatty acids and the quality of commercial butter apparently requires further investigation. An attempt by Fouts (6) to study the relationship between degree of rancidity and volatile fatty acidity was limited to 14 samples of unsalted butter, all of which were rancid to some degree. It was concluded that no correlation existed between degree of rancidity and volatile fatty acid concentration.

It would appear that if a relationship exists between fat acidity and quality of experimental butter kept in storage, as indicated by Bendixen (1), a similar relationship, possibly modified to some degree, might be shown to exist with commercial market butter.

Most of the market butter today is made from pasteurized cream. As the pasteurization process inactivates lipolytic enzymes of milk and cream, there is much less chance that hydrolytic rancidity will occur. However, poor quality butters, even if manufactured from pasteurized cream, may have a high free fatty acid content as a result of certain factors. The cream prior to pasteurization may have developed some rancidity. Although some of the volatile fatty acid contributing to this rancidity would be washed out of the butter, Ferris, Redfield, and North (3) have shown that more remained in the butter from cream of high volatile acidity than in butter from cream showing low volatile acidity. In a similar way, Jack, Tarassuk, and Scaramalla (10) have obtained data which show that as the acid degree increased the flavor score of butter made from rancid cream decreased. Certain microorganisms can hydrolyze butter-fat. If the cream is improperly pasteurized or if recontamination after pasteurization occurs, these organisms may be present and eventually increase the free fatty acid content of the butter. Finally, the production of free fatty acids through oxidative rancidity should be considered.

As there was on hand a new method considered sensitive enough to determine the free volatile fatty acid content of butter over the normal marketable flavor score, a study was undertaken to investigate the possible relationship between free volatile fatty acid concentration and flavor score of salted commercial butters. At the same time, determinations of acid degree and Knaysi-Guthrie number (11) were conducted on the same butters to see to

what degree these constants were interrelated with each other and with flavor scores of salted commercial butter.

EXPERIMENTAL METHODS

Butter samples for this study were obtained in 1-lb. lots, either directly from grocery stores throughout the central New York State area or from various plants manufacturing butter throughout the state. At first the plan was to obtain all samples of butter from different groceries, but due to extreme shortages less than half of the samples could be obtained in this manner. The buttermaking concerns were instructed to send a variety of grades of marketable butter which was held by them in storage. A total of 69 samples of salted butter was obtained.

As the samples of butter were received they were placed in a cold storage room until ready to be tested, which was usually 2 or 3 days later. To prepare the butters for analytical testing, each sample had its outer layer (0.25 inch thick) removed and then some of the interior portion was melted to a liquid state in a water bath having a maximum temperature of 50° C. The melted butter was next centrifuged for a few minutes and the oil layer drawn off by means of a suction pump into a clean flask. The serum also was saved for analyses.

Analytical methods used in this work included the following:

Acid degree. The total fat acidity was determined by the recently published method of Herrington and Krukovsky (9). In this method 5 g. of butter oil were placed in a small flask, followed by the addition of 20 ml. neutral alcohol and 5 drops of 1 per cent phenolphthalein indicator (1 per cent in 50 per cent alcohol solution). The solution was heated to boiling and titrated with N/20 NaOH in 50 per cent alcohol. The results were reported as ml. N alkali required to neutralize 100 g. of fat. Acid degree and acid number were considered synonymous in this work.

Knaysi-Guthrie number. This technic gives an index of free fatty acids. The method was applied to butter by Knaysi and Guthrie (11) to estimate quality. To 1 ml. of clear butter oil in a test tube, 3 ml. of neutral red dye (pure xylol saturated with the base of neutral red) were added and the mixture well agitated. The tube was compared to a set of color standards containing known quantities of oleic acid.

Free volatile fatty acids in butter oil. Twenty grams of melted butter oil were mixed with 175 ml. of ethyl ether and the whole placed in a separatory funnel. The ether-fat solution was next washed six times with N/10 NaOH in a manner described by Gould and Johnson (7). The alkali washings carefully were heated over a hot plate to remove any ether; then they were placed in a Kjeldahl flask (800 ml.) to which 35 g. of $MgSO_4 \cdot 7\,H_2O$ and a few glass beads already had been added. The mixture was brought to pH 2 with 50 per cent H_2SO_4, refluxed for 5 minutes, and distilled in

a slightly modified Kjeldahl distillation apparatus recently described by Smiley, Kosikowsky, and Dahlberg (12). Distillation continued until crystallization occurred. The distillate and neutral alcohol rinse of the condenser tube were titrated with N/20 NaOH. Both water-soluble and water-insoluble volatile fatty acid values were recorded.

Free volatile fatty acids in butter serum. The recovery of the volatile acids in the serum was conducted as follows: Ten grams of serum were added directly to a Kjeldahl flask containing 35 g. of $MgSO_4 \cdot 7\,H_2O$, a few glass beads, and 280 ml. of distilled water. Enough 50 per cent H_2SO_4 was added to lower the pH of the mixture to 2. After refluxing for 5 minutes and rinsing down the refluxer with 15 ml. of distilled H_2O, the mixture was distilled. The distillate (285 ml.) with the neutral alcohol rinsings from the distillation apparatus was titrated with N/20 alkali. Water-soluble and water-insoluble acids were measured.

Total free volatile fatty acids in butter. In order to arrive at the total free volatile fatty acid content of the butter, it was assumed that for all butters the serum constituted one fifth of the butter. On this basis, the total free volatile fatty acidity of the butter was calculated on a ratio of four parts butter oil to one part butter serum. In routine analysis the tests would be made on the butter oil and serum from a weighed sample of butter.

Butter score. The butter was graded by two of the authors. Butters were scored for flavor only, but were marked on the basis of 93 to < 85 or from excellent to very poor. Butters scoring lower than 85 were considered to be unmarketable.

EXPERIMENTAL RESULTS

Since the acid degree and the Knaysi-Guthrie number deal only with butter oil, it was necessary for comparative purposes to obtain the total and water-soluble volatile fatty acids of the butter oil. Furthermore, since it was felt that the key to certain relationships might be associated with the volatile acids of the serum, this portion of the butter also was analyzed. The results obtained from the oil and serum made it possible to arrive at the total and water-soluble volatile fatty acid content of the butters.

The data obtained on 69 samples of salted butter are outlined in table 1. In this table the data are averaged together on the basis of half-point divisions in score. This type of grouping has the disadvantage of uneven weighting, as the groups vary considerably in the number of butters. In order to remedy this condition, a smaller number of groups, based on approximately equal quantities of butter (except in the last division), is presented in table 2.

It may be noted in tables 1 and 2 that inverse general relationships of varying degrees exist between butter scores and the free fatty acid concentration of the butter and butter oil expressed as acid degree, volatile acidity, and Knaysi-Guthrie number. The most clear-cut and consistent relationship existed between total volatile fatty acid and flavor score of butter. The aver-

TABLE 1

Relationship between flavor score, acid degree, and free volatile fatty acidity of salted commercial butter

Butter score	No. of butters	Volatile acidity of butter		Acid degree	Knaysi-Guthrie no.	Volatile acidity of butter oil	
		Total	Water-soluble			Water-soluble	Total
		(*ml. N/20 acid/20 g.*)	(*ml. N/20 acid/20 g.*)			(*ml. N/20 acid/20 g.*)	(*ml. N/20 acid/20 g.*)
93.0	17	0.97	0.64	0.65	0.21	0.55	0.87
92.5	5	1.15	0.71	0.66	0.60	0.62	1.05
92.0	5	1.31	0.83	0.79	1.00	0.59	1.03
91.5	2	1.27	0.80	0.55	1.00	0.67	1.08
91.0	5	1.51	1.02	1.10	0.90	0.78	1.20
90.5	3	1.40	0.82	0.98	1.00	0.75	1.17
90.0	8	1.81	1.24	1.20	1.00	0.95	1.43
89.5	3	2.03	1.38	1.83	1.83	1.18	1.87
89.0	9	2.07	1.43	1.37	0.89	1.01	1.54
88.5	5	2.33	1.57	1.89	0.90	1.07	1.72
88.0	2	2.83	2.08	0.61	1.00	1.89	2.33
86.5	2	5.08	3.43	3.35	3.30	1.85	2.22
< 85.0	3	7.33	6.04	6.82	9.33	5.66	6.94

age volatile acid titer of 17 butters scoring 93.0 was 0.97 ml. N/20 acid/20 g. butter, and for 16 butters scoring 89 to 88 the average total volatile acid titer was 2.25 ml. N/20 acid/20 g. (table 2). Also, a fairly good inverse relationship was shown between the free water-soluble volatile fatty acid content and the flavor score of butter.

The data in tables 1 and 2 also reveal that the acid degree and flavor score of butter appear to be related to some extent, but the relationship was not as consistent as that shown by the volatile acids of the butters.

TABLE 2

Relationship between flavor score, acid degree, and free volatile fatty acidity of salted commercial butter, using relatively even groupings

Butter score	No. of butters	Volatile acidity of butter		Acid degree	Knaysi-Guthrie no.	Volatile acidity of butter oil	
		Total	Water-soluble			Water-soluble	Total
		(*ml. N/20 acid/20 g.*)	(*ml. N/20 acid/20 g.*)			(*ml. N/20 acid/20 g.*)	(*ml. N/20 acid/20 g.*)
93.0	17	0.97	0.64	0.65	0.21	0.55	0.87
92.5 to 91.0	17	1.32	0.85	0.82	0.85	0.66	1.09
90.5 to 89.5	14	1.77	1.18	1.29	1.18	0.96	1.47
89.0 to 88.0	16	2.25	1.56	1.44	0.91	1.14	1.70
< 86.5 to no score	5	6.43	5.00	5.43	6.92	4.14	5.05

In general, based only on averaged values, as the butter quality became extremely poor, the Knaysi-Guthrie number showed a high value, while for the butter of excellent quality the Knaysi-Guthrie number showed a low value. However, in the area between excellent and extremely poor, the Knaysi-Guthrie number was irregular and insensitive.

Analysis of the data obtained with the butter oil in comparison to those

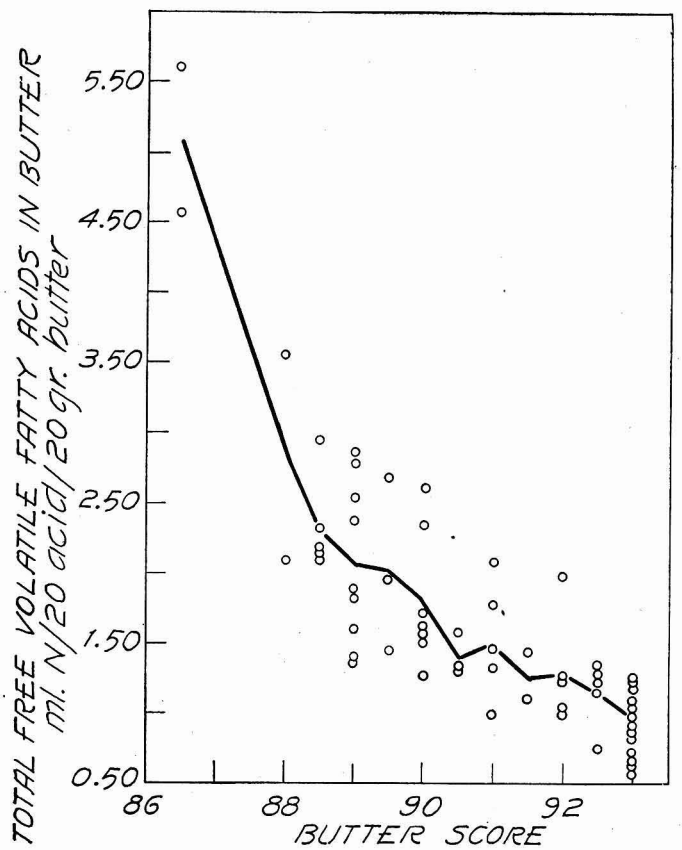

FIG. 1. The relationship between the total free volatile fatty acid content and the flavor score of salted commercial butter.

obtained on butter (tables 1 and 2) reveals that the free volatile fatty acid content of the oil exhibits a similar, but less consistent, trend in its relationship to flavor score of the butter. This indicates that the free volatile fatty acids of the butter serum, in conjunction with those of the fat, must be considered in any study of this nature if the results are to be correlated with observations on the butter.

Although data shown in tables 1 and 2 appear on the whole to exhibit clear-cut relationships in some cases, it must be emphasized that these data represent averages and not individual values and, in most instances, there was a wide range of values within each flavor score division. This is to be expected in a study of this type where many factors cannot be controlled. Some butters may be scored down as a result of defects not associated with increased fatty acids. In the case of other butters, neutralized cream may

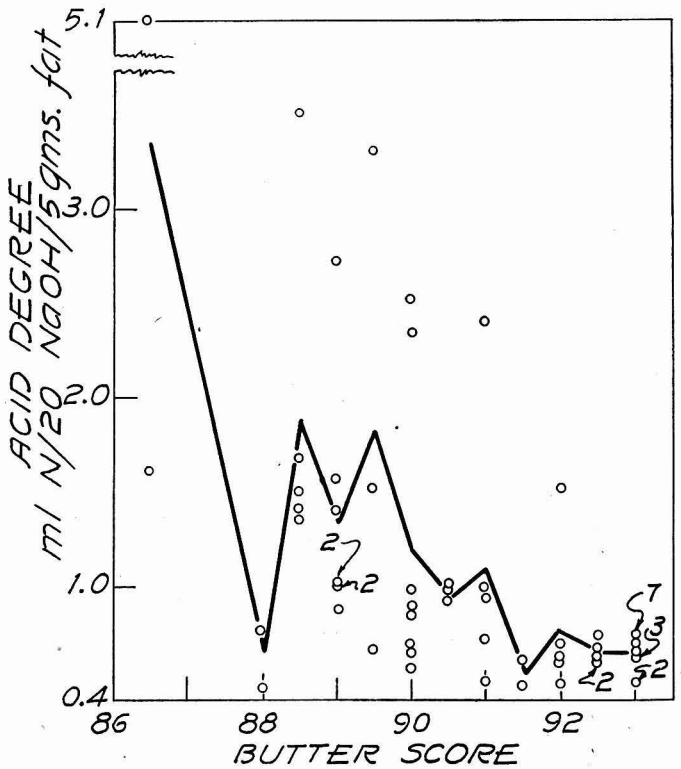

FIG. 2. The relationship between the acid degree and the flavor score of salted commercial butter. (The numbers in the figure show the times that the same data were obtained.)

produce an effect on acid degree determinations unrelated to concentration of free fatty acids. To show this point more clearly, part of the averaged data in table 1 was plotted on graphs, accompanied by results for the individual butters. Figures 1, 2, and 3 show the relationship existing, both in terms of averaged and individual values, between flavor score and total free volatile fatty acid content of butter; flavor score and acid degree; and flavor score and Knaysi-Guthrie number, respectively. Butter scores ranging from 93 to 86.5 were plotted on these graphs.

It may be seen (fig. 1) that a definite inverse relationship does exist between the free volatile fatty acids and the flavor score of salted commercial butters. However, even this relationship, though definite in trend, is quite general when individual samples of butter are considered. The acid degree plotted against flavor score (fig. 2) shows wide variations between individual samples, although the general trend is for a good butter to have a low acid

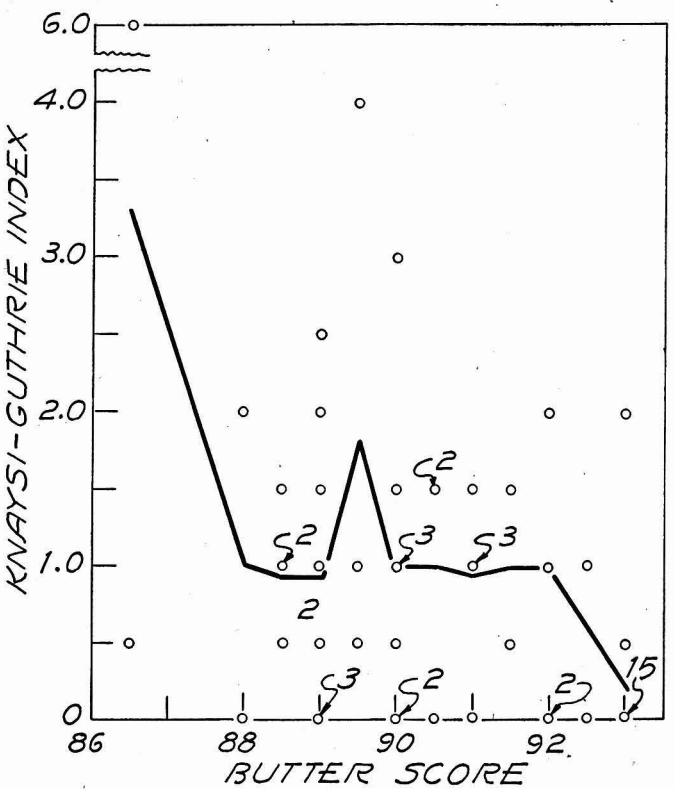

FIG. 3. The relationship between the Knaysi-Guthrie number and the flavor score of salted commercial butter. (The numbers in the figure show the times that the same data were obtained.)

degree and a poor butter a high acid degree. The relationship of Knaysi-Guthrie number to flavor score of butter (fig. 3) generally was similar to that exhibited by the acid degree.

DISCUSSION

A study was undertaken to clarify the situation in regard to the free fatty acid content of salted commercial butters and its relationship to flavor score.

Data obtained in this study tend to confirm, in part, the conclusion of Fouts (4, 6) in regard to acid degree, since only an inverse relationship of a very general nature was observed from an analysis of 69 salted commercial butters. This relationship may be disturbed by various factors. Fouts (5) found that when the titratable acidity of sour cream was reduced by the addition of an alkali, the acid number of the fat also was reduced but not proportionately. In the present investigation, several low-scoring samples of butter possessing extremely high concentrations of free volatile fatty acids showed surprisingly low acid degrees. Another factor which might upset this relationship would be the grading down of a butter because it had absorbed flavors from its environment or because it had other flavor defects not associated with fatty acids. Of 69 samples analyzed, only two of the butters were considered as having slight absorbed flavors. Naturally, the variation in the number of these types of butter would affect any relationship proportionately. However, this kind of butter probably represents only a very small percentage of the whole.

Studies on the free volatile fatty acids of butter show that these acids are allied with flavor deterioration to some extent. This appears logical, since it is well known that lower chain fatty acids, such as butyric, caproic, and caprylic, usually are associated with odors of a rancid nature in butter.

The new method evidently recovered more volatile fatty acids from butter than previous methods, and this was an important factor in showing the relationship between free volatile acids and butter score more clearly than heretofore. For example, Ferris *et al.* (3) found that the average free volatile acidity for 14 samples of 93–94 score butters was 0.65 N/10 acid per 100 g. of butter; whereas by the method used for this work, 17 samples of butter scoring 93 averaged 2.43 ml. N/10 acid per 100 g. of butter, an increase of more than three times. In this respect, Fouts (6), using a steam distillation method, found that for a series of butters exhibiting slight to pronounced rancid flavor, the percentage of total free fatty acid that was volatile ranged from 11.4 to 16.7 per cent. In contrast, from sweet-cream butters used in the current work, an average percentage recovery of approximately 30 per cent was obtained for all butter oils, again indicating more complete recovery. This value of 30 per cent was in good agreement with that obtained by Gould and Johnson (7) on fresh fat churned from milk and ether-extracted before steam distillation.

Neutralization of sour cream for buttermaking should not affect the free volatile acid value of the butter in the same way it affects the acid degree. This is due to the fact that in the process of recovery of the free volatile fatty acids, the salts of the fatty acids formed by a neutralizer would be split by acidification to pH 2. However, neutralization might be a factor in reducing some of the free volatile acids of butter as the result of increased possibilities of losses of the neutralized acid during the washing of the butter. The indication is that this effect could not be great.

In regard to the free volatile fatty acids in the serum, it was assumed that the butter existed in a ratio of four parts of butter oil to one part of serum. Actually this ratio is not always found, but for commercial butters it will remain quite constant. It is evident that for routine determination of total volatile acidity in butter, the analysis should be made on the fat and serum from a given weighed sample.

Although the free volatile fatty acids show an inverse relationship to flavor score of butter, this relationship does not appear exact enough to warrant using it as a basis for determining the flavor score of butter. As a basis for roughly determining the excellent, good, or poor qualities of a butter, it might be acceptable.

The Knaysi-Guthrie number did not correlate well with the butter score because of its apparent lack of sensitivity in regions of low fatty acid concentration. In the method advocated by Knaysi and Guthrie (11) for butter, the authors stress the fact that no perfect agreement should be expected between the quality of butter as estimated by their method and the score of the expert. The data presented herein show that 94 per cent of all butters gave Knaysi-Guthrie numbers of 2 or less and flavor scores ranging from 86 to 93, which substantiates the conclusion of Knaysi and Guthrie (11) who stated that "a test of 2 or below indicates, almost always, butter of fair, good, or excellent quality".

SUMMARY

The existence of a possible relationship between butter quality and free fatty acid concentration, including those of a volatile nature, was investigated. Methods involved included the Knaysi-Guthrie method on butterfat, a titration method for acid degree, and a modified ether-extraction direct-distillation technic for free volatile fatty acid concentration in butter and butterfat.

Free volatile fatty acid concentration of butter determined either as total or water-soluble acidity was found, in general, to be inversely related to the flavor score of 69 lots of salted commercial butter. Individual samples varied appreciably from the averages.

The relationship between the acid degree and the butter score was not well defined. An inverse relationship was discernible but individual samples varied greatly.

It was not possible to observe the existence of a close relationship between the flavor score of commercial butter and the Knaysi-Guthrie number of butterfat, even in average values, except that very high-scoring butters generally gave low values.

On the basis of the data obtained, it would not be advisable to recommend using either the free total acidity or the free volatile fatty acid values of butter as an index for determining flavor scores of salted commercial butters,

due chiefly to variation of individual samples from the averages. For a rough classification of commercial butters as excellent, good, fair, or poor, the use of free volatile acid values might have merit. However, the accumulation of much more data would be required before even this rough classification could be established.

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THE VALUE OF GROUND WHOLE GRAINS VERSUS BY-PRODUCTS IN CONCENTRATE MIXTURES FOR DAIRY COWS[1]

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The nature of concentrate mixtures fed to dairy cows varies widely, depending upon the availability of ingredients. In regions where farm-grown grains are raised abundantly, the concentrate mixture consists primarily of corn, oats, or barley, and a protein supplement. Other areas depend to a greater extent on various by-product feeds to supply a part of the concentrate portion of the dairy ration. Regardless of the source of ingredients, widely different mixtures give satisfactory results under practical conditions. Consequently, it was of interest to learn the relative value of quite different types of concentrate mixtures when fed under similar conditions. Two mixtures were chosen, one composed largely of by-product feeds, and another containing a high proportion of farm-grown grains.

Several investigations (1, 2, 3, 4, 5, 6, 7, 8) have been conducted comparing the nutritive value of simple and complex concentrate mixtures. In general, the results have indicated that simple mixtures are practically equal to more complex mixtures. However, little research has been conducted to compare by-product feeds and farm-grown grains when composing a major portion of the concentrate mixture. The following series of experiments was designed primarily to study the effect on milk production of concentrate mixtures composed of feeds of different sources.

EXPERIMENT A

This investigation was a double reversal feeding trial consisting of three 7-week periods. Two groups of six cows each were used. These groups were equalized on the basis of breed, age, weight, stage of lactation, and average production during a 2-week preliminary period. There were four Holsteins, one Brown Swiss, and one Ayrshire in each group. During the sixth week of the experiment, one Holstein cow died of an internal hemorrhage so her mate in the other group also was removed from the experiment.

Group I was fed the Cornell test mixture especially developed for feeding cows on official test and containing 58 per cent of by-product feeds. Group II received a ground whole grains mixture containing 76 per cent of farm-

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3 Deceased.

grown grains. At the end of each 7-week experimental period both groups of cows were reversed without a transitional feeding period.

The formulas of the concentrate mixtures are shown in table 1. The analyses shown in the table are for the mixtures fed in experiment C, which was conducted a year later than experiments A and B. Although the same formulas were used in all three feeding trials, the analyses showed the Cornell test mixture fed in experiments A and B contained 20.0 per cent of total protein and 5.8 per cent of fat and was calculated to contain 16.2 per cent of digestible protein and 77.8 per cent of total digestible nutrients. The

TABLE 1

Formulas and analyses of the concentrate mixtures used

Ingredients	Cornell test mixture	Check 22% mixture	Ground whole grains mixture	By-products mixture
	(*lbs.*)	(*lbs.*)	(*lbs.*)	(*lbs.*)
Ground yellow corn	340	370	500	.....
Ground oats	370	300	600	.....
Linseed meal	200	240	350	.....
Wheat bran	360	200	.....	370
Distillers' corn grains, dried	300	300	.....	300
Coconut oil meal	300	240	.....	.....
Ground wheat	.....	.....	200	.....
Ground soybeans	.....	.....	220	.....
Corn gluten feed	.....	.....	.....	400
Hominy feed	.....	.....	.....	500
Soybean oil meal, 41% protein	.....	220	.....	300
Molasses	100	100	100	100
Dicalcium phosphate	15	15	15	15
Ground limestone	5	5	5	5
Salt	10	10	10	10
Total amount, lbs.	2,000	2,000	2,000	2,000
Total protein, %	18.47	22.15	17.77	22.90
Fat, %	5.27	5.18	5.44	5.58
Digestible protein, %	14.93	18.06	14.86	18.40
T.D.N., %	76.89	77.48	78.71	79.96

ground whole grains mixture fed in the first two experiments contained 20.3 per cent of total protein and 5.5 per cent of fat and was calculated to contain 16.9 per cent of digestible protein and 76.9 per cent of total digestible nutrients.

U. S. no. 2 clover-timothy mixed hay that analyzed 13.1 per cent of total protein and fairly well-eared corn silage supplied the roughage part of the ration. Hay was fed at the rate of 1 per cent and silage at the rate of 3 per cent of initial body weight. The concentrate mixtures were adjusted at weekly intervals in accordance with production the previous week. Concentrates were fed three times daily at the rate of 1 lb. per 3.5 lbs. of 4 per cent fat-corrected milk (F.C.M.). The experimental animals were milked three times a day.

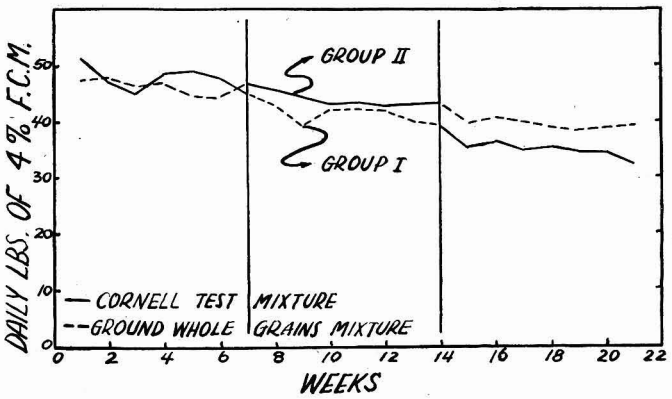

FIG. 1. The trend in milk production of the two experimental groups when receiving different concentrate mixtures.

Figure 1 shows the trend in milk production. There was very little difference between the two concentrate mixtures in promoting milk production. The average production of both groups on the Cornell test mixture shown in table 2 was 42.7 lbs. of 4 per cent F.C.M. and 42.3 lbs. of 4 per cent F.C.M. on the ground whole grains mixture. The difference in production of the groups on the two concentrate mixtures was not significant statistically. Since the difference was less than 0.5 lb. of milk per cow per day, it is likewise of little practical importance.

There was an average total gain in body weight for both groups of 3 lbs. per cow when the Cornell test mixture was fed, and an average total loss of 7 lbs. per cow during the periods when the ground whole grains mixture was fed. There was little difference in the consumption of concentrates, hay, and silage on the two rations.

From these results it appears that both concentrate mixtures were of nearly equal value when compared on the basis of milk production and maintenance of body weight. The difference in palatability, if any, was too small to be brought out by this experiment. Both mixtures were palatable enough

TABLE 2

Daily production of 4 per cent fat-corrected milk by experimental groups

	No. of cows	Cornell test mixture (control)	Ground whole grains mixture (experimental)
		(lbs.)	*(lbs.)*
Experiment A			
Double reversal trial (21 weeks)	10	42.7	42.3
Experiment B			
Continuous trial (26 weeks)	8	37.4	35.1

that the cows consumed all of the concentrates that were offered throughout the experiment.

EXPERIMENT B

A continuous feeding trial with two groups of six cows each was designed to study any accumulative effects of the two concentrate mixtures used in experiment A. This study was conducted simultaneously with the first experiment and extended over a period of 26 weeks. During the trial one cow in each group had to be dropped from the experiment, so the mate of each of these cows also was removed.

The experiment was summarized using only the four cows that completed the feeding trial in each group. The cows received the same general treatment and were fed at the same rates as those in experiment A. As this was a continuous trial, group III received the Cornell test mixture (table 1) for the entire 26 weeks, and group IV received the ground whole grains mixture for the same period. The trend in milk production is shown in figure 2.

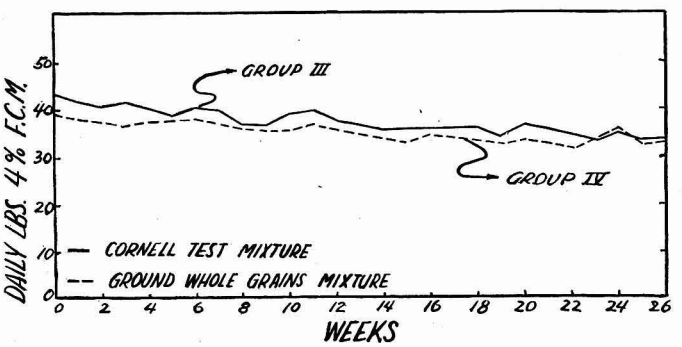

FIG. 2. The trend in milk production of the two experimental groups during a continuous feeding trial of 26 weeks.

During the experimental period, group III produced an average of 37.4 lbs. of 4 per cent F.C.M., while group IV averaged 35.1 lbs. of 4 per cent F.C.M. per day (table 2). This difference of 2.3 lbs. in favor of the group receiving the Cornell test mixture does not indicate necessarily any superiority of that mixture in feeding value. One more accurately might assign this difference in production to the fact that group III, which received the Cornell test mixture, was a higher-producing group. During the 2-week preliminary period, this group averaged 2.8 lbs. more milk than did group IV. Figure 2 shows that the trend in milk production was essentially the same. The difference existing between the groups at the end of the feeding trial was slightly less than at the beginning of the experiment. The body weight changes were of greater magnitude but were in the reverse order of those that occurred in experiment A. The cows in group III lost an average

of 22 lbs. during the 26 weeks while receiving the Cornell test mixture, and group IV showed an average gain in body weight of 12 lbs. per cow.

EXPERIMENT C

Four groups of six cows each were selected for this reversal type of experiment. Three Holsteins, one Brown Swiss, and two Jerseys were in each group. Four concentrate mixtures were fed in rotation to each group of cows in order to eliminate the effect of differences in production among the groups. The allotment of the cows to the various groups was based on breed, age, weight, stage of lactation, and expected productive ability.

The formulas and analyses of the concentrate mixtures fed are given in table 1. The Cornell test mixture and the ground whole grains mixture had been used earlier in experiments A and B. Two additional mixtures which contained approximately 22 per cent of total protein also were included. The by-products mixture consisted entirely of by-product feeds and minerals and contained 22.9 per cent of total protein. The check 22 per cent mixture was fed as a control mixture to determine the effect, if any, of a slightly higher protein mixture, since the two mixtures first mentioned contained about 18 per cent of total protein.

These two latter mixtures contained a larger amount of protein for two practical reasons. First, mixtures of such protein content fit the type of roughage fed on many farms, especially where non-leguminous roughages are fed. Second, it is difficult to make up a satisfactory mixture of by-products alone that has less than 20 per cent of total protein.

The average grade of the hay fed was no. 2 timothy medium clover mixed hay, and this hay contained 10.2 per cent of total protein. The corn silage was of excellent quality and was fairly well-eared.

The experimental periods were 6 weeks in length. At the end of each period the concentrate mixtures were changed abruptly with no intervening transition. The cows were milked three times daily, and the concentrates were fed previous to each milking. Hay and silage were fed twice daily. Concentrates were fed at the rate of 1 lb. for each 3.5 lbs. of 4 per cent F.C.M. produced daily during the previous week. One pound of hay was fed for each 100 lbs. of body weight. Slightly more than 3 lbs. of corn silage per day per 100 lbs. of body weight were fed. Daily weighbacks of uneaten hay were recorded, but it was unnecessary to take weighbacks of concentrates or silage.

It was somewhat surprising that the concentrate mixtures that differed so much in their ingredients were eaten so readily when the cows were changed abruptly from one mixture to another. Judging from the rate at which the cows consumed the mixtures, it must be assumed that they were unable to detect or were indifferent to the overnight changes that occurred at the end of each experimental period. There were no observable differences in the palatability of the four concentrate mixtures.

Table 3 gives a summary of the production of 4 per cent F.C.M. This table summarizes the production on the basis of concentrate mixtures and groups of cows. The highest average production, 42.9 lbs. of 4 per cent F.C.M. per cow per day, was obtained when the groups received the check 22 per cent mixture. The average production was 42.5 lbs. when the Cornell test mixture was fed; 42.4 lbs. of 4 per cent F.C.M. were produced when the ground whole grains mixture and the by-products mixture were fed. The greatest average difference in production on these four mixtures was only 0.5 lb. of milk per day. This difference was not statistically significant. The variation in production on the different concentrate mixtures was considerably less than the differences among the experimental groups. Also,

TABLE 3

Summary of the daily production of 4 per cent fat-corrected milk

Group	Av. production of 4 per cent F.C.M. per day				
	Cornell test mixture	Check 22% mixture	Ground whole grains mixture	By-products mixture	Av. production
	(*lbs.*)	(*lbs.*)	(*lbs.*)	(*lbs.*)	(*lbs.*)
I	47.2 (period 1)	43.6 (period 2)	40.5 (period 3)	36.0 (period 4)	41.8
II	35.2 (period 4)	46.1 (period 1)	43.7 (period 2)	39.2 (period 3)	41.1
III	43.2 (period 3)	40.1 (period 4)	47.3 (period 1)	46.5 (period 2)	44.3
IV	44.2 (period 2)	41.7 (period 3)	38.1 (period 4)	47.8 (period 1)	43.0
Av. production	42.5	42.9	42.4	42.4	42.6

there was less difference in production on the Cornell test mixture and the ground whole grains mixture than was shown in the double reversal trial in experiment A.

Feed consumption was practically the same for all groups. Since the concentrate portion of the ration was fed according to production, the higher producing groups received slightly more concentrates. The change in body weight was a general trend toward a slight gain in body weight throughout the experimental period.

DISCUSSION

This series of experiments has several practical implications. In periods when some of the standard ingredients in feed mixtures are difficult to obtain, the results of these experiments indicate that substitutions may be made on a rather wide basis without altering the feeding value or palatability so long as the total protein and total digestible nutrients remain fairly constant. If it is economical to do so, the results indicate that by-product

feeds of the vegetable oil-producing and milling industries may replace farm-grown grains entirely, and vice versa, to a certain extent, without noticeably affecting the nutritive value of the mixture. In fact, such a procedure is rather common practice among feed mixers in producing economical feeds from ingredients that change in their price relationships to one another from time to time. Although not a commonly recommended feeding practice, abrupt changes in the concentrate mixture may be effected without producing harmful results.

SUMMARY

A series of three experiments comparing the feeding value of different concentrate mixtures indicated that there was little or no difference in the palatability of concentrate mixtures that differed widely in the ingredients used. A mixture containing 76 per cent of farm-grown grains was equal in promoting milk production and in palatability to a standard concentrate mixture throughout a continuous study of 26 weeks' duration. Similar results were obtained in a double reversal trial.

Another experiment involving four concentrate mixtures containing widely different ingredients showed there was little difference in feeding value among the four mixtures. Abrupt changes from one mixture to another had no unfavorable effect on feed consumption. All mixtures proved equally palatable. Body weight essentially was unaffected by the different concentrate mixtures.

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THE HEAT RESISTANCE OF LACTOBACILLI FOUND IN AMERICAN CHEDDAR CHEESE[1]

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The heat treatment of milk for cheesemaking is not a new development. However, pasteurization as ordinarily defined has not been used extensively in the cheese industry, the temperature and time of exposure often being less than the minimum required by public health officials. A number of states have passed laws requiring that cheese either be made from pasteurized milk as defined by public health ordinances or be aged a specified length of time. Such laws affect not only the cheese made in these states but also all the cheese produced in other states for sale in the areas concerned.

Experience has shown that Cheddar cheese made from pasteurized milk rarely develops the full, characteristic flavor ordinarily found in good quality raw milk cheese, even after an extended ripening period (11, 19, 20). This may be due to the destruction of enzymes, destruction of microorganisms, or to a chemical change in the milk as a result of pasteurization. Bacteriological studies have shown that lactobacilli often grow extensively in Cheddar cheese and frequently are present in tremendous numbers after ripening for several weeks (1, 15, 16, 17, 21, 22, 23). This suggests that these organisms may be important in the cheese-ripening process. The reason pasteurized milk cheese ripens more slowly may be that many of these organisms are destroyed in the pasteurizing process. The object of this investigation was to study the heat resistance of lactobacilli found in Cheddar cheese.

REVIEW OF LITERATURE

The standard of comparison of heat tolerance of different species of bacteria originally was the thermal death point, *i.e.*, the lowest temperature at which a suspension of bacteria could be killed in 10 minutes. This method cannot give comparable results unless conditions such as age of culture, approximate number of cells, pH of suspension, dimensions of test tubes, and thickness of glass in the test tubes are standardized.

The idea has since gained acceptance that (a) there is no critical lethal temperature, (b) any temperature high enough to have an unfavorable effect upon the growth and stamina of the bacteria is lethal and (c) bac-

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teria will be destroyed if they are subjected to an unfavorable temperature long enough. Research workers in the canning industry have found it more suitable for their purposes to keep the temperature constant and to vary the time. The thermal death time is considered to be the shortest time necessary to kill all bacteria in a given suspension at a given temperature.

Since the basic work of Krŏng and Paul (19) in 1897, it has been recognized that the mortality rate of bacteria exposed to unfavorable conditions follows a generally regular and consistent course. Under a wide variety of conditions, this course is such that a straight line is obtained when the log of the number of bacteria surviving at a given moment is plotted against the time elapsed since the beginning of the experiment.

The order of death of spore-forming bacteria has been found to be logarithmic by Chick (10), Bigelow (6), Weiss (27), Esty and Meyer (11), and Watkins and Winslow (26).

Bigelow and Esty (8) were perhaps the first to consider some of the factors now recognized as very important, and they proposed a standard technic for determining the resistance of organisms to heat. They proposed an accurately controlled oil bath and special thermal-death-time tubes of soft glass 250 mm. long, 7 mm. inside diameter, and with a wall thickness of 1 mm. The spores were suspended in juices expressed from various canned foods which had received one heat treatment. When a juice had been inoculated with a spore suspension, it was introduced into the thermal-death-time tube, which then was sealed and placed in an oil bath for the heat treatment. Fifteen seconds were allowed for the tubes to come to bath temperature before time was counted. This method was designated as the "single tube" method in contrast to one proposed later by Esty and Williams (12). One difficulty with the single tube method was described as "skips", *i.e.*, destruction of organisms at shorter times when longer heating would leave viable cultures.

In 1924 Esty and Williams (12) introduced a "multiple tube" method to reduce the number of skips. Instead of heating one tube for a given time, 25 to 30 tubes were heated, each containing a portion of the same suspension, and all were heated alike for at least four different time intervals. These intervals were selected to cover the entire range of heat resistance based on percentage survival.

Bigelow (6), using the thermal-death-time data reported by Bigelow and Esty (8), plotted the results on semi-logarithmic paper instead of coordinate paper. The curves were drawn so that they passed between the time intervals representing the last positive and the first negative thermal death tubes in the greatest number of pairs of observation points with each organism. Such curves were straight lines or nearly so, and from them was secured the thermal death time of the organism between the temperatures which were used to construct the curve. Bigelow's work was done with spore-forming,

thermophilic organisms. Since no data were available for non-spore-forming bacteria, he determined the heat resistance of four such organisms (*Bacterium alkaligenes, Bacterium coli, Bacterium aerogenes,* and *Bacterium proteus*) at temperatures of 40° C. (104° F.) to 65° C. (149° F.) at 5°-intervals. He did not find as consistent results with these organisms as he did with the spore-forming, thermophilic bacteria. However, he concluded that the thermal-death-time curves for these organisms were logarithmic.

Since Bigelow's suggestion that death of non-spore-forming bacteria was logarithmic, Watkins and Winslow (26), Beamer and Tanner (5), and Baker and McClung (2) have published confirmatory results.

Since bacteria follow a more or less uniform logarithmic order of death, death rates can be computed and conclusions drawn from them. Bigelow, Bohart, Richardson, and Ball (7) described the "general method" for making calculations of processing times for canned foods. One of the requirements was that the thermal death time of the organisms being destroyed by the process must be known at all temperatures attained during the process. This knowledge was obtained by determining the thermal death times at several temperatures in the processing range. The data so obtained were plotted, using a logarithmic time scale and a linear temperature scale. The resulting points were connected by a smooth curve. From this curve, thermal death times were found for all temperatures obtained during the heating process. It was not necessary to know the mathematical formula relating the thermal death time to the temperature.

Ball (3, 4) suggested some improvements for the "general method" of process calculations used in the study of temperatures required in the canning of vegetables. He did not use death rates or temperature coefficients but the factors F and z. The value F_1 was the thermal death time of the bacterial species at 121° C. (250° F.), while the value F represented the thermal death time at any other temperature. The letter z referred to the temperature increase in degrees Fahrenheit necessary to reduce the death time one-tenth. The value of z indicated the slope of the straight line obtained by plotting the logarithms of death time against temperature. The value F gave one point on the curve. Therefore, F and z were sufficient to characterize the thermal resistance of the bacterial spores at any temperature.

When making thermal-death-time tests involving relatively short times (less than 10 minutes), the heat penetration lag, or the time for the thermal-death-time tube and its contents to come up to the temperature of the constant-temperature bath, may make up an appreciable percentage of the total death time (24). Many investigators apparently have ignored this fact. Bigelow and Esty (8), Weiss (27), Esty and Meyer (11), and Esty and Williams (12) used a series of glass tubes containing suspensions of heat-resistant bacteria which were heated in oil baths. Not more than 15 seconds

were allowed for lag in heat penetration. Townshend (25) measured the heat resistance of spore-forming anaerobes, using a water bath. He allowed a lag correction of 1 minute in the heating times. Sognefest and Benjamin (24) measured the heating lag in Pyrex thermal-death-time tubes by means of a thermocouple when various media such as water, sugar solutions, and vegetable juices were placed in the tubes. The correction factor for water figured for an organism with a z value of 18 was 0.85 minute when heated in a water bath. Gross (14) used Kimble brand no. 45050 chemical test tubes in thermal-death-time studies of a staphylococcus in a meat-juice medium heated in an oil bath. The lag on these tubes was measured by means of a thermocouple and found to be approximately 3 minutes when heated to 140–160° F.

EXPERIMENTAL METHODS

Samples of cheese were obtained, using sterile triers, and the samples transferred to sterile sample jars. An 11-g. sample of each cheese was transferred to a sterile mortar and ground to a homogeneous suspension with the aid of a pestle, a small amount of sterile sand, and the addition of part of the water from a 99-ml. sterile water dilution blank, the mixture representing a 1 to 10 dilution of the cheese. From this dilution, other desired dilutions were prepared. The various dilutions then were plated, using Difco tomato juice agar containing 400 ml. tomato juice, 10 g. Bacto peptone, 10 g. Bacto peptonized milk, and 11 g. Bacto agar per liter. The plates were incubated at room temperature (21° C.) for 10 days. Twenty-five contiguous colonies were picked from one plate in each set and inoculated into tubes of sterile litmus milk. After 10 to 14 days incubation at room temperature, the appearance of each litmus milk culture and the morphological characteristics of the organism were recorded. The cultures were stained with the gram stain using the Burke (9) modification. Non-spore-forming, gram-positive rods that reduced and coagulated litmus milk in 10 to 14 days at room temperature were selected as lactobacilli. The length and width of cells and the speed of growth in litmus milk were considered in the selection of cultures for the heat-resistance studies. Not more than two cultures were selected from any one cheese. The cultures selected were streaked on tomato juice agar, covered with another layer of agar, and incubated for 10 days at room temperature. Colonies then were picked into litmus milk and incubated again for 10 days at room temperature. The morphology of these cultures was observed, using the gram stain, and one culture was selected for the heat-resistance studies. The cultures selected were inoculated into glucose, galactose, lactose, fructose, maltose, mannite, mannose, salicin and inulin broths.

The cultures were numbered as follows: the first number refers to the number of the cheese in which the organism was found, the second to the

number of the colony picked from the plate used in the isolation, and the third to the colony picked when the cultures were streaked on tomato juice agar. A record was kept of morphology, colony, and fermentation characteristics so that it was possible to get the history of a culture whenever necessary.

The method employed for the heat-resistance studies was similar to that used by Bigelow and Esty (8), with litmus milk made from fresh skim milk. One drop (from a 2.2-ml. pipette) of each lactobacillus culture was transferred into a 10-ml. sterile, skim milk dilution blank. The dilution blank was shaken vigorously for 1 minute. One milliliter of this dilution was added to each 100 ml. of sterile litmus milk to be inoculated for the heat treatment. The inoculated litmus milk was allowed to remain over night at 5° C. and then transferred to sterile, Kimble brand no. 45050 (10 × 75 mm.) chemical test tubes and the tubes sealed. The number of bacteria in the inoculum was determined by plating various dilutions of the litmus milk or tomato juice agar.

The sealed tubes were submerged in a De Khotinsky constant-temperature water bath with a maximum temperature variation of ± 0.2° F. The tubes were exposed in the constant-temperature bath for varying periods of time, the time intervals being measured with a stop watch. When the tubes were taken from the water bath, they were immersed at once in water at 60–65° F. to cool. The tubes then were allowed to incubate 4 weeks at 30° C., after which all tubes were observed for growth. The first negative tubes in a series frequently were plated or observed under a microscope to be sure no viable organisms were present. Single tubes were heated at 5-minute intervals to get a general picture of the heat resistance of the lactobacillus cultures. To determine the z values, ten tubes were removed at from 1- to 5-minute intervals at each of four different temperatures.

In order to determine the heat lag on the Kimble tubes used in the heat resistance studies, a skim milk thermometer was made by attaching a 29-inch capillary tube to one of the Kimble tubes. A vacuum was pulled on the test tube with the capillary tube attached, and the test tube filled with skim milk containing a few drops of formaldehyde. It then was attached to a meter stick and calibrated against a mercury thermometer by holding in a water bath at different temperatures. To get the heat lag, this milk thermometer was placed in a constant-temperature bath at various temperatures and the meter stick reading recorded every 15 seconds. To get the cooling lag, the milk thermometer was transferred directly from the constant-temperature bath to water at 65° F. and the readings recorded every 15 seconds until it reached 65° F. The time of heating and cooling was converted to an equivalent time at the temperature of the constant-temperature bath by a method of graphic integration.

The temperature lag correction, when heating a skim milk medium in water to 135°, 145°, and 155° F., using z values from 8 to 12, was found

TABLE 1

Thermal death times at 145° F. of cultures from raw milk cheese

Period of exposure in minutes									
< 5	10	15	20	25	30	35	50	60	Over 60
Culture nos.									
3–8–5	11–9–5	6–15–5	7–14–6	10–1–8	15–5–1	8–6–3	8–16–3	17–6–3	13–20–6
4–17–4	16–14–1	11–14–5	23–1–3	10–2–8	3–13–4		20–8–1	19–1–6	14–4–4
7–13–6	24–14–4	15–27–1	25–15–6	12–27–6	4–27–6				19–27–6
9–7–2	24–20–5	16–11–3		13–26–6	6–25–7				
9–17–1		17–21–1		14–5–1					
12–9–2		21–8–1		20–6–6					
18–1–5		25–4–6		22–19–6					
18–19–6		32–1–1		2–14–6					
21–11–6		32–6–1							
22–7–4									
23–19–1									
2–1–7									

to be approximately 1 minute. One minute was subtracted from the time that the tubes were exposed to the constant temperature to get the lethal time of exposure in the constant-temperature bath.

Thirty-two cheeses made in various parts of Wisconsin and Minnesota were the source of the organisms used in these experiments. Twenty-four of the cheeses were made from raw milk. Two cheeses were made from milk pasteurized at 145° F. for 30 minutes, while six were made from milk flash-heated, the temperature fluctuating from 155° to 170° F. The age of the cheese varied from 1 week to 2 years.

RESULTS

Eight hundred colonies were picked from the 32 cheeses; 448 colonies were of organisms of the rod type. Of the 25 colonies picked from a plate from each cheese, the types varied from all rods to all cocci. Very few rod types were found in the 2-year-old cheese. In the other cheese, many had a very high proportion of rods. When inoculated into litmus milk, 439 cultures were found to be acid coagulating, 345 acid non-coagulating, 12 formed a yellow sediment at the bottom of the litmus milk tubes, and 6 cultures digested the milk solids. Sixty cultures were selected for further study on the basis of morphology, growth in litmus milk, and the source of the culture (raw or pasteurized milk cheese).

A summary of the thermal death times at 145° F. of lactobacilli from raw milk cheese is given in table 1. Twelve cultures could be killed in less

TABLE 2

Thermal death times at 136° F. of cultures from raw milk cheese killed in less than 5 minutes at 145° F.

Period of exposure at 136° F.	Thermal death time of culture no.										
	18–1–5	12–9–2	9–17–1	9–7–2	21–11–6	18–19–6	23–19–1	22–7–4	3–8–5	4–17–4	7–13–6
Minutes											
0	+	+	+	+	+	+	+	+	+	+	+
5	+	−	+	+	+	+	+	+	+	+	+
10	+	−	+	+	−	+	−	+	−	+	+
15	+	−	+	+	−	+	−	−	−	+	−
20	+	−	−	−	−	+	−	−	−	−	−
25	+	−	−	−	−	−	−	−	−	−	−
30	+	−	−	−	−	−	−	−	−	−	−
35	−	−	−	−	−	−	−	−	−	−	−
40	−	−	−	−	−	−	−	−	−	−	−
45	−	−	−	−	−	−	−	−	−	−	−
Plate count per ml. of litmus milk culture (thousands)	1	< 1	11	72	130	< 1	160	6	4	< 1	3

+ Indicates growth.
− Indicates no growth.

TABLE 3

Thermal death times at 154° F. of cultures from raw milk cheese not killed in 60 minutes at 145° F.

Period of exposure at 154° F.	Thermal death time of culture no.		
	13–20–6	14–4–4	19–27–6
Minutes			
0	+	+	+
5	+	+	+
10	–	–	–
15	–	–	–
20	–	–	–
Plate count per ml. of litmus milk culture	124,000	58,000	120,000

+ Indicates growth.
– Indicates no growth.

than 5 minutes, four in 10 minutes, nine in 15 minutes, three in 20 minutes, eight in 25 minutes, four in 30 minutes, one in 35 minutes, two in 50 minutes, and two in 60 minutes, while three cultures could not be killed in 60 minutes. Approximately 83 per cent of the cultures could be killed in 30 minutes or less at 145° F.

The thermal death times at 136° F. of cultures from raw milk cheese, which could be killed in less than 5 minutes at 145° F., are given in table 2. The thermal death time varied from less than 5 minutes to 35 minutes, with nine of the eleven cultures being killed in from 10 to 20 minutes.

The thermal death times at 154° F. of cultures from raw milk cheese not killed in 60 minutes at 145° F. are given in table 3. All three of these cultures could be killed in 10 minutes at 154° F.

TABLE 4

Thermal death times at 154° F. of cultures from pasteurized milk cheese

Period of exposure at 154° F.	Thermal death time of culture no.									
	5–6–6	5–8–9	26–2–1	26–6–1	27–2–1	27–19–1	28–2–1	28–16–2	30–1–1	30–20–1
Minutes										
0	+	+	+	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+	+	+	+
10	+	+	+	+	+	+	–	+	+	+
15	+	+	+	–	+	+	–	+	+	+
20	+	+	+	–	–	–	–	–	–	+
25	+	–	–	–	–	–	–	–	–	–
30	–	–	–	–	–	–	–	–	–	–
35	–	–	–	–	–	–	–	–	–	–
40	–	–	–	–	–	–	–	–	–	–
Plate count per ml. of litmus milk culture (thousands)	100	130	235	17,000	100	3.800	51	122	73	3,000

+ Indicates growth.
– Indicates no growth.

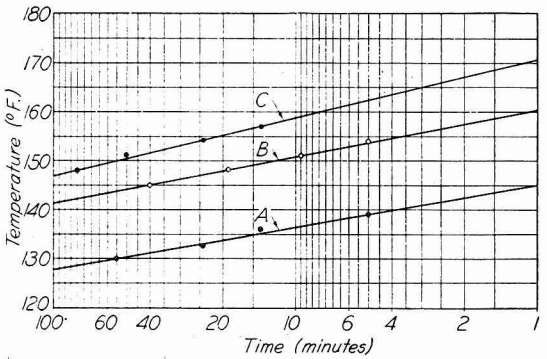

FIG. 1. Thermal-death-time curves: Curve A, Culture no. 3–8–1, z value = 8.5. Curve B, Culture no. 8–16–3, z value = 9.5. Curve C, Culture no. 5–6–6, z value = 12.

The thermal death times at 154° F. of cultures from pasteurized milk cheese are given in table 4. The thermal death times varied from 10 to 30 minutes. The colonies of this group of organisms on tomato juice agar commonly were very small, approaching pin-point size.

The fermentation characteristics of all cultures isolated were studied and found to have little or no correlation with their heat resistance.

The heat resistance of the organisms was the only factor considered in selecting the cultures for the thermal-death-time curve studies. Two cultures (3–8–1 and 11–9–5) having a low heat resistance, three (8–16–3, 6–25–7, and 19–1–6) having a medium heat resistance, and two (5–6–6 and 30–20–1) having the maximum heat resistance were selected.

Culture no. 3–8–1 could be killed within 5 minutes at 139°, 14 minutes at 136°, 24 minutes at 133°, and 55 minutes at 130° F. When these data

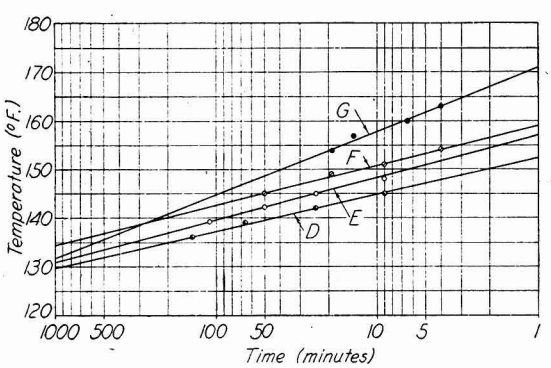

FIG. 2. Thermal-death-time curves: Curve D, Culture no. 11–9–5, z value = 8. Curve E, Culture no. 6–25–7, z value = 8. Curve F, Culture no. 19–1–6, z value = 8.5. Curve G, Culture no. 30–20–1, z value = 13.

were plotted on semi-logarithmic paper, they gave curve A shown in figure 1. The z value (slope of the curve) for this culture was approximately 8.5.

Culture no. 8–16–3 could be killed in 5 minutes at 154°, 9.5 minutes at 151°, 19 minutes at 148°, and 40 minutes at 145° F. When these data were plotted, they gave curve B (fig. 1). The z value was approximately 9.5.

Culture no. 5–6–6 could be killed in 14 minutes at 157°, in 24 minutes at 154°, in 50 minutes at 151°, and in 80 minutes at 148° F. These data gave thermal-death-time curve C (fig. 1). The z value was 12.

Culture no. 11–9–5 could be killed within 9 minutes at 145°, 24 minutes at 142°, 65 minutes at 139°, and 140 minutes at 136° F. These data gave curve D (fig. 2). The z value was 8.

Culture no. 6–25–7 could be killed within 9 minutes at 148°, in 24 minutes at 145°, in 50 minutes at 142°, and 110 minutes at 139° F. These data gave curve E (fig. 2), indicating this culture had a z value of approximately 8.

Culture no. 19–1–6 could be killed in 4 minutes at 154°, 9 minutes at 151°, 19 minutes at 149°, and 50 minutes at 145° F. These data gave curve F (fig. 2). The z value was 8.5.

Culture no. 30–20–1 could be killed in 4 minutes at 163°, 6.5 minutes at 160°, 14 minutes at 157°, and 19 minutes at 154° F. These data gave curve G (fig. 2), indicating a z value of approximately 13.

The lactobacilli that could be killed in 30 minutes or less at 145° F. had z values varying from 8 to 8.5, while the organisms that could be killed in from 30 to 60 minutes at 145° F. had z values from 8.5 to 9.5. The organisms having a thermal death time of over 60 minutes at 145° F. had z values varying from 12 to 13.

DISCUSSION

The heat resistance of lactobacilli found in Cheddar cheese varied within rather wide limits. Some of this variation undoubtedly was due to the differences in the numbers of organisms in the cultures used for the heat-resistance trials. However, this variation was not great when the thermal death time was less than 30 minutes at any temperature. It usually was possible to take different cultures of the same strain of lactobacilli and have the thermal death time on successive trial runs check within 5 minutes. When the thermal death time was over 30 minutes, a much greater variation frequently was observed. Since the number of lactobacilli in a normal raw milk supply is comparatively low (1), the heat resistance data reported in this study may suggest a greater heat resistance for some organisms than would actually be the case in a raw milk supply. This observation seems justified because of the large numbers of organisms present in some of the cultures used for these heat-resistance trials.

In this study the percentage of lactobacilli destroyed by pasteurization exposure was considered more important than the variability of the heat resistance. Approximately 83 per cent of the lactobacilli found in Cheddar cheese made from raw milk could be killed in 30 minutes or less at 145° F. The lactobacilli found in Cheddar cheese made from pasteurized milk were much more heat resistant, having a thermal death time of from 10 to 35 minutes at 154° F. This might explain why Evans, Hastings, and Hart (13) found only one-tenth as many *Lactobacillus casei* in pasteurized milk cheese as in raw milk cheese made from the same milk up to the forty-second day of ripening. The destruction of lactobacilli by pasteurization may be an important reason why cheese made from pasteurized milk ripens more slowly than cheese made from raw milk. This suggests the possibility that the ripening of cheese made from pasteurized milk may be accelerated either by adding the proper lactobacillus cultures or by ripening the cheese at a higher temperature in order to supply a more favorable growth temperature for the reduced numbers of lactobacilli that survive pasteurization.

The fermentation characteristics of the lactobacilli found in Cheddar cheese had very little correlation with heat resistance. When the organisms were grouped according to their heat resistance, the more organisms in any one group the fewer the fermentation characteristics they had in common.

The temperature lag on the Kimble brand test tubes used was approximately 1 minute in a water medium. This checks closely with the correction determined by Gross (14) using the same tubes and by Sognefest and Benjamin (24) using similar tubes.

The z values for the lactobacilli varied from eight to thirteen, with the most heat-resistant organisms having the highest z values. A thermal-death-time curve with a slope of 8 passing through a point at 145° F. for 30 minutes shows that the lactobacilli which could be killed in 30 minutes or less at 145° F. also could be killed in 27 seconds at 160° F. or 7 seconds at 165° F. This would include 83 per cent of the lactobacilli found in Cheddar cheese made from raw milk, as milk for cheesemaking commonly is pasteurized at 165° F. for 15 seconds. Most ordinances require a minimum time and temperature exposure of 143° F. for 30 minutes or 160° F. for 15 seconds for public health reasons. These heat exposures would destroy approximately 52 per cent of the bactobacilli found in raw milk cheese. Using the minimum exposures would permit a significant increase in the number of lactobacilli surviving pasteurization.

Some skips were encountered, especially where the thermal death time was over 1 hour. Few skips were encountered when the thermal death time was less than 30 minutes at any temperature.

SUMMARY AND CONCLUSIONS

1. The heat resistance of 60 lactobacillus cultures found in Cheddar

cheese made from raw milk was studied and found to vary within wide limits.

2. The majority of lactobacilli found in Cheddar cheese made from raw milk can be killed by pasteurizing at 143° F. for 30 minutes or 160° F. for 15 seconds.

3. The fermentation characteristics of the lactobacilli found in Cheddar cheese had little correlation with their heat resistance.

4. The *z* values vary in a general way with the heat resistance of the organisms, the most heat-resistant lactobacilli having the highest *z* values.

5. The destruction of lactobacilli by pasteurization suggests the possibility of accelerating the ripening of Cheddar cheese made from pasteurized milk either by adding the proper lactobacillus culture to the milk or by raising the ripening temperature of the cheese to supply a more favorable growing temperature for the reduced numbers of lactobacilli that survive pasteurization.

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THE STABILIZATION OF CAROTENE IN DEHYDRATED LEGUMES (ALFALFA) AND CEREAL GRASSES[1, 2]

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In an earlier study on the stabilization of carotene (2) in dehydrated feeds and foods, consideration of various physical and chemical treatments was made.

Additional heat treatments were effective in reducing the loss of carotene in dehydrated oats from 70–80 per cent to 30–50 per cent in 6 months storage. The addition of 0.9 per cent of diphenylamine to dehydrated oats decreased the loss of carotene from 77 to 41 per cent in 6 months. Experiments with a number of chemical agents which changed the reaction of the material or of substances which could act as reducing agents or acceptors of oxygen were ineffective. Pelleting and coating with flexo wax reduced the loss from 74 to 45 per cent in 6 months. Attempts to remove the oxygen from the pellets before coating by washing with nitrogen also helped materially in decreasing the carotene loss.

Further studies (3) showed that autoclaving dehydrated oats or alfalfa at 15 lbs. pressure for 1 hour and then pressing into large pellets (3×4 inches) and dipping in flexo wax, reduced the loss in dehydrated alfalfa to 28 per cent in 3 months and to 0 per cent in the case of dehydrated oats.

EXPERIMENTAL

Additional studies now have been made on the influence of time of autoclaving on the stabilization of carotene, as well as pelleting and nitrogen washing before pelleting and waxing. In table 1 the data show the effect of autoclaving for 1 hour in the absence of oxygen. In this process the chlorophyll is destroyed and the material is of dark brownish color. Carotene determinations were made by the method outlined previously (1). These data show that mere autoclaving to assure complete destruction of the "lipoxidase", which can bring about the destruction of carotene, had no significant effect in checking carotene losses. Only when oxygen is excluded, either in part or, preferably, completely, is preservation of the carotene brought to a comparatively high percentage. Washing with nitrogen before pressing was quite effective in further reducing the loss. However, after washing in nitrogen, the material was exposed to air in the process of pellet making.

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In table 2 are the records of the effect of time of autoclaving on the carotene conservation. These data show that autoclaving for 5 minutes gave results similar to those secured with 60 minutes of autoclaving; carotene was well preserved in the material that had not been autoclaved at all but protected from oxygen through pelleting and waxing, or, even better, by washing with nitrogen and then pelleting in air and waxing. These data are in harmony with earlier observations by other investigators. The carotene can be preserved in plant tissues where the dehydrated material is stored in an inert gas such as nitrogen (1). Mere destruction of the carotene oxidizing

TABLE 1

Effect of autoclaving for 1 hour on the stability of carotene in dehydrated cereal grasses and alfalfa kept at 22–25° C.

(All samples pressed[1] into large pellets 3 × 4 in.)

Material and treatment	Carotene content, μg./g. (air-dry basis)			% loss 6 mos.
	Initial	3 mos.	6 mos.	
Dehydrated oats				
No treatment	450	155	116	74.2
Autoclaved	423	171	74	82.5
Auto. + flexo waxed	423	379	335	20.8
Auto. + flexo waxed + N_2 washing	423	417	368	13.0
Dehydrated sudan grass				
No treatment	299	96	83	72.2
Autoclaved	323	175	136	57.9
Auto. + flexo waxed	323	191	171	47.0
Auto. + flexo waxed + N_2 washing	323	260	256	20.7
Dehydrated alfalfa				
No treatment	222	88	72	67.6
Autoclaved	235	117	75	68.1
Auto. + flexo waxed	235	154	151	35.8
Auto. + flexo waxed + N_2 washing	235	160	173	26.5
Alfalfa dried at 50° C.				
No treatment	236	154	153	35.2
Autoclaved before drying	334	190	129	61.4
Auto. + flexo waxed	334	280	282	15.5
Auto. + flexo waxed + N_2 washing	334	262	313	6.3

[1] Carver press: 1,500 lbs. per sq. in.

enzyme, lipoxidase, will not lead to carotene preservation. Oxygen must be excluded or auto-oxidation of the carotene will proceed.

In further experiments small tubular cellophane casings were used. Into these casings the commercially dehydrated oat material was lightly pressed and the ends merely twisted together and tied with a string. Various treatments were given the material before and after placing in the casings. All of the samples were mixed with water to a content of 15 per cent, giving a total initial moisture content of about 22 per cent. After mixing with the water some of the samples were dried at 95° C. for varying lengths of time. In table 3 the treatments of the materials and the results secured are given.

TABLE 2

Effect of time of autoclaving on preservation of carotene in dehydrated cereal grasses (oats) and alfalfa kept at 22–25° C.

(Pressed into large pellets 3 × 4 in.)

Material and treatment	Carotene content, μg./g. (air-dry basis)		% loss 3 mos.
	Initial	3 mos.	
Dehydrated oats			
Unheated	380	212	44.0
Unheated + flexo wax	380	280	26.0
Unheated + flexo wax + N_2 washing	380	390	00.0
Auto. 60 min.	425	356	16.0
Auto. 60 min. + flexo wax	425	380	10.0
Auto. 60 min. + flexo wax + N_2	413	362	12.0
Auto. 30 min. + flexo wax + N_2	394	399	00.0
Auto. 15 min. + flexo wax + N_2	394	378	4.0
Auto. 5 min. + flexo wax + N_2	382	403	00.0
Dehydrated alfalfa			
Unheated	161	77	52.2
Unheated + flexo wax	161	141	12.4
Unheated + flexo wax + N_2	161	154	4.3
Autoclaved 10 min.			
No wax	147	99	32.6
Flexo waxed	147	131	10.9
Flexo waxed + N_2	147	160	00.0
Autoclaved 30 min.			
No wax	155	105	32.2
Flexo waxed	155	129	16.7
Flexo waxed + N_2	155	166	00.0

The results indicate a loss of carotene where the material was loose although washed with nitrogen and waxed. The result secured with sample no. 2 (table 3) was striking. No loss occurred when the material was unheated and only waxed but contained total moisture at a level of about 20 per cent. Further, the material had turned brown and had a very pleasant aroma. Perhaps the oxygen left in the material had combined with the chlorophyll and the chlorophyll had gone into the "brown" stage, giving an anaerobic

TABLE 3

Effect on carotene preservation of various treatments of dehydrated cereal grasses (oats) involving addition of 15 per cent of water

(Loose in cellophane tubes, kept at 22–25° C.)

Treatment	Color	Carotene content, μg./g. (air-dry basis)		% loss 3 mos.
		Initial	3 mos.	
Unheated—no wax	Green	380	189	49.7
Unheated—waxed	Brown	380	380	0.0
Unheated—N_2 washed—waxed	Brown	380	381	0.0
95° C.—40 min.	Green	418	285	32.0
95° C.—40 min.—waxed	Green	418	310	26.0
95° C.—40 min.—N_2 washed—waxed	Green	418	303	27.6

condition, or possibly the oxygen had been used up by tissue respiration or microorganisms with CO_2 production and O_2 consumption. At any rate, there was complete carotene preservation under a very simple procedure. Where the samples had been dried at 95° C. and the added water lost, the color remained green with considerable loss of carotene.

To secure more data on the behavior of sample 2 (table 3), an extended series of samples was prepared using both commercially dehydrated oats and dehydrated alfalfa.[3] Round cardboard boxes, 3.5 inches in diameter by 4 inches deep, were used as receptacles. The materials were mixed with varying percentages of water, firmly pressed by hand into the receptacles, and

TABLE 4

Effect of varying levels of added water on carotene preservation in dehydrated cereal grasses (oats) and alfalfa kept at 22–25° C.

Treatment	Color	Carotene content, μg./g. (corrected to original water basis)		% loss 3 mos.
		Initial	3 mos.	
Dehydrated oats—10.1 per cent initial water content				
No H_2O added—no wax	Green	379	278	26.6
No H_2O—waxed	Green	379	297	21.6
5% H_2O—waxed	Brown	379	386	00.0
10% H_2O—waxed	Brown	379	431	00.0
15% H_2O—waxed	Brown	379	387	00.0
15% H_2O—½″ head—waxed	Brown	379	410	00.0
Dehydrated alfalfa—7.2 per cent initial water content				
No H_2O added—no wax	Green	159	108	32.0
No H_2O added—waxed	Green	159	142	10.7
5% H_2O—waxed	Brown	159	153	3.7
10% H_2O—waxed	Brown	159	171	00.0
20% H_2O—waxed	Brown	159	171	00.0
20% H_2O—½″ head—waxed	Brown	159	174	00.0
30% H_2O—waxed	Brown	159	169	00.0

then covered tightly. In some cases a 0.5-inch head or air space above the material was left. Some of the alfalfa receptacles were covered completely with a thin layer of wax known as "Durex" and secured from the Dewey and Almy Chemical Company, Cambridge, Massachusetts. After 3 months of storage at room temperature (21–30° C.) the receptacles were opened and carotene determinations made. The results are shown in table 4.

All of the materials to which 5 per cent or more of water had been added turned brown in color. Those with the higher levels of water were deeper brown. The added water was in addition to that already present in the material, which was about 7 per cent in the alfalfa and 10 per cent in the oats. Where the color of the product was brown, a pleasant aroma not unlike

[3] We are grateful to the Cerophyl Laboratories, Inc., Kansas City, Missouri, for the supply of dehydrated alfalfa and cereal grasses.

well-cured silage had developed. In all cases where 5 per cent or more of water had been added and the package covered with a wax to exclude free exchange of gases, the carotene was conserved completely for 3 months. There is no reason to believe that a longer time would have changed the results in this series.

There was no bulging of the boxes or evidence of internal gas pressure. However, there may have been a slow diffusion. The nature of the chemical changes and character of the gases produced (if any) were studied further. Where no water had been added, the material remained green in color but a considerable loss of carotene (20–30 per cent) had occurred. In many cases the amounts recorded as carotene were above the initial determinations. This phenomenon has been observed in studies on AIV silage (4) and on the effect of acids on carotenoids (5), and is attributed to the action of the acid on certain carotenoids with production of pigments of similar solubility to carotene. The amount of such pigments produced is relatively small. The fact that pigments of non-carotene nature may be produced by the action of acid on xanthophyll led to an examination of these samples for acidity. Surprisingly, the pH in all of the oat samples, including those where no change in color was observed, was 6.0. In the alfalfa samples it was 6.0–6.3. The higher figure was obtained with the alfalfa to which no water had been added. These figures represent an exceedingly low degree of free acidity.

The pH was determined by suspending 3 g. of the material in 25 cc. of water, stirring, and, after standing 20 minutes, reading on a pH meter. If there were acids produced the amounts must have been quite alike in all samples, mainly, CO_2. Even where a 0.5-inch head of air had been left in the receptacle, no loss of carotene occurred.

Further, to make certain that the observed increase in carotene did not represent an actual loss of carotene, with compensation by formation of other pigments, the carotene content was redetermined by the chromatogram. The method used was that outlined by Wilkes (6). The initial analysis of the alfalfa by the phasic method showed 159 μg./g. After storage for 4 months in the cold room (– 4° C.), it showed 143 μg. by the same method. By the chromatographic method 150 μg. of carotene were recovered where 5 per cent of water had been added and 138 μg. where 10 per cent of water was added and the materials kept at room temperature and sealed with flexo wax.

Similar results were secured with dehydrated oats where comparisons were made by the phasic and chromatographic methods. The original analysis of the dehydrated oats showed 379 μg./g. by the phasic method. After 4 months storage in the cold room (– 4° C.), it showed 385 μg. by the same method and 344 μg. by the chromatographic method. The experimental samples with 5 per cent of water, sealed with flexo wax and held at room temperature, showed 350 μg./g. by the chromatographic method and, where 15 per cent of water had been added and the samples likewise flexo-waxed

and held at room temperature, 360 μg./g. were obtained. If the thesis is accepted that by the chromatographic method more precise data are secured for the carotene content of a sample of dehydrated alfalfa or cereal grass than by the phasic method, then these data confirm the conclusion that practically no carotene is lost by the process of storage outlined. The increases observed under special storage with addition of water may be due, in part, to new pigments and also to limitations of the analytical methods.

To determine whether microorganisms were principally concerned in the reactions observed, samples of dehydrated oats and alfalfa were mixed with 10 per cent of water, placed in pasteboard containers 3.5 × 4 inches, lightly pressed by hand, and sealed with flexo wax. Controls with no additional water also were prepared. These samples were allowed to stand at room temperature for 5 days, then opened and assayed for bacterial count. The results follow:

	Color	*Aroma*	*Bacterial count/g.*
Dehydrated oats, control	No change	No change	2×10^4
Dehydrated oats, +10% water	"	Aroma more prominent	2×10^4
Dehydrated alfalfa, control	"	No change	6×10^4
Dehydrated alfalfa, +10% water	"	Aroma more prominent	4×10^4

The bacteria present were mostly aerobic spore-bearing bacilli, *Bacillus subtilis*. Very few staphylococci and very few mold spores were present.[4] The data indicate that the changes in the material containing added water were not primarily of bacterial origin, at least not in the first 5 days of the experiment.

It was important to determine whether carbon dioxide was being produced and oxygen used up where these dehydrated materials were mixed with added water, and further, whether the changes were occurring in the first 5 days after preparation. To this end 240 g. of dehydrated alfalfa as control (7.5 per cent water) and 240 g. with 10 per cent of water added were lightly packed in separate glass tubes, fitted with proper carbon dioxide guards, and set aside for 5 days at room temperature. At the end of this time the gases in the tubes were swept through weighed potash bulbs and the carbon dioxide determined. The control showed 8.4 mg. CO_2 while the alfalfa containing extra water showed 53.5 mg. CO_2.

In a somewhat similar experiment apparatus was designed to determine the amount of carbon dioxide and oxygen left in the air in contact with the alfalfa mass after standing at room temperature for 1, 3, 5, and 10 days. These experiments were conducted in glass tubes, where contact with outside

[4] We are indebted to Mrs. M. I. Robblee for this bacterial examination.

air was completely nullified. The air-dried material contained 7.5 per cent of water.

The results follow and are expressed in volume per cent of CO_2 and O_2 left in the atmosphere surrounding the alfalfa particles.

	CO_2	O_2
1 day	2.4	17.8
3 days	3.8	16.7
5 days	4.0	14.3
10 days	6.9	10.4

It is evident from the data that the process of respiration was comparatively slow, but was, nevertheless, a condition under which the carotene would be preserved. Just how complete a displacement of the O_2 with CO_2 is necessary for carotene preservation has not been determined.

Dehydrated plant tissue will vary in the rate of respiration, depending upon the temperature and time of drying, as illustrated in the following experiment. Alfalfa, cut on a University field, was spread on the laboratory floor and dried before a fan at a temperature of 22–25° C. This material was ground, lightly packed in glass tubes with and without added water (10 per cent), and the amount of CO_2 determined after standing 5 days at room temperature. The amount of material used in each experiment was 220 g. and contained an initial water content of 12.4 per cent. The air-dry sample (12.4 per cent water) produced 45 mg. of CO_2. The air-dry sample plus 10 per cent of water produced 144 mg. of CO_2. The amount of CO_2 produced where the water had been added represented, approximately, a concentration of 16 per cent of CO_2 in the gas mixture surrounding the alfalfa particles. It is apparent that this material had a respiratory rate appreciably greater than the commercially dehydrated product.

To determine what temperature changes would occur when the dehydrated products were stored with 10 per cent of added water, each of two large fiber cartons lined with paraffin paper was filled with approximately 28 lbs. of dehydrated alfalfa or dehydrated rye and sealed at the cover joint with paper. The material was lightly pressed into the cartons. Thermometers were inserted through the covers and sealed to prevent leakage of air. These cartons were held at room temperature of approximately 23.5° C. There was no observable temperature rise in either carton. Daily readings remained the same and at the end of 2 weeks both cartons recorded temperatures of 23.5° C., which was the room temperature. Theoretically, heat must have been a product of the respiratory changes in these masses but, apparently, the rate of production was so slow that through radiation the constant temperature prevailing in the room was maintained in the mass of material.

Smaller cartons filled with dehydrated alfalfa or rye (after addition of 10 per cent of water) and completely sealed with flexo wax, likewise showed no rise in temperature by the method used.

The data on gas production, bacterial activity, and temperature records

lend credence to the belief that tissue respiration is restored after addition of the water. In the dehydration process, not all, if any, of the respiratory enzymes were destroyed and, in the presence of added water and room temperature, their action was renewed. Their activity automatically creates an atmosphere of carbon dioxide with reduced oxygen tension, an ideal condition for carotene preservation.

DISCUSSION

The results secured in these studies emphasize the necessity of oxygen exclusion for carotene preservation in dehydrated cereal grasses or dehydrated alfalfa during storage. Destruction of the lipoxidase by autoclaving without further protection from access to air will not preserve the carotene.

The results secured by mere addition of water to the dehydrated material and then protecting against free access to air seem to offer practical procedures for carotene preservation in these materials. A total water content of 12 to 20 per cent, brought about by the addition of only 5 to 10 per cent of water, and the further protection against free access to air effectively stabilized the carotene for 3 months. In this process the material turned slightly brown and developed a very pleasant aroma. There may be objections to the use of a process where the green color partially is lost, but it should be emphasized that greenness is not always an assurance of a high nutritive value in these materials. At the present time there is no conclusive evidence that cholorophyll has any function in animal nutrition.

Whether the material could be prepared commercially with a final water content of 12–20 per cent has not been studied. Possible difficulties in grinding to a fine state would be encountered. If these materials could be so prepared and then stored under slight pressure in metal or fiber cartons or other containers so constructed as to prevent free exchange of air, it would seem probable that the carotene loss could be reduced considerably, if not prevented entirely. Such a process would save the adding of water after drying the material to a 6–10 per cent water content. The material to which only 5 per cent of water had been added was not so deep brown in color as when 10 per cent or more of water had been added. In fact, an olive green more nearly would describe the color. The nature of the chemical changes is not entirely clear. Oxygen absorption by the chlorophyll, with changes to the brown stage, appears possible but was unconfirmed experimentally. Acid products of a fixable character, such as lactic or acetic, must have been small in amounts and have served only as temporary intermediates.

Samples set up with added water and sealed from free access of air produced estimable quantities of carbon dioxide. Probably the reactions resulting from the addition of the water were those of tissue respiration, with utilization of the oxygen and production of carbon dioxide thus establishing partial, if not complete, anaerobic conditions. Under such conditions it would be expected that the carotene could be preserved.

Bacterial multiplication that could account for the chemical changes pro-

duced was not observed. The samples with added water showed no increase in bacterial numbers as compared with the controls in the first 5 days of the experiment; yet carbon dioxide was being produced. It seems probable that the phenomenon observed was one of restored tissue respiration.

Practical application of this principle can be made by the use of containers allowing little or no diffusion of air or carbon dioxide.

It is possible, indeed probable, that the respiratory enzymes left in the dehydrated materials will vary with the temperature and the time the material has been exposed in the process of drying. If this is true, the standardization of the drying method is necessary in order that a maximum of respiratory enzymes survive the process of drying and thus make possible the conservation of carotene by the method outlined.

SUMMARY

1. Destruction of the lipoxidase by autoclaving for 1 hour at 15 lbs. pressure did not preserve the carotene content of dehydrated alfalfa or cereal grasses exposed to air at room temperature.

2. The addition of 5 to 10 per cent of water to these dehydrated materials and then lightly packing them in receptacles sealed with flexo wax or Durex wax preserved the carotene completely for 3 months, when held at room temperature (22–25° C.). The total water content for the oats was 15–20 per cent and for the alfalfa 12–17 per cent.

3. The process of preservation appears to be a restoration of more rapid respiratory enzyme action with utilization of the oxygen and formation of carbon dioxide. There was no indication that bacterial action directly was responsible for the changes that occurred. Temperature changes during the process of respiration were negligible in the masses of material used.

4. It is evident that receptacles with minimum or no air and CO_2 effusion rates are necessary for success in the preservation of the carotene by the method outlined. Oxygen must be excluded or at least held at a low concentration. This phase of the problem is under further study.

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EFFECTS OF SHADE AND SPRINKLING WITH WATER ON SUMMER COMFORT OF JERSEY COWS

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Results from a previous Louisiana test (7) have shown that dairy cows during warm weather spend a large portion of the daytime in the shade and that grazing time between morning and evening milkings may average less than 2 hours. After entering the shade of trees (average time 9:20 a.m.) respiration rates and body temperatures of cows showed a slow but gradual increase, with a maximum registered at 3:00 p.m., when cows entered the milking barn.

As explained by Rhoad (4), cows eliminate body heat by radiation and conduction of heat from their skin, and as latent heat of water vapor from skin and lungs. The portion of elimination by way of the lungs grows in importance as respiration increases, which in turn is most often caused by a rise in air temperature. At 71° F. Forbes, Braman, and Kriss (1) found that about 40 per cent of the heat left the cow's body as latent heat of water vapor. As reported by Kendall (3), the amount of water lost in this manner may vary as much as 12 lbs. per animal daily even when air temperature, feed, and other conditions are kept as uniform as possible. Each pound of moisture lost carries with it 1,086 B.T.U. of heat, he reports, but as air temperature drops there is a decrease in the amount of water eliminated by insensible perspiration.

Rhoad in his review (6) and report on experimental work (5) shows how time spent by cattle in the shade is associated with heat tolerance and that those with low tolerance, such as Angus, spend much more time in shade than do those of high tolerance, such as Brahman. He found Jersey cattle comparable to crossbreds carrying one fourth Brahman and three fourths Angus blood. Tests with these crossbreds on a hot day (air temperature 80–102° F.) showed a respiration rate of approximately 90 per minute while in the sun, with a drop to around 40 after 1 hour in the shade. Body temperatures were approximately 102.8° F. and 101.4° F., respectively, under these two conditions. Tests on a cooler day, with air temperature between 80 and 84° F., showed less change due to shade, *i.e.*, respiration rate was around 50 while cattle were in the sun, but dropped to 30 after 1 hour in the shade. Body temperature changed from approximately 101.7° F. in the sun to 101.0° F. in the shade.

Reports by Villegas (10) on use of an air-conditioned barn near Singapore with temperature kept at 70° F. showed Holstein cows averaging 24 lbs.

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of milk daily as compared to 9 lbs. from cows in an open, well-ventilated barn exposed to tropical temperatures. Reproduction records showed that 58 per cent of cows in the air-conditioned barn conceived as compared to 25 per cent in the other barn.

Conversation with people who have visited the tropics has disclosed observations made by them where water in a pond or stream or from various water sprinkling devices was used to make milking animals more comfortable during hot days. This applies particularly to water buffalo and to a lesser extent to cattle. Observations in Louisiana (9) revealed that Holstein cows had body temperatures on warm days that averaged approximately 0.75° F. higher than did Jerseys within the same herd. A high percentage of these Holsteins sought relief by lying in water and mud whenever available, a practice not often followed by the Jersey cows.

EXPERIMENTAL

Four grade Jersey cows were observed over a period of 10 days in an attempt to determine how shade alone, or shade following sprinkling with water, affected milking cows removed from the effects of direct sun's rays during the summer. Bright sunshiny days were selected for making the tests; the first day of observation was on June 22, 1945, and the last one on August 1, 1945. Air temperatures in the shade varied from 83 to 90° F. and relative humidity from 61 to 80 per cent.

The reversal experimental design was used for the test. On each test day the cows were tied by halters to a fence located in the sunshine. They were left exposed to the direct rays of the sun between the hours of 12:00 noon and 2:00 p.m. Records then were made of rectal body temperatures, respirations as indicated by flank movements, and pulse rates as determined by placing tips of fingers on the underside of the tail and adjacent to the coccygeal artery. Following this, two of the cows were removed (dry) to the shade of a small barn (with numerous openings for ventilation) while the other two first were sprinkled thoroughly with water varying from 83 to 85° F. before being taken into the barn. The procedure was varied so that each pair of cows had 5 days when they entered shade without sprinkling (dry) and 5 days when they were sprinkled first before entering the shade of the barn. Sprinkling was performed by using a hand-type sprayer and thoroughly wetting all portions of the cow's body. Records were made of body temperature, pulse rate, and respiration rate 0.5 hour and 1 hour after cows entered the shade of the barn, using the same procedure as when cows were outside.

RESULTS

Body temperature. In each case shade alone, as provided by the barn, was effective in reducing materially the body temperatures of the dry cows. Mean reduction for 5-day records on individual cows after 0.5 hour in

shade (table 1) varied from 0.24 to 0.42° F. with an average of 0.34° F. After remaining in the shade 1 hour, the reductions varied from 0.58 to 0.88° F., with an average of 0.74° F. Thus, actual body temperature after 1 hour in the shade averaged 101.92° F. This was lower than after 0.5 hour by 0.4° F. Reductions after 1 hour were 118 per cent greater than at the half-hour period.

When cows were sprinkled prior to entering the shade of the barn, their mean body temperature reductions in 0.5 hour varied from 0.3 to 0.8° F. with an average of 0.54° F. After 1 hour in the shade the mean reduction for the four cows varied from 0.78 to 1.4° F. In this case the 1-hour-period

TABLE 1

Changes in body temperature caused by shade or shade plus water sprinkling
(5-day mean values for individual cows)

Cow no.	Shade alone trial			Sprinkling plus shade trial		
	Body temp. after 2 hr. in sun	Body temperature reduction		Body temp. after 2 hr. in sun	Body temperature reduction	
		After 0.5 hr. in shade	After 1 hr. in shade		Wet and in shade 0.5 hr.	Wet and in shade 1 hr.
	(°F.)	(°F.)	(°F.)	(°F.)	(°F.)	(°F.)
3	102.46	0.26	0.70	102.14	0.30	0.78
4	102.42	0.42	0.82	102.20	0.54	1.00
11	103.24	0.42	0.88	103.22	0.80	1.40
12	102.50	0.24	0.58	102.56	0.54	1.16
Av.	102.66	0.34	0.74	102.53	0.54	1.08

decreases averaged 1.08° F., or 100 per cent greater than at the end of 0.5 hour.

Cows sprinkled prior to entering shade averaged at the end of 0.5 hour 0.2° F. lower than when not sprinkled; and after 1 hour they were 0.34° F. lower. The advantage of sprinkling vs. not sprinkling at the end of 0.5 hour was 59 per cent, and at the end of 1 hour 46 per cent. Actual temperatures of sprinkled cows after 1 hour in the shade averaged 101.45° F., or well within the range of normal (2).

Respiration rate. After being in the shade (dry) for 0.5 hour, respiration rates reduced from an average of 83 to 55.8 per minute. Actual mean reductions due to shade alone (table 2) ranged from 22.6 to 32.6 among the four cows and averaged 27.2. With but one exception (cow no. 12), respiration rates were slightly faster at the end of one hour than at the half-hour period. The average reduction was 25.2 per minute, showing that cows were breathing two respirations per minute faster than at the half-hour period.

Cows when sprinkled prior to entering shade dropped much lower in respiration rates than when not sprinkled. Before sprinkling, respiration

TABLE 2

Changes in respiration rate caused by shade or shade plus water sprinkling
(5-day mean values for individual cows)

Cow no.	Shade alone trial			Sprinkling plus shade trial		
	Respiration after 2 hr. in sun	Respiration reduction		Respiration after 2 hr. in sun	Respiration reduction	
		After 0.5 hr. in shade	After 1 hr. in shade		Wet and in shade 0.5 hr.	Wet and in shade 1 hr.
	(*per min.*)	(*per min.*)	(*per min.*)	(*per min.*)	(*per min.*)	(*per min.*)
3	74.0	22.6	16.5	74.0	37.8	34.2
4	88.2	26.4	22.2	82.2	39.8	36.6
11	80.8	27.4	24.4	92.2	50.8	37.2
12	89.2	32.6	37.8	105.6	69.2	58.6
Av.	83.0	27.2	25.2	88.2	49.4	41.6

rates averaged 88.2 (table 2), while at end of 0.5 hour in shade they averaged 38.8, a reduction of 49.4. At the 1-hour period respirations had increased to an average of 46.6 or 7.8 per minute faster than at end of 0.5 hour. When compared to reductions in respiration rates of non-sprinkled cows, the reductions following sprinkling were 81 per cent greater at the half-hour period and 65 per cent greater at the hour period.

Pulse rates. Pulse rates appeared to change more slowly than did body temperatures or respiration rates. When dry cows entered the shade, they showed little change in pulse rate at the end of 0.5 hour (table 3). The average reduction from the original rate of 68.5 was only 0.8 per minute. Cow no. 11 actually averaged faster by 0.6 per minute. Shade alone at end of 1 hour effected a significant change in pulse rate, with mean reductions for cows varying from 1.0 to 5.8 and averaging 3.6 per minute.

Sprinkling of cows prior to entering shade resulted in a great reduction in pulse rate. After 0.5 hour in shade pulse rates had dropped an average

TABLE 3

Changes in pulse rate caused by shade or shade plus water sprinkling
(5-day mean values for individual cows)

Cow no.	Shade alone trial			Sprinkling plus shade trial		
	Pulse rate after 2 hr. in sun	Pulse rate reduction		Pulse rate after 2 hr. in sun	Pulse rate reduction	
		After 0.5 hr. in shade	After 1 hr. in shade		Wet and in shade 0.5 hr.	Wet and in shade 1 hr.
	(*per min.*)	(*per min.*)	(*per min.*)	(*per min.*)	(*per min.*)	(*per min.*)
3	71.8	1.8	5.8	67.6	7.8	7.6
4	69.0	0.6	1.0	64.8	5.8	3.8
11	69.6	−0.6	5.8	71.0	2.8	7.0
12	63.6	1.2	2.0	68.6	8.0	7.9
Av.	68.5	0.8	3.6	68.0	6.1	6.6

of 6.1 per minute, and the reduction averaged 6.6 per minute 1 hour after entering shade, leaving actual pulse rate at 61.4 per minute, the lowest of any observation period.

DISCUSSION

In the present study cows entering shade (dry) derived more benefit from the shade furnished by the openly ventilated barn than did cows observed in a previous study (7) utilizing shade of trees in a pasture. It is probable that the barn furnished more complete shade than did the trees in the pasture. Also, air temperatures in the previous study continued to increase after cows entered shade (average time 9 : 20 a.m.) ; in this study there was little increase in air temperature after 2 : 00 p.m., when cows were taken from sunshine into shade. Another factor to consider is that cows used in the present study were all grade Jerseys producing only small amounts of milk. In the pasture study (7) heavier producing cows were observed and one-half of the cows were Holsteins, a breed shown (9) to have a lower rating on heat tolerance than Jerseys. It is possible that a higher humidity in the forenoon than in the afternoon (which is usual in Louisiana) may be a contributing factor to differences found in these two experiments. The effects due to this cause, however, would not be expected to be large, in view of results from a previous study (8), where it was found that high humidity played a minor rôle as a factor affecting body temperature, respiration rate, and pulse rate of dairy cows.

When cows in this study were sprinkled with water prior to entering shade, their body temperatures and respiration rates rapidly approached what has been reported as normal (2). It probably would require periodic sprinkling, perhaps once per hour, to hold such cows closer to normal than cows going into shade without sprinkling. However, as has been shown in this experiment, the unsprinkled group of cows would be slower in approaching normal. Whether or not practical sprinkling devices can be developed remains to be seen. Preliminary trials by the authors have shown that cows do not care to go into a coarse spray of water such as that produced by a conventional hose nozzle often used for lawns and gardens. Cows will go into a finer spray when located in the shade, according to a verbal report from a dairyman having had experience on a tropical island during the last war emergency period. Likewise, it has been observed by the authors that cattle when abnormally warm will usually relish wading into streams or ponds, particularly if they are located in the shade.

SUMMARY

1. Four grade Jersey cows were observed during 10 relatively warm days in an effort to determine how shade alone or sprinkling with water followed by shade affected their comfort. Air temperatures during periods of obser-

vation varied from 83 to 90° F. and relative humidity between 61 and 80 per cent.

2. Body temperatures of cows after exposure to sunshine for 2 hours averaged 102.66° F., and removal to shade (dry) resulted in reductions of 0.34° and 0.74° F. after 0.5 hour and 1 hour, respectively.

3. Sprinkling of cows (with original body temperatures after being in the sun of 102.53° F.) reduced body temperatures by 0.54° F. after 0.5 hour in shade, and by 1.08° F. after 1 hour in shade. In the latter case cows had temperatures which are considered normal.

4. Respiration rates reduced to levels which averaged lower after 0.5 hour than after 1 hour in shade. Cows not sprinkled showed a respiration rate of 83 per minute in the sun and an average decrease in rate of breathing of 27.2 at end of 0.5 hour and 25.2 after 1 hour in the shade.

5. Cows sprinkled prior to entering shade had much greater reductions in rate of breathing than did non-sprinkled cows, *i.e.*, 49.4 less after 0.5 hour and 41.6 less after 1 hour.

6. Reductions in rate of breathing for non-sprinkled cows vs. those sprinkled favored the latter group by 81 per cent at end of 0.5 hour and 65 per cent after 1 hour in shade.

7. Average reduction in pulse rate for non-sprinkled cows after being in shade 0.5 hour was insignificant (0.8 per minute) but was significant (3.6) after 1 hour. Cows when sprinkled showed decreases in pulse rate that averaged 6.1 after 0.5 hour and 6.6 after 1 hour.

8. Either shade alone or sprinkling followed by shade was found effective in reducing body temperature, respiration rate, and pulse rate of dairy cows, with the second procedure being more rapid and also more effective in causing animals to approach readings which are considered normal.

Thanks are due Dr. L. L. Rusoff of the Dairy Research Department for suggestions made toward the improvement of the report on this experiment.

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ETHYL ALCOHOL FROM WHEY

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The preliminary report by Browne (1) on the production of ethyl alcohol from the fermentation of lactose in whey was published before the War. This early work with small batches of material gave evidence of promise. Whey as a raw material seemed a likely source of alcohol, since it probably is as cheap as any source of fermentable sugar, if a sufficient supply is readily and locally available. Furthermore, there is the constant problem, sometimes serious, of reducing the B.O.D. of effluents to streams. Therefore, work was conducted on the selection of desirable yeast strains, on the physiology of lactose-fermenting yeasts, of which practically nothing was known, and on the definition of the conditions for a more efficient and economically feasible fermentation of lactose to alcohol by yeast.

EXPERIMENTAL AND RESULTS

At the beginning of this work it was quickly apparent from the results being obtained with the very few strains of lactose-fermenting yeasts then available, that it was essential to examine many different types of lactose-fermenting yeasts for their suitability for alcohol production. Accordingly, a large and heterogeneous collection of lactose-fermenting yeasts was acquired.

The ability of the different types of lactose-fermenting yeasts to ferment the lactose in whey was measured by direct analyses of the residual lactose in the fermenting flasks after various periods of incubation at the optimal fermentation temperature for each organism. In each instance at least five analyses were made at different times during the course of a fermentation period. The relative rates of fermentation of whey containing 5 per cent of lactose at the beginning of the fermentation are shown in figure 1. After 55 hours *Torula cremoris* #2 had fermented all the lactose. In comparison, the following percentages of residual lactose were present in the case of other organisms tested: *Zygosaccharomyces lactis,* 3.8; *Torulopsis kefir,* 2.9; *Mycotorula lactis,* 3.1; *Candida pseudotropicalis,* 1.7; *Saccharomyces anamensis,* 1.6; *Saccharomyces lactis,* 1.7; *Saccharomyces fragilis,* 1.4; *Torula lactosa,* 1.3; *Torula sphaerica,* 1.2; and Type F, an unidentified lactose-fermenting yeast, 1.3. Thus, certain strains of *Torula cremoris* were the most efficient of all the tested lactose-fermenting yeasts in the fermentation of lactose in whey. Consequently, the later pilot plant experiments were conducted with a strain of this yeast, *Torula cremoris* #2.

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[1] Deceased January 7, 1947.

It then seemed advisable to determine the optimal conditions for fermentation. Tests at temperatures of 30°, 32°, 34°, 37° and 42° C. were made in a number of experiments, the results of which are depicted in figure 2. Fermentation took place faster at 37° C. than at any of the other temperatures used. However, after slightly longer intervals of time than are shown in the figure, the initial and somewhat later superiority of 37° C. over 32° C.

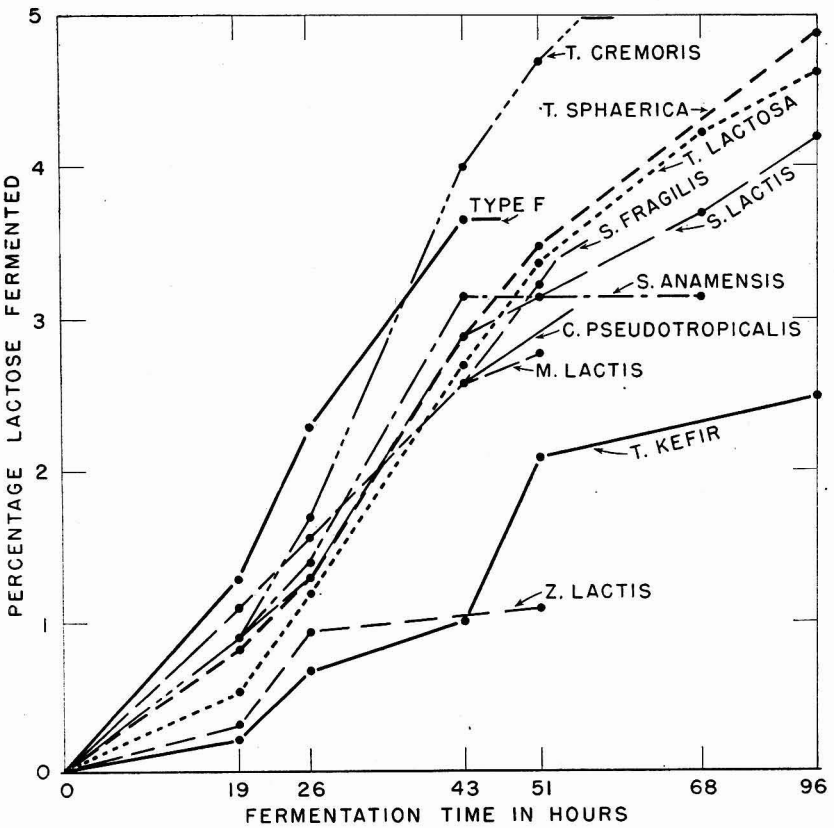

FIG. 1. Relative efficiency of lactose fermentation by lactose-fermenting yeasts.

is hardly apparent, and usually there is very little difference in the times necessary to effect complete fermentation (no residual lactose) at the two temperatures. Also, in fermenting larger batches of whey (150 gallons) which had an initial temperature of 30° C., the temperature rose to a maximum of 33–34° C. (heat of fermentation) and remained at this level throughout the most active period of the fermentation. Because of these considerations and also because higher temperatures may induce greater losses of

alcohol by evaporation, thus lowering the yield, it is recommended that a temperature range of 33–34° C. be used.

The question as to how much yeast should be used in the fermentation is important in terms of the time and economy of the fermentation. On the basis of the average number of grams of lactose fermented per gram of yeast per hour of elapsed fermentation time, it was established that a maximum amount of yeast corresponding to 2 per cent of the weight of the lactose initially present is sufficient to ensure a satisfactory rate of fermentation. In experiments with larger batches of whey, amounts of yeast as

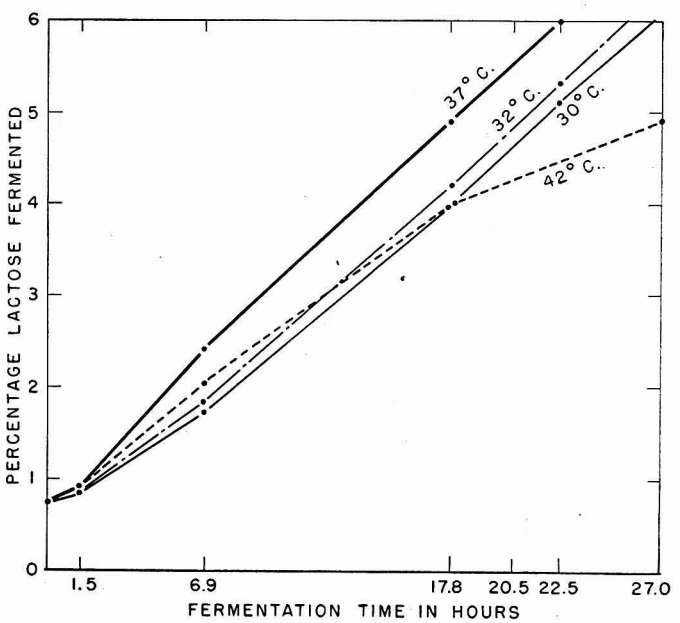

FIG. 2. Influence of temperature on the rate of lactose fermentation by *Torula cremoris*.

low as 1 per cent fermented the whey at a satisfactory rate if the yeast was in good condition.

The whey may be treated with heat, and either sour whey or acid may be added to precipitate the protein in the whey before the fermentation. If the whey is not treated, the initial pH of the whey mash should approximate a value of 6.0. If the whey is acidified, our experience with different batches and types of whey has been that the initial pH of the clarified whey should lie within a range of 4.8 to 5.2. Obviously, it is important to know what effects the initial pH, as well as the change in pH during the course of the fermentation, have on the rate and extent of lactose fermentation by the yeast. Also, it is desirable to conduct the fermentation at as low a

pH value as possible in order to minimize growth of contaminating microorganisms. Clarification may be of great advantage regardless of the utility or economy of isolating the whey protein, since the pH is lowered.

Results of fermentation begun at different pH levels from 6.0 to 4.6 are depicted in figure 3. A pH range of 4.7 to 5.0 is satisfactory for a good fermentation. Peculiarly, an initial pH of 6.0 (unclarified whey) also was satisfactory, whereas at intermediate pH levels irregular and less satisfactory results were obtained.

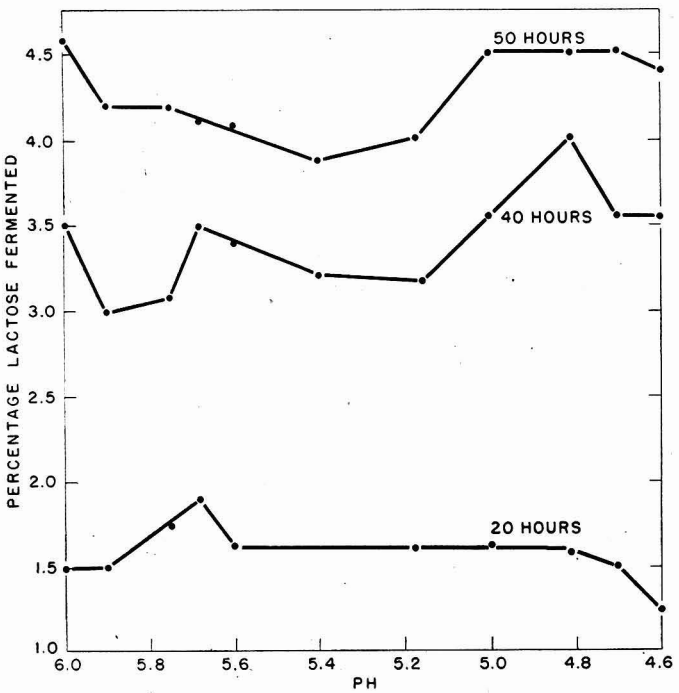

FIG. 3. Influence of pH on the fermentation of lactose by *Torula cremoris*.

The course of pH change from the initial value is shown in figure 4. A relatively small change in acidity occurs during the course of a fermentation when the fermentation is begun within the range of pH 4.7 to 5.0. In view of these results, it is recommended that the initial pH of a whey mash be adjusted to a range of 4.7 to 5.0.

Yields averaging 90.73 per cent of the lactose as alcohol have been obtained from the complete fermentation on a laboratory scale. Under semiplant conditions yields were somewhat lower (as low as 84 per cent), probably due to the inefficient still employed. These yields compare favorably with other processes.

The quality of the alcohol was highly satisfactory. Customary "rub" tests for fusel oils and esterification tests for amyl alcohol were negative. Like other alcohols produced from grain and similar raw materials, this alcohol contains small quanties of aldehydes. However, they may be eliminated conveniently in the rectification of the crude distillate.

By-products from the fermentation, such as the whey protein and the slops, are of value as feed. The riboflavin and other vitamin content will

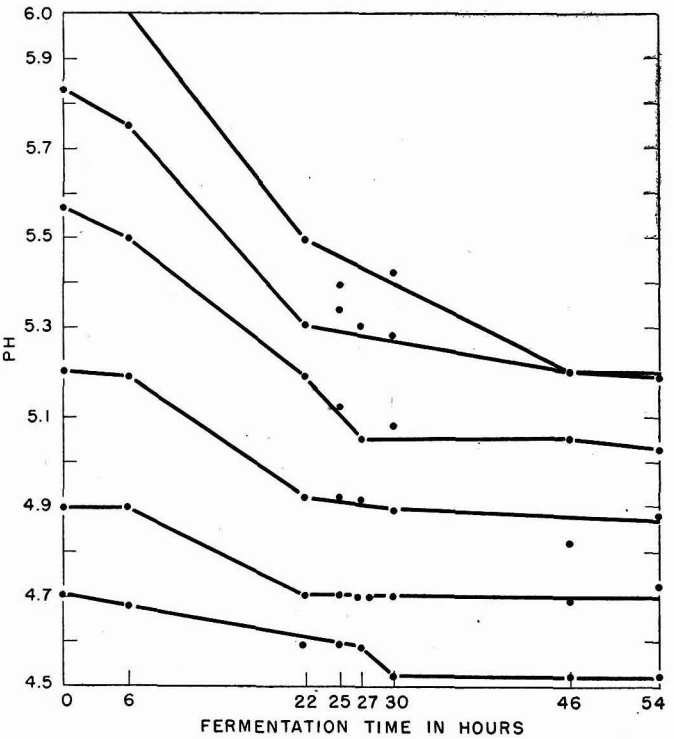

FIG. 4. Course of pH change during fermentation by *Torula cremoris*.

compare well, if not more favorably, with the vitamin content of the original whey on a dry basis. If the slops are to be dried for feed, the beer should be distilled at its naturally acid pH. Subsequent rectification of the crude alcohol can be conducted in the alkaline region to remove aldehydes.

EQUIPMENT AND OPERATION

On the basis of experimental work with 150-gallon batches of whey, it appears that the equipment for alcohol production should include at least the following items: a separator for removing the fat from the whey, a tank

fitted with a steam pipe for heating the whey, a filter press, a cooler for cooling the heated whey, one or more closed fermenting vats depending on the capacity of the plant, yeast tubs in a yeast room for propagating the yeast, an air line provided with a filter to furnish sterile air, a yeast recovery separator, an appropriately designed still, a storage tank for the distilled alcohol, condensing and drying facilities for the stillage slops if they are to be recovered, pumps, pipe lines, and a source of steam.

The accompanying flow-sheet (figure 5) gives a simplified and general

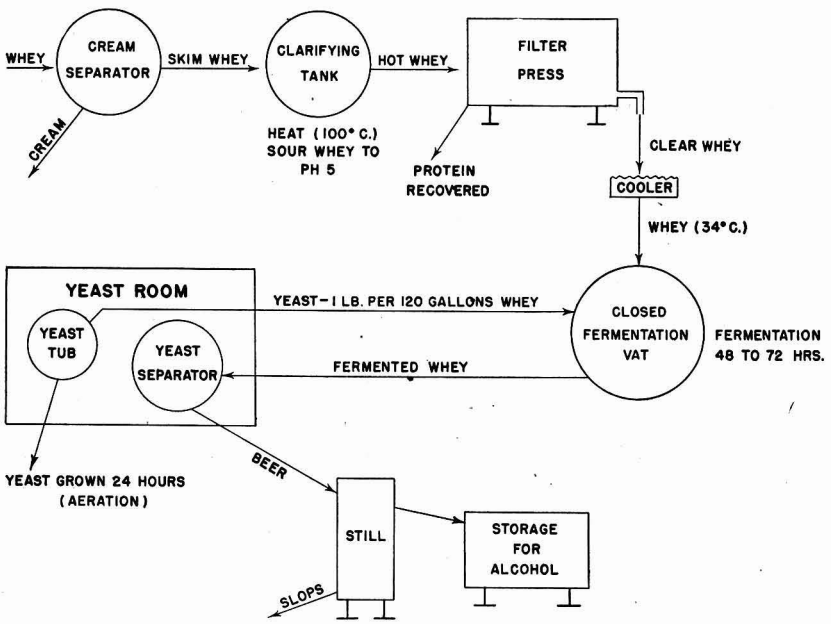

FIG. 5. Flow-sheet of alcohol production from whey.

picture of a total operation. The steps in which a filter press and yeast recovery separator are used may be omitted. This is true particularly if the slops are to be recovered and sold for feed. In this case all the protein in the whey and the yeast from the fermentation are wanted in the condensed or dried stillage slops for their nutritional value.

DISCUSSION

It is difficult to predict the costs involved compared to grain or molasses fermentation because much depends on local conditions, such as availability of raw materials; nevertheless, it is possible to make some tentative statements. Capital costs may compare favorably with other processes, since the alcohol plant could be a by-product plant operating as an adjunct to a

cheese or casein factory from which some space, equipment, and low-pressure steam would be available. In this case, the major capital outlay would be limited to the cost of clarifying, fermenting, condensing, and distilling equipment. The steam cost for a finished 95 per cent alcohol from whey would be higher than that from other processes, since a grain or molasses mash can be fermented to a higher alcohol content. But the relative cost of capital outlay, raw materials, and similar items probably would compensate for the higher steam costs of the whey process. However, higher steam costs might be reduced considerably and even to a favorable competitive basis because sugar (glucose sirups or molasses) might be added to the whey and fermented to a higher alcohol content than the lactose naturally present in whey would permit. The addition of other sugars is feasible since whey contains all the necessary growth factors for the fermentation of these sugars by lactose-fermenting yeasts. Since the supply of whey may not be steady, and since the plant should be constructed for a maximum supply of whey, the addition of sugar sirups seems to be an economically desirable feature of the process.

SUMMARY

1. Various types of lactose-fermenting yeast were tested for their efficiency in fermenting lactose in whey, and *Torula cremoris* was selected as the most efficient organism.

2. The optimal operating temperature for the fermentation in the semi-plant was found to be 33–34° C.

3. The pH of a whey mash should be within the range of 4.7 to 5.0.

4. Yeast equivalent to two per cent of the weight of the lactose is sufficient for satisfactory fermentation.

5. Yields of alcohol were obtained averaging 90.73 per cent in the laboratory and as low as 84 per cent in the plant.

6. The equipment and the operation of a plant producing alcohol from whey are described.

7. The relative economy of the process is discussed.

REFERENCE

(1) BROWNE, H. H. Ethyl Alcohol from Fermentation of Lactose in Whey. Indus. and Engin. Chem., News Ed., 19: 1271. 1941.

ASSOCIATION ANNOUNCEMENTS

ANNUAL MEETING: ONTARIO AGRICULTURAL COLLEGE, GUELPH, ONTARIO, CANADA, JUNE 24–26, 1947

ABSTRACTS OF PAPERS

All abstracts of papers to be given at the annual meeting must be received by the section Chairman by May 30. They should be mailed to the committee chairman to whom the title was sent.

REGISTRATION AND HOUSING

Registration headquarters will be in the Administration Building, Ontario Agricultural College, Guelph, Ontario.

Housing facilities will be available in College dormitories. Rooms in local hotels are very scarce. Meals will be served cafeteria style in Creelman Hall. An attempt will be made to house family groups in the same dormitories. Rooms and meals will cost $2.50 a day. Individual meals for delegates not in the dormitories will cost 50¢ each. A return card relative to advance registration and housing will be sent to members by the Association Secretary in May.

PROJECTION EQUIPMENT

Lanterns will be available in all lecture rooms for projection of standard and 2″ × 2″ slides. Projectors for 16-mm. movies will be available by arrangement. Request for projection equipment should be made at the time abstracts of papers are submitted to the respective section Chairman. For the benefit of any bringing special electrical equipment, the available current is all 25 cycle.

COMMITTEE MEETINGS

Those wishing rooms for Extension and Production Section Committee meetings should write or contact G. E. Raithby and those in the Manufacturing Section wishing the use of rooms for Committee meetings should write or contact W. H. Sproule.

SPECIAL MEETINGS

Groups wishing rooms and equipment for special meetings before, during, or after the regular session will please contact G. E. Raithby. Provision can also be made for a limited number of breakfasts, luncheons, or dinners for special groups.

TRAVEL SUGGESTIONS

Guelph is serviced by the two main railway lines in Canada, Canadian National and Canadian Pacific. Bus lines from the South, East and West

lead to the city. Highways nos. 6, 7, and 24 pass through the city, and motorists should make inquiry after crossing the border for highway suggestions. Representatives of the Ontario Tourists Association, located at border crossing points in Ontario, will be notified of the Conference and will be glad to give assistance. The nearest airport is at Malton, Ontario, about fifty miles from the College. Malton is on the main line of the Canadian National Railway between Toronto and Guelph.

RECREATION

On the campus are tennis courts, baseball diamonds, and an indoor swimming pool. Adjoining the College is a pay-as-you-play golf course.

G. E. Raithby of the Animal Husbandry Department, Ontario Agricultural College, Guelph, has been designated as the representative of the host institution.

W. D. Tolton of the Ontario Agricultural College, Guelph, has been appointed to membership on the Extension Section Committee on Teaching Methods and Exhibits.

VOLUME XXX APRIL, 1947 NUMBER 4

JOURNAL OF DAIRY SCIENCE

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ABSTRACTS OF LITERATURE

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JOURNALS

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American Journal of Public Health
Archives of Pediatrics
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Biochemical Journal

Canadian Dairy and Ice Cream Journal
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Endocrinology

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Ice Cream Trade Journal
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Nordisk Mejeri-Tidsskrift

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Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

SPECIAL PUBLICATIONS

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Milk Industry Foundation

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New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEWS

86. Milk Marketing under Federal Control. CARL MCFARLAND, Formerly Assistant Attorney General of the United States. 205 pages. $7.50. Milk Indus. Found., Washington, D. C. 1946.

This book deals in a technical legal manner mainly with regulation conducted under the Agricultural Marketing Agreement Act of 1937. The growth in the last 50 years of legislation by administrative directive rather than by statute is commented upon. Most dairy laws in the past have consisted of rather narrow and specific governing statutes with provision for judicial enforcement. Broad administrative powers are given in the Food, Drug and Cosmetic Act of 1938 and still broader ones in the Agricultural Marketing Agreement Act of 1937. The official code carries the last four sections of the 1937 act under the chapter title "Agricultural Marketing Agreement Act" and the remainder under the "Agricultural Adjustment Act of 1933".

The essential substance of the Marketing Act is the fixing of minimum producer prices to be paid and prescribing how they are to be paid by handlers. In discussing detailed procedure and administration, the statement is made that the Marketing Act prescribes what is in some essential respects the most complicated procedural system on the Federal statute books. Detailed steps are outlined covering mediation and arbitration, the marketing agreement and order procedure, administrative and judicial review of orders, enforcement provisions and methods, and, finally, organization and personnel. Responsibility for the administration of the act rests with the Secretary of Agriculture. The final chapter gives a summary of typical marketing order provisions and a review of the issues which underlie them.

Appendices include a transcript of the Act, rules of practice and procedure, and marketing order references to the Federal Register for 49 different markets. E.F.G.

87. Bovine Mastitis. A symposium edited by RALPH B. LITTLE AND WAYNE N. PLASTRIDGE. 546 pages, illustrated. $7.00. 1946. McGraw-Hill Company, Inc., 330 West 42nd St., New York 18, N. Y.

This book is a thorough and critical treatment of the various aspects of this widespread and costly disease of dairy cattle. The editors and publisher are to be commended for their method of having the various sections or chapters written by recognized authorities in the field. The subject is covered in a broad and critical sense and wide differences of opinion recog-

nized. The anatomy of the udder, the physiology of milk secretion, the pathology, diagnosis, bacteriological classification, transmission, treatment, control and public health significance of mastitis are among the subjects covered. An appendix giving details of tests, laboratory techniques, and methods is a useful addendum. Although this book is prepared in the form of a symposium, it should prove to be a useful text for students and investigators in the field and a reference work for veterinarians, dairymen, public health officials, and milk sanitarians. T.S.S.

88. The Problem of Fertility. Edited by EARL T. ENGLE. 254 pages. $3.75. 1947. Princeton University Press, Princeton, N. J.

This publication consists of a series of 16 papers presented at the Conference on Fertility sponsored by the National Committee on Maternal Health. These papers cover fields of active interest and investigation relating to the problem of fertility in man and animals. The inclusion of the discussions which followed the presentation of each paper provides additional interesting information and points of view.

The following subjects are presented: Patterns of Estrous Cycles, by S. A. Asdell; Ovulation in Sheep and Goats, by R. W. Phillips, R. M. Fraps, and A. H. Frank; Induction of Ovulation and Subsequent Fertility in Domestic Animals, by L. E. Casida; the Induction of Ovulation in Domestic Animals, by John Hammond; the Ovary at the Time of Ovulation, by George W. Corner; Hormonal Control of Ovulation, by H. H. Cole; Cervical Mucus and the Menstrual Cycle, by W. T. Pommerenke and Ellenmae Viergiver; Spermatozoa and Cervical Mucus, by A. R. Abarbanel; Glycolosis, Livability, and Fertility of Bovine Spermatozoa, by G. W. Salisbury; Metabolism and Motility of Human Spermatozoa, by John Macleod; Fertilizing Capacity of Rabbit Spermatozoa, by M. C. Chang; Biology of Equine Spermatozoa, by Victor R. Berliner; Artificial Insemination of Dairy Cattle, by J. W. Bartlett; The Cervix Uteri in Sterile Matings, by Fred A. Simmons; The Effect of Synthetic Thyroprotein on Sterility in Bulls, by E. P. Reineke; and Methods of Determining the Time of Ovulation in Domestic Animals, by John Hammond.

This book should prove of special interest and value to those engaged in the various phases of artificial insemination work. The discussions are well supported by experimental data and illustrations. T.S.S.

BACTERIOLOGY

89. The Growth of Coliform Bacteria in Pasteurized Milk Stored at Refrigerated Temperatures. A. C. DAHLBERG, Dept. of Dairy Ind., Cornell University, Ithaca, N. Y. Dairy Indus. Found. Assoc. Bull., *39*, 4: 86–95. Jan. 10, 1947.

Results previously published by the author (Jour. Dairy Sci., *29*: 651–

655, 1946) are given in detailed tables which show that coliform bacteria increase more rapidly in numbers than other bacteria in pasteurized milk held at refrigeration temperatures. Coliform bacteria were present in the majority of freshly pasteurized milk in one quart volumes. After storage at 45–50° F. and 55–60° F., the coliform bacteria constituted significant percentages of the total bacterial content. Since coliform bacteria in themselves are not a public health problem unless present in excessive numbers, a standard for condemnation might well be one that can be met by the best sanitary plants in the summer when counts are naturally the highest. No numerical standard is proposed by the author. E.F.G.

90. **Coliform Bacteria Problem and Its Control.** A. C. DAHLBERG, Dept. of Dairy Ind., Cornell University, Ithaca, N. Y. Milk Dealer, *36*, 4: 130–133. Jan., 1947.

See preceding abstract.

91. **Coliform Organisms in Pasteurized Milk.** C. J. BABCOCK, Market Milk Specialist, B.A.I., Agr. Res. Admin., U. S. Dept. Agr., Washington, D. C. Milk Indus. Found. Assoc. Bul., *39*, 4: 78–85. Jan. 10, 1947.

During the war the Medical Department of the Army made extensive application of the coliform test at Army installations throughout the country as an index to the sanitary conditions under which pasteurized milk is handled. Milk to be tested was inoculated into five tubes. If three or more of the tubes showed fermentation, the sample was considered positive for coliform organisms. Army installations adopting this method obtained very satisfactory results. A positive test may be due to improper pasteurization, heat-resistant organisms, excessive contamination of raw milk, or growth after pasteurization. There was no correlation between the results of the coliform test and the standard plate count. Positive and negative coliform results were obtained on both low and high count milk. Whenever coliform organisms are found in the milk delivered to the consumer, the condition almost invariably can be corrected by a thorough cleanup of the plant equipment. Thus the test is an ideal means of checking the cleanup operations in a plant. E.F.G.

92. **The Viability of Dried Skim-Milk Cultures of *Lactobacillus bulgaricus* as Affected by the Temperature of Reconstitution.** MARVIN L. SPECK AND ROBERT P. MYERS, National Dairy Products Corp., Baltimore, Md. Jour. Bact., *52*: 657. Dec., 1946.

"In spray-dried skim-milk cultures of *Lactobacillus bulgaricus* a large number of cells that failed to grow when the temperature of the reconstitu-

ting fluid was 21 to 25° C. were activated sufficiently to produce normal growth when the temperature of the reconstituting fluid was 37 to 50° C. When the culture was reconstituted at 21 to 25° C. and warmed to 50° C., the activating effect of the heat was not obtained.

"The increase in the colony count resulting from reconstitution at 50° C. over reconstitution at 21 to 25° C. could not be explained by an increase in the solubility of the powder, nor an increase in the dispersion of the cells.

"Reconstitution of dried *L. bulgaricus* at 50° C. with subsequent inoculation into skim milk showed greater activity in the skim milk, particularly in the early stages of growth, than was obtained when the culture was reconstituted at 21 to 25° C.

"Freeze-drying part of a skim-milk culture that was also spray-dried showed that cells in the freeze-dried culture were not only activated by reconstitution at 50° but that this temperature actually was lethal to many of the cells. This suggested a physiological difference between freeze-dried and spray-dried cells of *L. bulgaricus,* since the latter were markedly activated by heat." D.P.G.

93. Spotting and Evaluating Biological Dirt. M. C. JAMIESON, H. J. FORSTER, AND A. REY. Canad. Dairy and Ice Cream Jour., *26*, 1: 28. Jan., 1947.

Biological dirt ordinarily is invisible dirt that contains bacteria, spoils food products, and sometimes causes sickness and even death. The suitcase type laboratory developed for assisting eating and drinking establishments in sanitation problems (Abs. no. 446, Jour. Dairy Sci., *29,* 12: A206, Dec., 1946) has been extended to the dairy industry. "Jamieson's Sanitation Kit" has been used by a few dairies and by the Manitoba Department of Public Health. The test is simple and requires little technical training or scientific interpretation. The representative area of surface is swabbed off; the swab is smeared over the medium prepared in convenient, small, screw-capped bottles and incubated at room temperature for 3 days. The fewer the colonies that develop, the cleaner the equipment. All plant employees see the results and take an active interest in producing clean culture bottles. Application of this test for farm use is promising. H.P.

94. Vitamin A and Carotene Content of Ontario Butter. W. H. SPROULE, F. W. HAMILTON, C. E. LACKNER, S. H. JACKSON, T. G. H. DRAKE, AND M. MOFFAT. Canad. Dairy and Ice Cream Jour., *25,* 12: 23. Dec., 1946.

The mean vitamin A potency of butter from 21 creameries representing the five geographical regions of Ontario was 13,269 I.U. per pound. The monthly mean for the period May to November was 14,702 I.U. and from

December to April 9,915 I.U. per pound. During the periods mentioned, carotene supplied 28.8, 25.2, and 17.6% of the total vitamin A potency of Ontario butter. The vitamin A and carotene contents of butter vary with the month of the year as well as with different regions of production, depending primarily upon pasture supplies. The peak values for both vitamin A and carotene were reached in the month of June, followed by a downward trend during the warm midsummer and early autumn period. The latter value returned to almost the June level in October. A slight decline took place in December, which continued throughout the winter, when the lowest values for the year were recorded. H.P.

CHEESE

95. A Study of Canadian Cheese on United Kingdom Markets. WM. C. CAMERON. Canad. Dairy and Ice Cream Jour., *26,* 1: 33. Jan., 1947.

There is a market in Great Britain for select cheese of uniformly high quality, for which a premium will be paid. To reach this objective, the three main points which warrant special care and attention are: (1) clean milk supply, (2) amount of acid in the finished cheese, and (3) closeness of body. Excellent cheese is one having a close-boring, meaty texture with a clean, nutty, cheddar flavor. Two major defects found in Canadian cheese were openness and curdy body, the latter varying from a dry texture to a chalky or pasty texture. It was generally agreed that in most cases where openness was found the curd had not been sufficiently matured on the pan before milling and later, before salting. It is claimed that too much "added acid" in the form of starter is detrimental to the Cheddar cheese. Not over 1.5% starter is recommended if the cheese is not to become acidy on aging. H.P.

96. Give the Cheese of the Lower Fat Type the Place Due It—20% Steppe Cheese. F. L. (FRANK LAMBERTSEN), Nordisk Mejeri-Tidsskrift, *12,* 6: 109–110. 1946.

Cheese made from partly skimmed milk should be produced more than it actually is. This cheese always will have a market because it is cheaper than cheese made from whole milk and it contains the same amount of the nutritionally important solids, protein, and calcium salts.

Steppe-cheese is a square-formed cheese, weighing from 11–13 lbs., with an elastic consistency. Cut, it shows evenly distributed eyes about ¼ in. in diameter. A method that has been used for making this cheese for many years in a Danish factory is given. The milk used is pasteurized. Before the renneting, 2–3% starter, 5% water, and calcium chloride (if necessary) are added to the milk. Rennet at the rate of 230 cc. per 1,000 lbs. of milk

(50 cc. per 100 kgs.) is added at 97° F. and the setting period is 40 min. The curd is cut by 1-cm. knives and stirred for 20 min., after which a little more than half of the whey is drained off. Now the curd is stirred vigorously by a fork and heated quickly to 106° F. by adding boiling water, while the vigorous stirring is continued. Some more whey is drained off and the stirring of the curd finished within about 40 min. Salt, 2.5 lbs. per 1,000 lbs. of milk (250 g. per 100 kgs.), is added to the water used for heating. The stirring finished, the curd is cooled down to 99° F., drawn to the end of the vat, and piled for about 20 min., after which it is cut in blocks, hooped and pressed in a cheese press for 45 min. After pressing the cheese is placed in cold water over night and next morning in brine for 72 hr. After a short period in a cooler at 61° F., the cheese is finished at 54° F. and 80% humidity. The cheese can be stored for 7–8 months. T.K.

CHEMISTRY

97. Colorimetric Determination of DDT in Milk and Fatty Materials. M. S. SCHECHTER, M. A. POGORELSKIN, AND H. L. HALLER, U. S. Dept. Agr., Agr. Res. Admin., Bur. of Entomology and Plant Quarantine, Beltsville, Md. Analyt. Chem., *19,* 1: 51–53. Jan., 1947.

Recent work has shown that contamination of milk, butter, eggs and meat may result when farm animals consume DDT-treated feed; that ingested DDT accumulates as such in the fatty tissues of experimental animals and can be excreted in milk; and that such milk may become toxic enough to kill other animals drinking it. This report describes a procedure for the determination of DDT as such in foodstuffs containing considerable amounts of fatty matter. The method is not rapid but it permits the detection and determination of DDT in milk in quantities as low as 1 p.p.m. Milk is extracted with Skellysolve B, the emulsions are broken by means of a centrifuge, and DDT is separated from the fatty fraction by a sulfuric acid treatment based on the solubility of fats and the insolubility of DDT in concentrated sulfuric acid. The DDT residue is nitrated and DDT is determined by spectrophotometric measurements. B.H.W.

98. Estimation of DDT in Milk by Determination of Organic Chlorine. R. H. CARTER, U. S. Dept. Agr., Agr. Res. Admin., Bur. of Entomology and Plant Quarantine, Beltsville, Md. Analyt. Chem., *19,* 1: 54. Jan., 1947.

The method presented describes a procedure for estimation of DDT in milk and butter samples by determination of the total organic chlorine. The method is rapid, simple, and reasonably sensitive, but it is not specific for DDT. The sample is extracted with ethyl ether and Skellysolve B, the fat

in the extract then is saponified and removed from the mixture, and the aqueous filtrate extracted and subjected to a determination of chloride ion by any standard procedure. The amount of DDT is calculated by multiplying the amount of chlorine by 2. B.H.W.

99. **Recovery of Lactic Acid from Dilute Solutions.** A. A. DIETZ WITH E. F. DEGERING, Purdue Univ., Lafayette, Ind., AND H. H. SCHOPMEYER, Amer. Maize-Products Co., Roby, Ind. Indus. and Engin. Chem., Indus. Ed., *39*, 1: 82–85. Jan., 1947.

Lactic acid of varying degrees of purity may be obtained by solvent extraction, steam distillation and crystallization of its salts. The recovery of lactic acid by passing vapors of an alcohol through a partly concentrated lactic acid solution previously has been reported. A pure grade of acid may be prepared by the hydrolysis of an alkyl lactate. In the present investigation a study was made of the recovery of lactic acid as an ester directly from dilute solutions. The acid is converted to an ester and is extracted with a solvent in which it is preferentially soluble. Certain chlorinated hydrocarbons were found to be selective solvents. The preparation of ethyl and propyl lactates with 1,2-dichloroethane as the solvent is described. The esters can be purified to any desired degree by distillation. B.H.W.

100. **Applied Ultraviolet Spectrophotometry of Fats and Oils.** B. W. BEADLE, Res. Lab., American Meat Institute, Univ. of Chicago, Chicago, Ill. Oil and Soap, *23*, 5: 140. May, 1946.

The application of spectrophotometry to the analysis of fats and oils is described. It is especially useful in studying the changes in the double bond systems of fatty acids. The method is applicable to routine analytical work in connection with the processing of oils as well as to academic studies on the composition of naturally occurring fats and oils. The determinations of small amounts of fatty acids with two or more double bonds or of small amounts of conjugated bonds are possible by this method because of its high sensitivity. J.L.H.

101. **The Oxidation of Methyl Oleate. I. The Preparation, Properties and Reactions of Methyl Hydroperoxido Oleate.** C. E. SWIFT, F. G. DOLLEAR, AND R. T. O'CONNOR. So. Regional Res. Lab., New Orleans, La. Oil and Soap, *23*, 11: 355. Nov., 1946.

The above work was designed to test reports in the literature that methyl hydroperoxido oleate is a product in the oxidation of methyl oleate. Methyl hydroperoxido oleate was separated by low temperature fractional crystallization from partially oxidized methyl oleate. Certain characteristics of the original hydroperoxido and its reaction products are described which "lend

definite support to the view that the first oxidation product of methyl oleate is a mixture of 8- and 11-hydroperoxido octadecenoic acid, at least under the conditions employed, *i.e.*, oxidation under the influence of ultraviolet light or reaction at temperatures up to 60° C." J.L.H.

102. Flavor Reversion in Soybean Oil. II. The Effect of Atmospheres of Different Oxygen Concentrations on the Flavor Reversion of Soybean Oil. CALVIN GOLUMBIC, C. J. MARTIN, AND B. F. DOUBERT, Dept. of Chemistry, Univ. of Pittsburgh, Pittsburgh, Pa. Oil and Soap, *23*, 11: 360. Nov., 1946.

Samples of soybean oil were treated with slow-moving streams of oxygen, tank nitrogen containing 0.5% oxygen, or nitrogen purified by passage over heated copper turnings. The samples were maintained in a water bath at 45.5° C. in Petroff culture flasks. A 250-watt G.E. reflector-drying lamp was placed 3 in. directly over the flask and allowed to act during the flowing of the gas.

It was found that the oxidation rate of soybean oil could be varied over a considerable range without influencing the organoleptic evaluation of the degree of inversion. Even the low rate of oxidation attained by the use of purified nitrogen failed to influence the tendency to revert. When low oxygen concentrations were used, the typical grassy reversion flavor was accompanied by a disagreeable and persistent drying after-taste not readily detectable in the soybean oil reverted in air or oxygen. Reversion under nitrogen ocurred at very low peroxide values. J.L.H.

103. Flavor Reversion in Soybean Oil. III. The Preparation and Flavor Characteristics of a Simulated Soybean Oil. CALVIN GOLUMBIC, A. I. SCHEPARTZ, AND B. F. DAUBERT, Univ. of Pittsburgh, Pittsburgh, Pa. Oil and Soap, *23*, 12: 380. Dec., 1946.

Fatty acids were prepared from Neofat, olive oil, cottonseed oil, and linseed oil. The fatty acids were mixed in the proportion in which they occur in soybean oil and were esterified with glycerol. The resulting simulated soybean oil was tested for flavor inversion, a defect common in soybean oil. The flavor produced in the simulated oil by heat and light treatment was distinctly different from the flavor appearing in soybean oil subjected to the same treatment. The results "tend to indicate that the ordinary fatty acid constituents of soybean oil are not entirely responsible for the flavor characteristics of reverted soybean oil. Likewise the hypothesis that linolenic acid is the sole causative agent does not appear likely although it is possible that this acid contributes to the flavor instability of soybean oil." J.L.H.

104. Evaluation of Tests for Rancidity in Edible Packaged Oils. JOHN E. W. MCCONNELL AND W. B. ESSELEN, JR. Food Tech. Dept.,

Mass. State College, Amherst, Mass. Oil and Soap, *23,* 12: 369. Dec., 1946.

In this study oils were stored in sealed containers and later subjected to several tests in order to evaluate the reliability of these tests for quantitative measurements of the extent of rancidity (oxidative). The organoleptic test was found to be the most satisfactory method for determining the quality of corn and cottonseed oils which had been aged in sealed containers.

A high storage temperature or the presence of air influenced the fading time of methylene blue. In sealed containers the aldehyde formation in oils was very slow despite extensive development of rancidity. In oils exposed to air, the aldehydes increased. The results obtained on the changes in film pressure of monomolecular film of corn or cottonseed oil indicate that the change in pressure is not wholly dependent on the organoleptic quality of the oil but is influenced by the oxidation products formed in the presence of excess air.

The oils aged in the dark at 100° C. developed rancidity rapidly, whether stored in sealed containers or exposed to air. Little color change took place in the oils in sealed containers; those exposed to air darkened at first, after which bleaching occurred. Samples exposed to sunlamps at 38° C. deteriorated rapidly in organoleptic quality, whether exposed to air or not. Bleaching occurred in the sealed tubes whereas exposure to air slowed up this action appreciably. This indicates that light is the main factor in fading, while the darkening is caused by the excess oxygen and is accelerated by heat. The implications of these facts in the chain of reactions resulting in rancidity are discussed. The induction period of oils stored in sealed containers was found to be dependent upon the original peroxide value of the oils which, in turn, was influenced by exposure to light. Exposure to light resulted in destruction of peroxides. The chlorophyll value of an oil was found to be governed primarily by exposure to light rather than to its organoleptic state. Its general use is not regarded as a reliable test for rancidity. J.L.H.

105. Cleaning Procedure for Babcock Test Bottles. C. W. RINK. Canad. Dairy and Ice Cream Jour., *26,* 1: 30. Jan., 1947.

Calcium sulfate film in Babcock test bottles can be eliminated with a concentrated solution (30%) of caustic soda. The Babcock bottles are filled with the caustic soda and heated to boiling in a water bath for 30 min. The bottles are left in the bath for another 30 min. after the heat has been turned off. The caustic soda then is emptied and the bottles rinsed with water. If a haze remains, it can be removed with dilute hydrochloric acid or full strength vinegar. The 30% caustic soda can be reused for about three treatments. H.P.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

106. Milk Powder Production Quality and Marketing. H. F. GEORGE. Canad. Dairy and Ice Cream Jour., *26*, 1: 68. Jan., 1947.

Good powdered milk has the qualities of any other form of milk. The ice cream and dairy industries will use considerably less powder in the near future than they recently were using. Powder used for standardizing will be replaced by fresh skim milk. Some extra solids for ice cream mix and for coffee cream will be needed, plus small amounts for standardizing purposes. The largest users of powdered milk will be the bakers. They will have to be educated to use more powdered milk. The solution to the marketing problem is to sell more powder to the bakers, both through personal contact and practical demonstrations, and to publicize the products for their high nutritional values. H.P.

FEEDS AND FEEDING

107. Methods of Making Potato Silage and Tests of Its Feeding Value for Dairy Cows. J. B. SHEPHERD, T. E. WOODWARD, AND C. G. MELIN. U. S. Dept. Agr. Tech. Bul. 914. 14 pp. May, 1946.

Feeding trials with several lots of potato silage, ensiled without preservative, with salt, with ground corn, or with varying amounts of mixed orchard grass and clover hay are reported. Best results were obtained when potatoes were ensiled with hay; such silage was very palatable and cows made good gains on it and maintained milk production. Ensiling potatoes alone or with salt or corn meal did not prove practical. Raw chopped potatoes also were fed with satisfactory results when the allowance was not more than 4 lbs. daily per 100 lbs. liveweight. When the quantity of potatoes is small, they can be fed raw to best advantage. Potatoes can be preserved satisfactorily as silage along with 20 to 25% of good quality hay or may be put into the silo along with corn or other green crops. However, not more than 500 lbs. of potatoes should be used for each ton of green crop; a crop such as corn should be well matured; hay crops should be wilted to not more than 60% moisture. Tower silos should be well reinforced because of the heavy weight of potato silage. Such silage should be fed after milking and along with other roughage of good quality so that the ration will contain sufficient fiber, fat, minerals, and carotene. J.G.A.

FOOD VALUE OF DAIRY PRODUCTS

108. The Digestibility of Fats—A Correlation of Experimental Data. KARL F. MATTIL, Res, Lab., Swift and Co., Chicago, Ill. Oil and Soap, *23*, 11: 344. Nov., 1946.

Reported data in the literature on the digestibility of fats fed to human adults, human infants, and white rats have been subjected to statistical

analysis and correlation coefficients calculated. A positive correlation (+0.77, calculated for 16 fats) exists between digestibilities found in human adults and those found for corresponding fats in albino rats.

The correlation coefficient for the relationship between digestibility coefficients and stearic acid content of fats was found to be negative (−0.80 for human adults for 40 fats; −0.77 for human infants for 16 fats; −0.86 for albino rats for 26 fats). The amount of saturated acids of 18 carbon atoms or more that a fat contains is the chief limiting factor of its digestibility.

The coefficients of correlation for the relationship between digestibility and melting point are not as high as those for digestibility and stearic acid content, being −0.66 for human adults for 37 fats and −0.42 for albino rats for 24 fats. This lesser degree of correlation is due to the fact that the melting point is partially a function of the amount of long chain saturated acids.

J.L.H.

109. The Rôle of Various Substances in Stabilizing Animal Tissues. G. O. BURR, W. O. LUNDBERG, AND J. R. CHIPAULT, Div. of Physiological Chemistry, Univ. of Minn., Minneapolis, Minn. Oil and Soap, *23*, 12: 382. Dec., 1946.

The diet exerts an important influence on the oxygen uptake of body fat. The fats are influenced by their fatty acid composition and the presence of antioxidants or prooxidants. The most clear-cut demonstration is obtained by feeding or withholding tocopherol to rats. Tocopherols were found to differ among themselves in their effect on the keeping time of body fat. The alpha and beta form are twice as effective as the gamma form when fed to rats. The gamma form is several times as effective as an antioxidant as the alpha form when added directly to rendered body fat.

The type of fat in a purified diet was found to be very important. Butterfat was much more effective than lard in increasing the keeping quality of body fat of rats. J.L.H.

110. The Rôle of Proteins in Animal Nutrition. H. C. SCHAEFER, Ralston Purina Co., St. Louis, Mo. Oil and Soap, *23*, 12: 375. Dec., 1946.

The rôle of proteins in animal nutrition is discussed. It is emphasized that adult ruminants are not as specific in their protein requirements as the single stomach or monogastric animals. The calf, in early life, is like the non-ruminants in that the rumen is undeveloped; hence it requires a better-quality protein in early life. The nutrition of small-stomached animals is concerned with amino acid nutrition or similar compounds, rather than with protein. More information is required on the nutrients or compounds furnished by proteins of high biological value and better methods are needed for the proper evaluation of proteins. J.L.H.

ICE CREAM

111. Rôle of Emulsifiers in Ice Cream Making. B. I. MASUROVSKY. Ice Cream Trade Jour, *42*, 12: 72. Dec., 1946.

Egg yolk, monoglycerides, and diglycerides are being used as emulsifiers for ice cream. To evaluate a commercial preparation as an emulsifying agent, the following test is suggested: Prepare a 15% sugar solution containing 10% butterfat. Introduce 0.25% of stabilizer and 0.25% of emulsifier into the sweetened oil and water system. Apply heat to insure the solubility of the emulsifying agent. Pour the entire mixture into a graduated cylinder, agitate it for 2 min., and allow it to stand undisturbed for 10 min. Examine the volume of free milk fat in the column and calculate the amount of fat emulsified. Compare it with a control mixture without an emulsifying agent.

Ice cream stabilizers sometimes contain emulsifying material, and it is advisable to follow directions given by the manufacturer of these products. The trend seems to be toward the increased use of emulsifiers in ice cream in an attempt to produce a higher quality product. W.H.M.

112. Problems Arising from Increased Costs. RIDGWAY KENNEDY, JR., Abbotts Dairies, Philadelphia, Pa. Ice Cream Trade Jour., *42*, 10: 118. Oct., 1946.

During the war years the cost of ingredients used in the manufacture of ice cream showed a marked increase. Costs such as delivery, sales, and merchandising have been held in check because of increased volume of sales and government restrictions. Production costs have risen because of increased labor costs and the type of labor available. After price controls were removed, the ice cream manufacturer could raise his price to offset increased costs. During the past year manufacturing overhead costs have been favorable, due to increased volume. However, they will go up if volume begins to go down.

Should the ice cream manufacturer go back to daily delivery and increase the number of flavors carried in stock, or spend excessive amounts of money to get new business, costs are sure to rise. In order that sales volume may be maintained, ice cream manufacturers might well consider the expenditure of money on advertising campaigns designed to increase consumer acceptance for ice cream. Money put into state and national nutrition programs will tend to increase per capita consumption of ice cream and by so doing, operating costs may be reduced. New competition from within and without the ice cream industry will make it necessary for ice cream manufacturers to make decisions based on sound business judgment. W.H.M.

113. Preserved Fruits—Preserve Flavor. F. I. HUTCHINS, Hutchins Advertising Co. Ice Cream Field, *48*, 6 : 30. Dec., 1946.

The manufacture of fruits, nuts and flavors represents a large industry which caters to the ice cream manufacturer. The trend is away from highly colored and extract-flavored products. Processed (*i.e.*, heated) flavors and fruits are considered more sanitary than fresh or cold packed fruits or "dry nuts". W.C.C.

114. Causes of Shrinkage in Ice Cream Making. B. I. MASUROVSKY. Ice Cream Trade Jour., *42*, 9 : 58. Sept., 1946.

Large air cells, heat shock due to sudden change in the temperature of ice cream cabinets, large ice crystals, utilization of certain types of milk solids such as those present in frozen cream, use of certain types of cocoa, improper blending of ingredients, and subjecting the ice cream to a wide range of temperature changes in storage are some of the causes of shrinkage. W.H.M.

115. Factors Affecting Shrinkage. R. J. RAMSEY, Ramsey Laboratories, Cleveland, Ohio. Ice Cream Trade Jour., *42*, 12 : 46. Dec., 1946.

Shrinkage in ice cream may be affected by the following factors: (1) The destabilizing effect of freezing upon the colloidal suspension of proteins surrounding each air cell. (2) Low viscosity in the frozen ice cream, which may be influenced by ice crystal structure, sugar, type of freezer, and condition of the ice cream. (3) Air cell structure (fine air cells actually cause ice cream to shrink more readily than large air cells). (4) The use of dry ice. (5) The use of untreated paper in ice cream cans, boxes, or cartons. (6) Freezer operation. More shrinkage occurs in ice cream that is frozen too stiff and too dry at the freezers. (7) Air pockets due to poor filling practices. (8) High overruns. (9) Increased air circulation over cans. (10) Composition of ice cream. High butterfat, high sugar, excessive amounts of corn sirup, and the use of eggs seem to increase the tendency for ice cream to shrink. W.H.M.

116. Planning the Modern Ice Cream Plant. JOHN W. FARLEY, Sales Engineering Dept., Cherry-Burrell Corp. Ice Cream Field, *48*, 6 : 18. Dec., 1946.

A consideration of small to medium combination milk and ice cream plants is presented. The general over-all purpose of planning such a plant is "To process the maximum quantity which can be sold of the highest quality products at the lowest possible cost".

The following factors are considered as important in the order listed: (1) amount of raw material to be handled, quantity of finished products to

be produced, as well as personnel and time available for required operations; (2) quantity of tools and equipment required, as well as expected methods of processing and handling; (3) location of building; (4) size and type of building to be constructed; (5) type of construction to be employed; (6) basis for deciding room arrangement in building; and (7) smallest number of changes which must be made in arrangement of equipment without disturbing the original plan. The necessity of surveys and reliable estimates of expected expansion are emphasized. By considering plant operation time schedules, equipment best suited for efficient operation can be selected. Flow plans are discussed from the point of view of efficiency in processing, packaging and storage. In plant layout it is highly desirable to have at least three sides of the building accessible. The use of a building accessible from only one side "almost invariably means a rather inefficient layout".

W.C.C.

117. Bulk-Gallon Sales Spreading. ANONYMOUS. Ice Cream Trade Jour., *42*, 10: 96, 180. Oct., 1946.

The sale of bulk ice cream in single gallon containers for home use, which was started in March, 1946, by the Breyer Ice Cream Company in the Harrisburg, Pa., area, now has been expanded to other areas. Other ice cream companies now sell bulk ice cream by the gallon for home use. A label is placed on the container showing the retail price and how to store and dip the ice cream. Dealers are taking a 26% markup on this item. W.H.M.

118. Trends in Ice Cream Advertising and Sales. E. L. WALKER, Arden Farms, Los Angeles, Calif. Ice Cream Trade Jour., *42*, 12: 60. Dec., 1946.

Selling is an art, not a science. It is simply common sense and sound, fast thinking applied to business problems. The trend is away from teaching salesmen too much theory. Show them successful principles in action. Give them facts. Teach them to deal with specific situations. Train them in all phases of operation, including making mixes, freezing, novelties, and delivery. They should be familiar with restaurants, hotels, food markets, and drive-in markets. Ice cream manufacturers should see that their dealers play fair with the public and strive to give them good value for their money. Better package identification in cabinets also is helpful in getting better consumer acceptance. The trend is toward better balanced ice cream advertising campaigns, employing all media such as radio, newspapers, billboards, deluxe boards, point of purchase, car cards, and direct mail.

New possibilities for profitable ice cream mechandising are opening up every day. Some of them are: frozen food stores, vending machines, dairy departments, ice cream cabinets in apartment houses, complete frozen meals

with ice cream, complete cooked meals with ice cream, air lines, home and farm deep freeze unit sales, push carts, retail trucks, bicycles and boxes, modern power scooters, liquor stores for package sales, theater lobbies, and cabinets in drugless drug stores and in regular drug stores other than at fountains. Packaged sales, cups, and bars are becoming more popular; frosty malts also are on the upswing. W.H.M.

119. Super-Market Merchandising. VINCENT M. RABUFFO. Ice Cream Trade Jour., *42*, 12: 34. Dec., 1946.

The anticipated entry of food chains and independent food stores into the ice cream marketing picture obviously is underway in all sections of the country. A striking example of how one well known wholesale ice cream manufacturer has reached out for important super-market ice cream volume is the case of the Bettar Ice Cream Co. of Baltimore, Md. The company supplies cabinets and the necessary promotional and advertising signs to 50 stores. The only item sold is the "Luxury Pint", which retails at 30 cents. The insulated bag for carry-home sales is an essential part of the program. A cardinal point in the sale of ice cream through food chains is that the ice cream be sold and merchandized through a department separate from that which sells frozen foods. W.H.M.

120. Modern Ice Cream Store Planning. DON MACK, Weber Showcase and Fixture Co., Los Angeles, Calif. Ice Cream Trade Jour., *42*, 12: 39. Dec., 1946.

The six basic layouts for retail ice cream stores include the straight counter, the horse shoe counter, the island arrangement, the full service, the self-service, and the drive-in. Successful store operators follow these rules: (1) Select a store on the shady side of the street in the afternoon, and on the right side of the street on the way home from the heart of town. (2) Select a location where there are at least 300 families within a radius of 10 blocks. (3) See that the floor is attractive, of a usable surface, and that the ceilings and walls are of a light finish. (4) If you are in the same room with other merchants, insist upon the same side of the room that the staple items are merchandised from. (5) Select fixtures which will provide the greatest convenience to your customers, and provide the best working conditions for your employees both from the standpoint of speed and personal comfort. (6) Buy your supplies from wholesalers and jobbers who have a reputation for handling only the best. (7) Send announcements by mail to the 300 families in your neighborhood 3 or 4 days in advance of the opening of a new store, and at frequent intervals when you are going to offer particular flavors or special dishes with a varied appetite appeal. (8) Keep your store and equipment spotlessly clean and never under any circumstances allow a

customer to leave your store dissatisfied, even if you have to take a temporary loss.

These rules do not apply in country towns with regard to location. In the country the best locations are near the busiest stores and on the same side of the street. W.H.M.

121. The Merchandising Power of Sanitation. GEORGE HENNERICH. Ice Cream Trade Jour., *42*, 10: 112. Oct., 1946.

The ice cream manufacturer and his dealers must assume responsibility for the sanitary service of ice cream, as people are more conscious of cleanliness than ever before. The first step should be the development of sanitary routines at the soda fountain and ice cream departments through which ice cream is sold to the public. Sterilization of glassware between each use, clean dispensers, clean towels, use of dipper pads, and clean water in the dipper wells are routines which should be done correctly. The motto of every retailer should be "Be Clean, Keep Clean, Serve Clean". W.H.M.

122. Glorifying the Pint Package. VINCENT M. RABUFFO. Ice Cream Trade Jour., *42*, 10: 102. Oct., 1946.

The Riviera Ice Cream Co. of California operates more than 30 stores and also sells to dealers. It produces only pint packages and controls the retail price by billing the ice cream to dealers at the full retail price less a percentage discount which represents the dealers' markup. Stores operated in Los Angeles are distinctively designed, handle only ice cream, and are operated by one girl. A high butterfat ice cream containing about 60% overrun is sold for 35 cents per pint. Jiffy insulated bags with dry ice are furnished to customers for a 5 cent deposit, which is refunded if the bag is returned five times for refills. Ten different flavors are sold. W.H.M.

123. Ice Cream on Retail Milk Routes. ANONYMOUS. Milk Dealer, *36*, 4: 42, 66. Jan., 1947.

The Adohr Milk Farms, Los Angeles, is successfully distributing ice cream on its retail milk routes. The ice cream is carried on the delivery routes in refrigerator boxes. These boxes hold 24 pints of ice cream and are refrigerated with 2.5 lbs. of dry ice. The ice cream is packaged only in pints. Vanilla and chocolate are the only flavors regularly packaged.

C.J.B.

124. The Ice Cream Industry and Frozen Foods. VINCENT M. RABUFFO. Ice Cream Trade Jour., *42*, 10: 100. Oct., 1946.

"The main ingredients of success in frozen food distribution are how well you are prepared to merchandise, sell, and service and remembering, all the

time, that frozen foods belong to the food business and yet are different than anything heretofore seen in the food industry." Actually, the frozen food business is six different businesses representing fruit, vegetables, fish, meat, poultry, and food specialties. It is a separate business from ice cream making and to be successful it must be operated as such. Any ice cream manufacturer going into the frozen food business should plan for all-year service and merchandising, but he also should have a separate organization for that purpose. W.H.M.

MILK

125. Some Angles on Leveling Milk Production. C. W. PIERCE, Pittsburgh District Dairy Council, Pittsburgh, Pa. Milk Indus. Found. Assoc. Bul., *39*, 3: 56–68. Jan. 3, 1947.

Increased milk production during the fall months will be needed for several years due to population increases, prospective high demand, and larger business activity associated with good incomes. A large recurring fall shortage is likely to result in enlarging a city milk shed to the point where later conditions might unduly reduce the price of milk to the producer. It is to the interest of the producer to avoid severe shortages of milk. Better feeding and care will help, but the greatest leveling effect comes from a change in the breeding program. Spring freshening continues to predominate because farmers think such milk is produced more cheaply, even though cost records apparently show that fall freshening produces lower cost milk. A survey of several hundred farmers in Pennsylvania showed many believed fall and winter costs are higher than spring and summer costs by $1.09 per 100 lbs. It is concluded that an incentive fall price of less than $1.00 over the spring price would not greatly increase fall milk production. A higher class I seasonal price of the equivalent of 2 cents per quart initially, with perhaps 1 cent after enough production is obtained, is favored by the author over the "base rating" plan. E.F.G.

126. Off-Flavored Milk Due to Production Methods. C. W. ENGLAND, Highland Dairy Farms, Washington, D. C., and Baltimore, Md. Milk Dealer, *36*, 4: 118–120. Jan., 1947.

The causes of off-flavor in milk are discussed. The discussion is summarized as follows: Off-flavored milk due to production methods can be avoided by eliminating the cause. Avoid feed flavors by bringing the cows off pasture-type feeds (or weeds) 3 to 7 hr. before milking. Strong flavored feeds, fed in the barn, should be fed after milking. Prevent flavors due to bacterial growth by practicing proper methods of sanitation and cooling. Eliminate off-flavors due to chemical composition changes by eliminating the guilty cows from the milking herd. Last, keep foreign materials out of milk.

Don't lose sight of the fact that people aren't going to drink milk unless they like it. C.J.B.

127. A Survey of Milk Bottle Costs, Disappearance and Trippage. J. M. McAirty. Canad. Dairy and Ice Cream Jour., *26*, 1: 54. Jan., 1947.

The rate of new glass purchases varies roughly in proportion to population; it is quite probable that the length of delivery routes also is a factor. Other factors which may throw the average out of line are: (1) faulty equipment in one or more of the larger plants, (2) disregard for 5-cent deposit charge, (3) carelessness in handling bottles, and (4) costly system of exchanging bottles between dairies.

The 5-cent deposit decreased the rate of purchase of new bottles and led to the resurrection of used bottles from cellars and back yards. In 1945 in 13 plants in eight cities, the average number of trips per bottle was 5.8 and the average disappearance rate 1.72%. The universal bottle has reduced breakage and loss and has reduced expenses by elimination of sorting and exchanging bottles. H.P.

128. The Treatment of Cream. Trygve Langslet, Malkeforsyningen, Oslo. Nordisk Mejeri-Tidsskrift, *12*, 7: 129–132. 1946.

I. The sanitary treatment of the cream.

The methylene blue test alone is insufficient for good control of the quality of milk and cream. Milk containing millions of bacteria of the type F3 (related to *Bacterium coli* and *Bacterium fluorescens liquefaciens*) has had a reduction time of more than 5.5 hr. by the methylene blue test. Lactic acid bacteria reduce methylene blue but do not grow on peptone agar; with the majority of the foreign bacteria the opposite is true. A combination of the methylene blue test and plate count on peptone agar gives an excellent evaluation of the bacteriological quality of the milk. A determination of the coli count in the milk received ought to be made at the same time.

Control when the milk is received is not enough. Samples for bacteriological control should be taken of the milk on its way through the whole pasteurization system, and from the moment the cream leaves the separator the control should be continued so the bacteriological quality of milk and cream always is known at any place. Small sampling valves can be placed in the system before and after possible sources of contamination.

A higher pasteurization temperature for the milk from which the cream is taken has been used with good results, as well as fast cooling and low storage temperature.

II. The treatment of the cream in order to get as high a viscosity as possible.

The treatment has been adapted from that of Henning and Dahlberg. The best results are obtained by cooling the cream slowly and to as low a temperature as possible after the pasteurization. The cream is heated to

between 75.2 and 91.4° F. Above or below these temperatures almost no effect in the viscosity is obtained. The best effect is obtained between 80.6 and 86° F.

A method similar to this one has been used in practice, a different one for cream with different fat content. After pasteurization the milk is cooled to 37.4° F. (not absolutely necessary but the best result is obtained by this) and is heated again to separating temperature. The cream is treated in special vats. Cream containing 35% butterfat or above is separated at 104–111.2° F., cooled to 37.4–39.2° F. in 1 hr., and remains at this temperature 1 hr. Next it is heated to 82.4° F. in 50–60 min. by warm water in the jacket under continuous stirring. Immediately after reaching this temperature the cream is cooled to 46.4° in ¾–1 hr. The cream is drawn in cans and placed in ice for further cooling.

Cream containing 30% butterfat is separated at 95–100.4° F., cooled to 35.6° F. in 1 hr., and kept at this temperature 0–1 hr. before heating to 82.4° F. in 90–110 min. (slow heating). The difference in the temperature between the warm water in the jacket and the cream in the vat must not be more than 18° F. Cooling to 46.4° F. in 1 hr. follows.

Cream containing 20% butterfat or less is separated at 78.8–86° F., cooled to 35.6° F. in 1 hr., and remains at this temperature for 0–1 hr. before heating to 82.4° F. in 110–130 min. (very slow heating). The difference in the temperature between the warm water and the cream must not be more than 9° F. Especially in the beginning the heating must be very cautious. Likewise the cooling from 82.4° to 35.6° F. must be done slowly in 90–110 min., for instance, first by water from 82.4–68° F. and then by brine. The cream is stored in the vat at 35.6° F. until the next day.

The treatment must be adapted for every plant. Bacteriological control of the cream has to made constantly or the cream can be subject to a reduction in quality.

III. The treatment of cream in regard to making it suitable for whipping.

The most important requirements for good whipping cream are:

a. Through the whipping the biggest possible increase in volume shall take place.
b. The cream shall be of a high stiffness.
c. It shall remain stiff for several hours without falling together.
d. The cream shall have a reasonable whipping time.
e. Little leaking of serum, and preferably none, at least not the first hour after whipping.

In order to get a stable product the separating temperature must not be too low. Pasteurized milk may be separated at 95° F. (depends on the season) and give a stable product, but not below 86° F.

Whipping cream ought not to be diluted with skim or whole milk, but

with thinner or fatter cream. The temperature of whipping ought to be 44.6–46.4° F.

IV. The packing of cream for sale.

The best thing to do is to sell the cream in bottles or cartons. This way gives the smallest loss and is the most sanitary. T.K.

129. **How to Sell Dairy Products Again.** GEORGE F. BARBER, Abbotts Dairies, Philadelphia, Pa. Milk Indus. Found. Assoc. Bul., *39*, 5: 105–119. Jan. 20, 1947.

A discussion of the selection of routemen is followed by a detailed procedure for conducting a 4-day training school for routemen, using the Milk Industry Foundation training manual, "The Balanced Job", as a guide. The time is divided into not over 15% in lecture, at least 40% in training the men, and 45% in exchanging experiences and opinions of specific problems and cases. The various duties of a routeman are analyzed and definite methods of instruction and procedure are specified. It is recommended that routemen be relieved of route duties for the period of the course, as it cannot be given effectively after a day of regular route service. E.F.G.

130. **What Kind of Plans and Materials are Put to Most Effective Use by Home Service Route Salesmen?** EDWIN FUNK, Sheffield Farms Co., Inc., New York, N. Y. Milk Indus. Found. Assoc. Bul., *39*, 5: 99–104. Jan. 20, 1947.

What helps are furnished to the routeman will depend upon whether a "moderate base, high commission" or "high base, moderate commission" payment system is in effect. A simple natural approach to the problem is advised to get him to use these helps most effectively. A check list of 23 details in producing routemen's sales tools is given under three headings, *viz.*, general, bottle collars and hangers, and folders and circulars. E.F.G.

PHYSIOLOGY

131. **Preparation and Chemistry of Anterior Pituitary Hormones.** ABRAHAM WHITE, Dept. of Physiol. Chem., Yale University, New Haven, Conn. Physiol. Rev., *26*: 574–608. 1946.

On the basis of physiological evidence, apparently at least six recognized individual hormones exist, although there is some biological overlapping among certain of the anterior pituitary secretions. The four most highly purified anterior pituitary proteins are the lactogenic, the adrenotrophic, the growth, and the luteinizing hormones. The thyrotrophic principle has been isolated in highly purified form but has not yet been examined by rigid criteria of protein purity. The follicle-stimulating hormone awaits further purification. D.E.

132. Mechanism of the Development of Obesity in Animals With Hypothalamic Lesions. JOHN R. BROBECK, Laboratory of Physiology, Yale University School of Medicine, New Haven, Conn. Amer. Jour. Physiol., *26*, 4: 541–559. Oct., 1946.

Experimental study has shown that the obesity of animals with hypothalamic lesions arises primarily from a marked increase in food consumption, sometimes accompanied by a decrease in locomotor activity and by a transitory depression of basal heat production. The extra food eaten by the animal constitutes a relatively large energy surplus, which the tissues dispose of by storing some of it and by oxidizing the rest to carbon dioxide and water. Since lesions of the hypothalamus induce these highly typical deficits, the hypothalamus probably normally participates in the maintenance of the over-all energy equilibrium; the control of food intake, work output and body temperature may be correlated and integrated within this portion of the diencephalon. D.E.

MISCELLANEOUS

133. Possible Trends of Dairy Research in Canada. J. A. PEARCE. Canad. Dairy and Ice Cream Jour., *26*, 1: 64. Jan., 1947.

Possible trends in post-war dairy research in Canada are: (1) the utilization of waste dairy products or dairy by-products as specialty foods, (2) the possibility of using dehydrated whey in baking, and (3) the use of continuously operated dairy equipment, such as continuous butter-making machines and the adaptation of this churn to Canadian composition requirements for butter. Keeping quality studies will have to be made on this butter and results compared with butter made from the conventional methods of manufacture. H.P.

134. Insect and Rodent Control in Dairy Plants. GEORGE C. DECKER, Entomologist, Ill. Natural History Survey and Ill. Agr. Expt. Sta. Milk Dealer, *36*, 4: 124–128. Jan., 1947.

In the control of insects and rodents, both preventive and remedial measures should receive thorough consideration. Plant location and construction are emphasized among the preventive measures. The discussion of insect control is based mainly on the use of DDT. It is pointed out that, because DDT is used under greatly varying conditions to control many kinds of insects, it is marketed in several forms. Each has its distinct uses, advantages, and disadvantages. Following is a list of the forms now readily available:

(1) Prepared DDT dusts, ready for use, are available in concentrations of from less than 1% to 10 or 15%.

(2) DDT dust concentrates, containing 25 to 50% of DDT, to be used by jobbers or growers for preparing dilute dusts.

(3) Wettable powders, which are similar to dust concentrates but contain a wetting agent, are intended for use in the preparation of sprays.

(4) Oil solutions of several kinds are available. Some for use as household fly sprays contain as little as 0.2 to 1% of DDT in refined kerosene. Others intended for household use on bedbugs, flies, roaches, etc., contain 5% of DDT in refined kerosene or other suitable solvent.

(5) Emulsion concentrates are solutions of DDT, an emulsifying agent, and a solvent. They can be mixed with water to make sprays.

(6) DDT bombs, or "aerosol" bombs, contain DDT dissolved in liquefied gas. These bombs are for use in homes and other enclosed places.

DDT is used either as space sprays or as residual sprays. The space sprays also contain some quick-acting agent and are highly effective. They are used extensively in enclosed places. With the residual sprays, the residue left on surfaces sprayed or painted with DDT suspensions, emulsions, or oil solutions containing 1 to 5% of DDT will continue to kill flies, mosquitoes, roaches, etc., for from 1–2 weeks to several months after the spray is applied. The use of a 5% DDT solution or spray to be applied at the rate of 1 gallon per 1,000 sq. ft. of surface is generally recommended. DDT is effective in some paints but decomposes rapidly in whitewash.

Rodent control is discussed from the standpoint of prevention as well as poisoning. In addition to the poisons usually used, the uses of Antu (alphanaphthylthiourea) and 1080 (sodium fluoroacetate) are discussed.

C.J.B.

135. **Berlin Diary (Dairy Edition).** HENRY I. TRAGLE. Milk Dealer, *36*, 4: 47–48, 100–106. Jan., 1947.

A description is given of the C. A. Bolle plant in Berlin, which in normal times handled from 150,000 to 250,000 liters of milk per day. The plant had manufactured butter, margarine, ice cream, skim and whole milk cheeses, and a variety of fermented milk products. In addition they had operated a recovery plant where various chemical by-products of milk, such as casein and milk sugar, were extracted from the milk waste. High-temperature, short-time pasteurization was used. A description is given of the plant layout and equipment. C.J.B.

136. **Future Price Supports for Dairy Products.** DON S. ANDERSON, Dairy Branch, Production and Marketing Admin. Milk Indus. Found. Assoc. Bul., *39*, 3: 49–55. Jan. 3, 1947.

The Act of 1941 and the Steagall Amendment require the support of the prices of certain agricultural products at 90% of parity for 2 years after

Jan. 1 of the year in which the war is officially declared "over". (Abstractor's note—on Dec. 31, 1946, President Truman officially declared the war "over", so this act now supports prices through Dec. 31, 1948.) Little direction was given the Department of Agriculture with regard to how the support was to be effected.

Three possible methods of price support are suggested: (1) Do little about production but dispose of surpluses as can be done best. (2) Put into effect a strong production and marketing program, using supports to encourage shifts in production in predetermined directions. This probably would mean higher support prices for some products and quotas for others. (3) Employ a minimum of controls and some incentives to prevent unmangeable surpluses. The author suggests that any adjustment in the dairy industry probably will be toward more milk production rather than less. E.F.G.

137. **How Efficient Is Your Creamery?** L. C. THOMSEN, Univ. of Wis. Natl. Butter and Cheese Jour., *37*, 12: 38. Dec., 1946.

Changing conditions in the creamery industry require careful evaluation of plant efficiency. A chart is given which may be used for systematic study of factory operations. Factors included are quality, manufacturing methods, personnel, operating losses, accounting, sales, purchases of equipment and supplies, and public relations. Each factor is evaluated by the answers to specific questions which call attention to the important phases of the factor under consideration. W.V.P.

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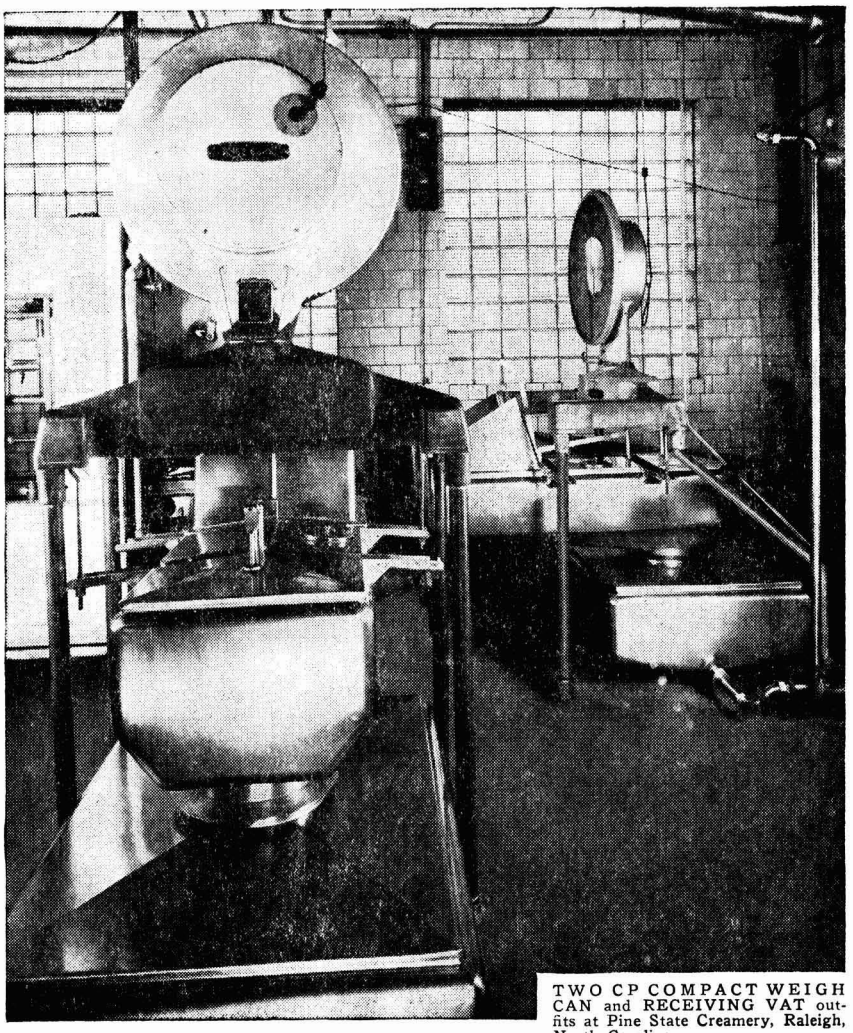

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