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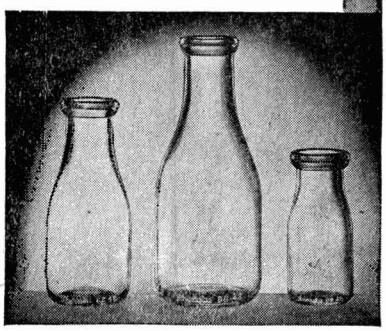

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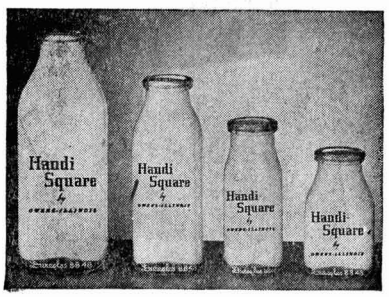

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JOURNAL OF DAIRY SCIENCE

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FACTORS INFLUENCING ACID PRODUCTION BY CHEESE CULTURES. I. EFFECT OF COOKING TEMPERATURES ON ACID PRODUCTION IN THE MANUFACTURE OF CHEDDAR CHEESE[1]

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The rate of lactic acid development by cheese cultures has received considerable attention in the past few years. Increased interest in acid development appears to be due to the larger amount of cheese being manufactured from pasteurized milk and the adoption of a definite time-schedule in the manufacturing operation. The schedules which have been proposed assume that a certain degree of acidity will be attained in a certain period of time. In order to follow such a method as closely as possible, it is of paramount importance that the cheesemaker have a culture that will produce acid uniformly and consistently from day to day. The cheesemaker should also be familiar with the particular culture he is using and know certain of its limitations.

In the manufacture of both semi-commercial and experimental lots of cheese in the cheese laboratories of Iowa State College, many cheese cultures have been studied with regard to rate and constancy of acid production. During the course of these trials, several instances of slow acid production occurred and these were studied in detail. Slow acid production was attributed to two factors: (a) the cooking temperature employed, and (b) the presence of bacteriophage. These two factors will be discussed separately.

HISTORICAL

The influence of temperature on acid production by cheese cultures has been studied by several investigators. Whitehead and Cox (6) noted that strains of lactic acid streptococci which could withstand temperatures of 37° C. (98.6° F.) developed acid in a normal manner right up to the salting stage in the manufacture of cheddar cheese when cooking temperatures of 37° to 39° C. (98.6° to 102.2° F.) were employed. Strains that could not

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withstand a temperature of 37° C. (98.6° F.) produced acid normally during the early part of the cooking period, and the manufacturing process appeared to proceed normally until the whey was drained; after the whey was drained slow acid production persisted throughout the remainder of the manufacturing process.

Harrison and Dearden (4) determined the rate of acid production by three cultures at temperatures of 22°, 28°, 30°, 37°, 40° and 45° C. (71.6°, 82.4°, 86°, 98.6°, 104° and 113° F.). Culture S produced acid at temperatures up to 37° C. (98.6° F.) but failed to produce acid at 40° C. (104° F.). Culture X as well as culture Y produced acid at 40° C. (104° F.). All of the cultures failed to grow at 45° C. (113° F.). After incubation at 40° C. (104° F.) for 24 hours, culture S was incapable of further growth at either 22° or 28° C. (71.6° or 82.4° F.). Cultures X and Y were capable of growth at the lower temperatures after 24 hours incubation at 40° C. (104° F.).

Dolby (2) studied the effect of cooking temperatures of 100° and 104° F. on the rate of acid formation in the manufacture of cheddar cheese; one culture was employed in these trials. With the higher cooking temperature, growth of the culture was restrained to such an extent that acid development in the later stages of the manufacturing process was definitely retarded. The pH of the young cheese cooked to the high temperature was considerably higher than that cooked at the lower temperature.

Golding *et al.* (3) concluded that a cooking temperature of 102° F. greatly retarded the development of acidity and the longer the culture organisms were held at this temperature, the slower was their subsequent development of acidity when returned to 86° F. These investigations were carried out in milk and not in actual cheesemaking operations.

Dahlberg and Ferris (1) inoculated milk with a cheese culture and held one portion at 86° F. and another portion at 100° F. Acid development at 86° F. was rapid, while at 100° F. it was very slow. When the milk was held at 86° F. for 2 hours followed by incubation at 100° F., acid development was good. In actual cheesemaking operations, when bacterial multiplication of cultures was commenced at 86° F. before cooking to 100° F., the acid developed satisfactorily at 100° F.

METHODS

Source of cultures. The cultures used in these studies came from the following sources: Cultures 1 and 5 were from the regular collection maintained in the Dairy Industry Department, Iowa State College. Cultures 2, 6 and 7 were obtained from commercial sources. Cultures 3 and 4 were prepared for experimental purposes; the organisms were obtained from sour cream.

Propagation of cultures. Whole mixed milk, heated to 200° F. for 1

hour, was used for propagation of the cultures. After heating, the milk was cooled to 70° F., inoculated with approximately 1 per cent culture, and incubated at 70° F. for 16 hours. After the incubation period, the cultures were placed in a refrigerator at a temperature of 34° F. The cultures were transferred every day except Sunday and had been transferred in this manner several months before this work was begun.

Titrable acidity determinations. The acidity determinations were made by titrating a 9-gram sample with N/10 sodium hydroxide, using phenolphthalein (5 drops of a 1 per cent solution in 50 per cent alcohol) as the indicator.

The rate of acid production by cultures in skim milk was determined on various days. The skim milk used in these trials was prepared from one lot of skim milk powder; 90 grams of powder were dissolved in 1 liter of distilled water. The reconstituted skim milk was heated to 180° F. for 10 minutes, cooled to the desired temperature, inoculated with culture and divided into portions of 250 ml.

The temperature of the cultures held at 86° and 98° F. was maintained by use of a water bath placed inside a thermostatically controlled incubator. The temperature of the cultures held at 101° and 104° F. were controlled by means of water baths; the variation in temperature was ± 0.5° F.

Manufacture of cheese. The method followed for manufacturing the cheddar cheese was essentially that outlined by Price (5) except that the curd was milled at a whey acidity of 0.50 per cent, calculated as lactic acid.

RESULTS

The experimental work was designed to demonstrate: (a) the effect of temperature on acid production by cheese cultures when the cultures were inoculated into skim milk and held for the entire incubation period at temperatures of 86°, 98°, 101° and 104° F., (b) the effect of a short exposure to a temperature of 104° F. on acid production by cheese cultures growing in skim milk, and (c) the effect of cooking temperatures of 100°, 102° and 104° F. on acid development in the manufacture of cheddar cheese.

Table 1 presents the data on rates of acid production as measured by the increases in titrable acidity, at temperatures of 86°, 98°, 101° and 104° F. Cultures 2, 5 and 6 produced acid more rapidly at 86° F., while cultures 1, 3, 4 and 7 produced acid more rapidly at 98° F. All of the cultures produced acid slowly at temperatures of 101° and 104° F. There was very little difference in the amounts of acid produced during the first two hours of incubation, regardless of the temperature employed. Although very little acid was produced by the cultures at 101° and 104° F., there were differences in acid production at these temperatures. Cultures 1, 5 and 6 produced practically no acid after being held at 101° or 104° F. for 4 hours. Cultures 2, 3, 4 and 7 showed some increase in acidity at 101° F. throughout

the holding period and cultures 4 and 7 showed some increase in acidity at 104° F.

The rates of acid production by cultures held (a) continuously at 86° F., and (b) for 2 hours at 86° F., then 2 hours at 104° F., and then 3 hours at 86° F. are given in table 2. Culture 3 was the only culture that produced acid more rapidly when returned to 86° F. after being held at 104° F. for 2 hours than when held for the entire period at 86° F. Culture 4 was

TABLE 1

Rates of acid production by cheese cultures when held at various temperatures

Culture No.*	Temperature of incubation (°F.)	Titrable acidity (ml. N/10 NaOH per 9 grams)					
		0 hours	2 hours	4 hours	5 hours	6 hours	7 hours
1	86	1.35	1.60	2.10	2.45	2.90	4.00
	98	1.35	1.65	2.30	2.80	3.50	4.30
	101	1.35	1.60	1.65	1.70	1.65	1.65
	104	1.35	1.55	1.55	1.60	1.65	1.65
2	86	1.40	1.50	2.05	2.65	3.85	5.50
	98	1.40	1.60	2.02	2.85	3.85	4.85
	101	1.40	1.60	1.85	2.00	2.20	2.30
	104	1.40	1.60	1.70	1.75	1.80	1.85
3	86	1.45	1.55	2.05	2.40	3.00	4.35
	98	1.45	1.60	2.15	2.50	3.40	4.55
	101	1.45	1.55	1.75	1.80	1.85	1.95
	104	1.45	1.50	1.65	1.70	1.70	1.85
4	86	1.40	1.55	1.80	2.25	3.05	4.00
	98	1.40	1.50	2.10	2.85	4.05	4.75
	101	1.40	1.50	1.80	2.05	2.30	2.60
	104	1.40	1.55	1.75	1.85	2.00	2.15
5	86	1.45	1.60	2.05	2.40	3.10	4.35
	98	1.45	1.70	2.25	2.55	2.90	3.25
	101	1.45	1.65	1.70	1.75	1.80	1.80
	104	1.45	1.65	1.65	1.65	1.65	1.70
6	86	1.40	1.50	1.90	2.20	2.55	3.10
	98	1.40	1.55	1.85	2.00	2.20	2.40
	101	1.40	1.50	1.70	1.70	1.75	1.75
	104	1.40	1.50	1.60	1.65	1.65	1.75
7	86	1.40	1.60	2.00	2.40	2.80	3.30
	98	1.40	1.65	2.15	2.65	3.15	4.00
	101	1.40	1.60	1.90	2.05	2.20	2.35
	104	1.40	1.60	1.85	1.95	2.10	2.20

* A one per cent inoculation was used.

inhibited slightly by the heat treatment. Immediately after the heating period, or after 4 hours, the cultures receiving the heat treatment had produced larger amounts of acid than the cultures held continuously at 86° F.; subsequent incubation, however, showed that the heat treatment decreased final acid production with all except culture 3. The various cultures showed appreciable differences in rates of acid production.

The results of 14 trials involving the use of cooking temperatures of 100°, 102° and 104° F. in the manufacture of cheddar cheese are presented in

TABLE 2

Rates of acid production by cheese cultures when held (a) continuously at 86° F. and (b) 2 hours at 86°F., then 2 hours at 104° F., and then 3 hours at 86° F.

Culture No.*		Titrable acidity (ml. N/10 NaOH per 9 grams)						
		0 hours	1 hour	2 hours	4 hours	5 hours	6 hours	7 hours
1	a	1.35	1.45	1.60	2.15	2.60	3.40	4.75
	b	1.35	1.45	1.60	2.30	2.60	3.05	3.65
2	a	1.45	1.60	1.80	3.00	4.40	5.90	6.35
	b	1.45	1.60	1.80	3.00	3.65	4.40	5.35
3	a	1.40	1.50	1.65	2.35	2.80	3.60	4.95
	b	1.40	1.50	1.65	2.60	3.15	4.00	5.15
4	a	1.45	1.55	1.75	2.55	3.45	4.70	5.80
	b	1.45	1.55	1.75	2.75	3.30	4.30	5.45
5	a	1.45	1.55	1.75	2.40	3.00	3.85	4.95
	b	1.45	1.55	1.75	2.65	3.15	3.65	4.15
6	a	1.45	1.55	1.75	2.30	2.80	3.60	5.10
	b	1.45	1.55	1.75	2.40	2.70	3.10	4.10
7	a	1.50	1.65	1.80	2.50	2.90	3.40	3.95
	b	1.50	1.65	1.80	2.50	2.60	2.80	3.00

* A one per cent inoculation was used.

table 3. With 5 of the 7 cultures employed, acid production was more rapid at 100° F. than at 102° F.; one culture produced the same amount of acid at both temperatures and one culture produced acid slightly faster at 102° F. A cooking temperature of 104° F. resulted in decreased rates of acid production with all of the cultures as compared with cooking temperatures of 100° and 102° F. The cultures showed variations in the time required to reach a whey acidity of 0.50 per cent. The variation between cultures at 100° F. was 40 min., at 102° F. it was 68 min., and at 104° F. it was 80 min. The average increase in manufacturing time of cheese cooked to 102° F. as compared with a cooking temperature of 100° F. was 14.5 min. for all cultures. When a cooking temperature of 104° F. was employed the time of manufacture was increased 35 min. as compared with the time of manufacture when a cooking temperature of 100° F. was employed. It was noted that when a

TABLE 3

Time required from setting to milling to reach a whey acidity of 0.50 per cent when cooking temperatures of 100°, 102° and 104° F. were employed

Culture No.	Cooking temperature			
	100° F.	102° F.	104° F.	104° F.*
1	4′30″	4′57″	5′15″	4′25″
2	4′10″	4′30″	4′35″	4′02″
3	4′20″	4′10″	4′25″	4′20″
4	4′35″	4′35″	5′00″	4′30″
5	4′45″	5′05″	5′25″	4′50″
6	4′20″	4′37″	5′10″	4′15″
7	4′50″	5′18″	5′45″	4′45″

* Ripened an additional 30 minutes before setting.

cooking temperature of 104° F. was employed, the rate of acid production was less affected if the cultures were growing rather rapidly at the time of cooking. When the vat to be heated to 104° F. was given an additional ripening time of 30 minutes before setting, the time from setting to milling was approximately the same for vats cooked to 100° F. as for vats cooked to 104° F.; the vats being milled at the same acidities.

DISCUSSION

In the several instances prior to the time at which these experiments were begun, in which acid production was slow during the manufacture of cheddar cheese, the slowness was usually first evident at the time of draining the whey or shortly thereafter. In all instances, the cultures appeared to be functioning normally up to this time. Since the slowness occurred right after the curd had been cooked, it appeared probable that the culture being employed might be inactivated by the cooking temperature. For this reason the influence of temperature on acid production by cheese cultures was studied.

Acid production by all of the cultures was fairly rapid when grown in skim milk at temperatures of 86° and 98° F. With some cultures a temperature of 98° F. tended to slightly decrease the rate of acid production in comparison to that produced at 86° F. while with other cultures this temperature appeared slightly more favorable than 86° F. Temperatures of 101° and 104° F. resulted in greatly decreased acid production when the cultures were continuously held at these temperatures during the entire incubation period. In most instances, only slightly more acid was produced at 101° than at 104° F.

The failure of a culture to produce acid when held continuously at temperatures of 101° or 104° F. does not necessarily mean that the culture will fail to produce acid when cooking temperatures of 101° or 104° F. are employed in the manufacture of cheddar cheese. This has been shown by experiments in which the cultures were heated to 104° F. and held at that temperature for 2 hours, and also by experiments in the manufacture of cheddar cheese in which various cooking temperatures were employed. In trials with various cultures that were grown in skim milk and first given an incubation period at 86° F. before heating to 104° F. the heating resulted in decreased acid production with 6 of the 7 cultures tested; one culture produced more acid. The extent to which acid production was decreased by heating to 104° F. for 2 hours varied with the different cultures, some being affected more than others. In no case did the production of acid nearly cease as a result of the heat treatment.

The cooking temperatures generally used in the cheese laboratories of Iowa State College range from 100° F. to 102° F. However, in the manufacture of experimental lots of cheese in small vats (50 gal.), the tempera-

ture at times will accidentally reach 103° or 104° F. Also, variations of 1° or 2° F. are quite common with certain dairy thermometers. When cooking temperatures of 100°, 102° and 104° F. were employed in actual cheese-making operations, acid production was most rapid at 100° F. with the majority of the cultures. The results indicate that 102° F. is the maximum temperature which should be used with the majority of cultures. If a higher temperature is desirable, the culture should be checked for its ability to produce acid at the higher temperature and for its ability to produce acid following the heat treatment. When a cooking temperature of 104° F. was employed, it was found to be more time-saving to ripen the milk for a longer period before setting than to ripen for the normal period of time and wait for acid development to occur while cheddaring. Even when the cheese was made by the regular procedure and cooked to 104° F., acid continued to develop, although at a slower rate. No evidence was apparent that temperatures of 104° F. would entirely stop the acid production, or very nearly stop acid production. With certain lots of cheese made prior to these investigations the acid formation practically ceased after the whey was drained following the cooking of the curd.

In order to eliminate the possibility that bacteriophage might account for some of the slow acid production in the trials reported in this paper, the cultures were examined for bacteriophage. In the studies involving the manufacture of cheese, both the culture and whey were examined. Since no phage was evident, the decrease in acid production was solely attributed to the temperature employed.

SUMMARY

The rates of acid production of 7 cheese cultures held at temperatures of 86°, 98°, 101° and 104° F. were determined. Three cultures produced acid more rapidly at 86° F., while 4 cultures produced acid more rapidly at 98° F. All of the cultures produced acid slowly at temperatures of 101° and 104° F.

The rates of acid production of 7 cheese cultures held continuously for 7 hours at 86° F., were compared with those of the same cultures held 2 hours at 86° F., then 2 hours at 104° F., and then 3 hours at 86° F. Six of the 7 cultures produced less acid as a result of the higher temperature and 1 culture produced slightly more acid.

In actual cheese-making operations, a cooking temperature of 102° F. slightly retarded acid development with 5 of the 7 cultures when compared with a cooking temperature of 100° F. A cooking temperature of 104° F appreciably retarded acid production as compared with a cooking temperature of 100° F.

Ripening the milk for a longer period before setting appears to be more time-saving in the manufacture of cheddar cheese when cooking tempera-

tures of 104° F. are employed than does following the regular procedure and waiting for acid development just prior to milling.

A slightly high cooking temperature (104° F.) may be an explanation for somewhat retarded acid development in the manufacture of cheddar cheese but it does not explain cases of greatly decreased acid production or the actual stopping of acid production by cheese cultures.

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FACTORS INFLUENCING ACID PRODUCTION BY CHEESE CULTURES. II. INFLUENCE OF BACTERIOPHAGE ON ACID PRODUCTION IN THE MANUFACTURE OF CHEDDAR AND COTTAGE CHEESE[1]

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Slow acid production by cheese cultures is much more evident in the manufacture of cheddar and cottage cheese than it is in the manufacture of certain other cheeses in which relatively small amounts of acid are developed. In the manufacture of cheddar cheese the acidity is carefully followed for a period of 5 or 6 hours and with cottage cheese, acid development may take place for a period of 14 to 16 hrs. if overnight setting is practiced. In the manufacture of cheeses in which only a small amount of acid is developed, and where the whey may be diluted with water in the manufacturing procedure, it is sometimes difficult to determine whether or not the cheese culture is producing acid properly.

Very little difficulty was experienced with slow acid production in the cheese laboratories of Iowa State College prior to November 1944. At this time considerable difficulty was encountered and the principal cause of this difficulty was bacteriophage. The characteristics of these incidences and results of studies on the causative factor will be presented in this paper.

HISTORICAL

Bacteriophage active against *Streptococcus lactis* has been reported by various investigators in the United States and elsewhere (2, 6, 7, 12). The ability of bacteriophage to influence acid development during cheesemaking has also been reported by various investigators in New Zealand (11), England (1), Australia (10), France (5), Canada (4) and perhaps other countries. Although bacteriophage active against the lactic acid streptococci of butter cultures has been reported in the United States (7), the literature reveals no instance of slow acid production in the manufacture of cheese being directly attributable to bacteriophage.

Whitehead and Cox (12) isolated a bacteriophage from an aerated culture which suddenly failed to produce acid. They emphasized the importance of bacteriophage action in connection with the problem of vitality in cheese cultures.

Bacteriophage was demonstrated in a sample of whey by Sutton (10). When the whey was tested by means of the plate-smear technique it exhibited

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no ability to cause plaque formation but by an enrichment procedure, bacteriophage was produced in demonstrable quantities.

Single-strain cultures of streptococci, used as "starters" in cheddar cheese manufacture in New Zealand, frequently failed to produce acid due to the apparently spontaneous appearance of bacteriophage (13).

The sudden stoppage of acid development in several experimental vats of cheddar cheese was shown by Johns and Katznelson (4) to be due to the activity of a polyvalent streptococcal bacteriophage. Although the culture used consisted of a mixture of organisms, the stoppage was as abrupt as in cases where single-strain cultures were employed. The presence of bacteriophage could not be demonstrated in the culture employed, nor could it be demonstrated in the milk, stable and laboratory air, or rennet extract.

Whitehead and Hunter (14) noted that bacteriophages active against lactic streptococci occurred in the atmosphere of commercial cheese factories. Finely divided particles of whey emitted from the whey separator appeared to be the main vehicle for the air-borne bacteriophages. The concentration of air-borne bacteriophages was sometimes so great that it was impossible to prevent infection of the cultures for more than a few propagations. Protection of the cultures from air-borne bacteriophages eliminated culture failures.

Anderson and Meanwell (1) state that culture troubles in the past may have been masked by the use of raw milk for cheese manufacture. The raw milk may have enabled sufficient acid to be produced from the natural flora in spite of partial culture failure, but the quality of the resulting cheese was often variable. Slow acid production was evident only when the culture used was infected with bacteriophage. When the milk used for preparing the bulk culture was slightly infected with bacteriophage, a one thousandfold increase in the amount of bacteriophage took place after over-night incubation in the presence of the susceptible culture. Cultures containing several strains of lactic acid streptococci failed to produce acid the same as single-strain cultures.

In England, Nichols and Wolf (8) found that bacteriophage was most prevalent in May and August. Phaging of cultures was widespread geographically. Studies made on the number of phaging samples obtained from factories making cheese from raw and heat-treated milk showed practically identical results for both raw and pasteurized milk cheese (23 per cent).

Hunter (3) states that the primary source of bacteriophage in cheese factories is the whey. Whey obtained from vats during the manufacture of cheese when acid production was normal frequently showed bacteriophage titers varying from 10^{-1} to 10^{-8}. When a bacteriophage preparation having a titer of 10^{-12} was added to milk in the proportion of 1 : 900,000 to 1 : 700,000, these additions were just on the borderline of causing a marked influence in acid production by the culture.

METHODS

Manufacture of cheese. The cheddar cheese was manufactured from pasteurized milk according to the method of Price (9) with the exception that the curd was milled at a whey acidity of 0.50 per cent when acid production was normal. When acid production was slow, the method of Price (9) was followed until the time of draining the whey. The curd from vats in which acid production was slow, was generally cheddared for a longer period and milled at much lower acidities (0.15 to 0.25 per cent).

The cottage cheese was manufactured from skim milk which had been pasteurized at 145° F. for 30 minutes. The skim milk was set at 72° F. with 1 per cent culture and 1 ml. rennet extract per 1000 pounds. The curd was cut with 0.5-inch knives after the whey acidity had reached 0.5 per cent. It was cooked to the desired firmness by the addition of hot water.

Preparation of bacteria-free filtrates. Bacteria-free filtrates of cheese cultures were prepared by filtering the cultures under aseptic conditions through coarse filter paper and the filtrate thus obtained through a Selas micro-porous filter (#03 porosity).

Bacteria-free filtrates of skim milk and whole milk were prepared by adding sterile lactic acid (10 per cent) in amounts just sufficient to coagulate the milk and then filtering in the same manner as for the cheese cultures.

Bacteria-free filtrates of whey and rennet were prepared by filtering directly through the Selas micro-porous filter.

Isolation of Streptococcus lactis from cheese cultures. Cultures of *S. lactis* were isolated from cheese cultures by plating on tomato agar and picking colonies. The plates were incubated at room temperature for 2 days. The tomato agar was prepared as follows: Ten grams of Bacto peptone, 10 g. of Bacto peptonized milk and 15 g. of agar were dissolved in 600 ml. water by boiling. Then 400 ml. of tomato juice (obtained by filtering canned tomatoes) neutralized to pH 7.0 with N/1 NaOH was added. The medium was filtered, placed in bottles, and autoclaved at 15 lbs. pressure for 25 min.

Formation of bacteriophage plaques. The method used to demonstrate plaque formation was as follows: About 15 ml. of tomato agar was poured into a sterile Petri dish and allowed to harden. A heavy suspension of a sensitive organism was spread over the surface of the agar by means of a bent glass-rod. Then a small amount of the bacteria-free filtrate to be tested for bacteriophage was spread over the surface of the agar and the plate incubated for 16 to 24 hrs. at 30° C.

Sensitivity test. In order to determine whether or not a cheese culture was sensitive to the action of a particular bacteriophage strain, the cheese culture was plated on tomato agar and representative cultures of *S. lactis* picked into litmus milk. The *S. lactis* cultures were transferred into duplicate tubes of litmus milk. One set of cultures served as controls, while the cultures in the other set were inoculated with a drop of the bacteria-free

filtrate containing bacteriophage. Retardation of the changes observed in litmus milk (acid, reduction, coagulation) served as the basis for determining whether or not a culture was sensitive. This same procedure was used to detect the presence of bacteriophage in unknown samples; using *S. lactis* cultures of known bacteriophage sensitivity as test organisms.

Bacteria counts. Bacteria counts were made by the plate method, using tomato agar and an incubation of 48 hrs. at 30° C.

Bacteriophage titer. The bacteriophage titer of a bacteria-free filtrate was determined by the dilution method and was recorded as the smallest amount of filtrate, expressed in milliliters, which would cause a significant retardation of acid production, reduction or coagulation of litmus milk.

RESULTS

Effect of bacteriophage on acid production during the manufacture of cheddar cheese. The effect of bacteriophage on acid production in the manufacture of cheddar cheese is presented in table 1. In the trial in which bacteriophage was absent, acid production proceeded normally and the curd was milled at a whey acidity of 0.52 per cent, calculated as lactic acid, 4 hrs. 35 min. after setting with rennet. In this trial the milk, culture and whey were free of bacteriophage in 1-ml. quantities, the largest amount used for detection of bacteriophage. In the trial in which bacteriophage was present, acid production appeared to proceed normally until the time of draining the whey. After the whey was drained, acid production practically ceased. The curd was milled at a whey acidity of 0.17 per cent, 6 hrs. 50 min. after setting with rennet. In this trial the milk was free of bacteriophage when 1-ml. quantities were tested but the culture employed was slightly contaminated with bacteriophage and had a bacteriophage titer of 10^{-2}. The whey at the time of draining had a bacteriophage titer of 10^{-6} and at the time of milling a titer of 10^{-8}. The mother culture employed in this trial showed no evidence of bacteriophage at the time it was used to inoculate the bulk culture in the cheese laboratory. The bulk culture had coagulated in a normal manner and after 14 hrs. incubation at 70° F., had devel-

TABLE 1

Effect of bacteriophage on acid production in the manufacture of cheddar cheese

Stage of manufacture	Bacteriophage absent		Bacteriophage present	
	Time	Titrable acidity	Time	Titrable acidity
		per cent		*per cent*
Milk (pasteurized)	8:00	0.16	8:00	0.16
Milk plus 1% culture	8:10	0.165	8:10	0.165
Setting	9:10	0.175	9:10	0.175
Cutting curd	9:40	0.12	9:40	0.12
Draining whey	11:10	0.14	11:10	0.13
Milling curd	1:45	0.52	4:00	0.17

oped an acidity of 0.82 per cent. The same mother culture was used to inoculate the bulk culture in both trials.

The effect of bacteriophage on acid production during the manufacture of cheddar cheese was so similar in all trials that the data for only one of the trials are given. Eight other trials showed practically identical results even though different cheese cultures were used. Cheese cultures containing several strains of *S. lactis* (strains showing differences in bacteriophage sensitivity) and also single-strain cultures were employed. In 5 of the 8 other trials bacteriophage could be detected in the bulk culture in small amounts; it could not be detected in the bulk culture in 3 trials but was present in fairly large amounts in the whey. However, acid production practically ceased after the whey was drained in all of the trials.

The ability of the bacteria-free filtrate, prepared from the whey obtained at time of milling (trial reported in table 1—bacteriophage present), to delay acid production by pure cultures of *S. lactis* is shown in table 2. The cultures of *S. lactis* were obtained from the mother culture which was used to inoculate the batch culture employed in the manufacture of the cheese from which the whey filtrate was obtained. The *S. lactis* cultures were picked at random from colonies appearing on a Petri dish. All of the control cultures (litmus milk inoculated with the various strains of *S. lactis*) showed acid, reduction and coagulation after being held for 16 hrs. at 30° C. When parallel cultures were inoculated with a drop of the whey filtrate containing bacteriophage, only 3 of 15 cultures were not sensitive to the action of bacteriophage present in the whey filtrate. After 40 hrs. at 30° C., 6 of the 15 cultures showed acid, reduction and coagulation of litmus milk and after 264 hrs., 7 of the 15 cultures showed acid, reduction and coagulation. There was no evidence of growth in 8 of the 15 cultures. Since the *S. lactis* cultures in this trial had different bacteriophage sensitivities, the cheese culture from which the *S. lactis* cultures were obtained would be considered a multiple-strain culture.

Bacteria-free filtrates of whey were prepared also from vats in which single-strain cheese cultures were employed and in which slow acid production occurred. When *S. lactis* cultures were isolated from these single-strain cheese cultures and tested for bacteriophage sensitivity, using whey filtrates from vats in which the particular single-strain cheese culture was employed, all of the *S. lactis* cultures were sensitive.

All of the bacteria-free whey filtrates (prepared from vats in which slow acid production occurred) which showed indication of the presence of bacteriophage by the sensitivity test were also tested for the presence of bacteriophage by the plaque method. *S. lactis* cultures which exhibited bacteriophage sensitivity according to the sensitivity test also produced bacteriophage plaques when the same bacteria-free filtrate was employed in both instances.

Effect of bacteriophage on acid production during the manufacture of cottage cheese. Data showing the effect of bacteriophage on acid production by a cheese culture in the manufacture of cottage cheese are presented in table 3. At the time of setting, or immediately after the addition of rennet and culture, the skim milk had a titrable acidity of 0.16 per cent and a total bacteria count of 2,460,000 per ml. A bacteria-free filtrate prepared from the vat contents at time of setting showed a bacteriophage titer of 10^{-1}. Individual samples of skim milk, culture and rennet extract showed no bacteriophage activity when 1-ml. samples were tested. One hr. after setting the titrable acidity increased to 0.17 per cent and the bacteria count increased to 4,200,000 per ml.; at the same time the bacteriophage titer

TABLE 2

Influence of a whey filtrate containing bacteriophage on growth and acid production by cultures of Streptococcus lactis in litmus milk

Streptococcus lactis culture No.	Control cultures after 16 hrs. at 30° C.	Cultures inoculated with one drop of whey filtrate containing bacteriophage and incubated at 30° C. for				
		16 hrs.	40 hrs.	88 hrs.	136 hrs.	264 hrs.
1	a r c	0	0	0	0	0
2	a r c	0	a r c	a r c	a r c	a r c
3	a r c	0	a r c	a r c	a r c	a r c
4	a r c	0	0	0	0	0
5	a r c	0	0	0	0	0
6	a r c	0	0	0	0	0
7	a r c	a r c	a r c	a r c	a r c	a r c
8	a r c	a r c	a r c	a r c	a r c	a r c
9	a r c	0	0	0	0	0
10	a r c	r	a r c	a r c	a r c	a r c
11	a r c	0	0	0	0	0
12	a r c	0	0	0	0	0
13	a r c	0	0	0	a r c	a r c
14	a r c	0	0	0	0	0
15	a r c	a r c	a r c	a r c	a r c	a r c

a = acid; r = reduction of litmus; c = coagulation; 0 = no evidence of growth.

increased to 10^{-2}. Two hrs. after setting the titrable acidity had increased to 0.18 per cent, the bacteria count to 11,800,000 and the bacteriophage titer to 10^{-5}. After 4 hrs., the titrable acidity had increased to 0.20 per cent but the bacteria count showed an appreciable decrease (3,600,000 per ml.); the bacteriophage titer increased to 10^{-7}. Eight hrs. after setting the titrable acidity was 0.21 per cent and the bacteria count had decreased further to 7,300 per ml.; the bacteriophage titer apparently reached its maximum at this time (10^{-9}). There was no increase in the titrable acidity or bacteriophage titer during the period 8 to 16 hrs. after setting but the bacteria count increased to 12,300 per ml. After 16 hrs. both the titrable acidity and bacteria count showed marked increases and the bacteriophage titer remained practically constant. At the 48-hr. period the titrable acidity was 0.68 per cent and the bacteria count 660,000,000 per ml.

TABLE 3

Effect of bacteriophage on acid production by a cheese culture during the manufacture of cottage cheese

Time after setting (hours)	Titrable acidity (per cent)	Number of bacteria per ml.	Bacteriophage titer
Initial	0.16	2,460,000	10^{-1}
1	0.17	4,200,000	10^{-2}
2	0.18	11,800,000	10^{-5}
4	0.20	3,600,000	10^{-7}
8	0.21	7,300	10^{-9}
16	0.21	12,300	10^{-9}
24	0.25	7,200,000	10^{-8}
36	0.43	310,000,000	10^{-9}
48	0.68	660,000,000	10^{-8}

The titrable acidity, number of bacteria and bacteriophage titer was followed with four other vats of skim milk used in the manufacture of cottage cheese and in which acid production was slow due to the presence of bacteriophage. The same general results as those given in table 3 were obtained. In all cases acid production was slow for about 24 hrs.; later, a more or less normal acid production occurred. The number of bacteria generally showed a slight increase which was followed by a very large decrease and then a large increase. The bacteriophage titer commonly showed an increase during the first 7 to 12 hrs. after setting; after this period the titer remained practically constant.

DISCUSSION

In all of the trials in which slow acid production during the manufacture of cheddar cheese was due to bacteriophage, acid development appeared to be nearly normal until the time of draining the whey. However, only slight increases normally are observed in the titrable acidity during this period and titration values frequently are confusing since those obtained on milk are not comparable to those obtained on whey. A rapid increase in the whey acidity takes place after the whey is drained with normal working vats. When such an increase in whey acidity fails to take place, it is easily recognized. For experimental purposes it might be desirable to follow the pH rather than the titrable acidity since removal of the casein from solution would not alter its value. The cultures selected for all of the trials were checked for their ability to produce acid at the cooking temperature employed (102° F.); therefore, temperature was not an influencing factor. When acid production is somewhat slow during the manufacture of cheddar cheese, many cheesemakers prefer to cheddar for a longer period of time so that each vat will be milled at about the same acidity. When bacteriophage was the cause of slow acid production, the curd commonly could be cheddared for very long periods of time (4 to 5 hrs.) without an appreciable increase in acidity.

The action of a bacteria-free whey filtrate (obtained from a vat of cheddar cheese in which acid production was slow) containing bacteriophage on pure cultures of *S. lactis* (obtained from the cheese culture employed in the same vat) is shown by data presented in table 2. Since the data show that 20 per cent (3 of 15 cultures) of the *S. lactis* cultures were not affected by bacteriophage, it would be presumed that these bacteriophage-resistant cultures would produce an appreciable amount of lactic acid. However, this was not the case in actual cheesemaking operations. Considerable variation was shown among the various sensitive strains of *S. lactis* in their ability to produce secondary growth. In the manufacture of cheddar cheese the time of manufacture could not be increased sufficiently to observe the effects of secondary growth.

The literature on bacteriophage as a cause of slow acid production in cheesemaking is largely associated with the manufacture of cheddar cheese. In this country, where a considerable amount of cottage cheese is manufactured, bacteriophage difficulties can be expected. Since cottage cheese is prepared from acid-coagulated skim milk, lactic acid production by the cheese culture is perhaps more important than in any other type of cheese. The data presented on the effect of bacteriophage on acid production by a cheese culture during the manufacture of cottage cheese would be expected to be very similar to data obtained when the bulk culture becomes contaminated with bacteriophage and fails to coagulate. As in the manufacture of cheddar cheese, acid production appears quite normal and there is evidence of growth of the culture organisms soon after setting. Later, however, acid fails to develop, the bacteria count decreases and the bacteriophage titer increases. Still later, the secondary growth of the culture organisms is manifest, and from then on acid production and the increase in number of bacteria proceeds in a more or less normal manner. If the skim milk intended for cottage cheese is set in the usual way and acid fails to develop as the result of bacteriophage, the skim milk will coagulate if left in the vat long enough. In many of the trials in which slow-acid production was encountered during the manufacture of cottage cheese, the skim milk was allowed to stand in the vat for periods of 40 to 50 hrs. before the milk had coagulated and the acid had reached a whey acidity of 0.50 per cent. Although a long setting period was required to develop sufficient acid, the cottage cheese finally obtained usually was of good quality and in most instances could not be distinguished from cottage cheese in which acid development had proceeded normally (14 to 16 hrs.). The initial bacteriological quality of the skim milk is an important factor in this respect.

SUMMARY

Slow acid production, due to the presence of bacteriophage, in the manufacture of cheddar cheese usually was apparent at the time of draining the whey or shortly thereafter.

The presence of bacteriophage resulted in almost complete cessation of acid production in the manufacture of cheddar cheese when either single-strain or multiple-strain cheese cultures were employed.

Cheddaring for a long period of time (4 or 5 hrs.) did not result in an appreciable increase in acidity when acid production was slow because of bacteriophage action.

The presence of bacteriophage in bacteria-free filtrates of whey, culture, etc., could be demonstrated by adding a small amount of the filtrate to pure cultures of *S. lactis* isolated from the culture used in the manufacturing process and also by the production of bacteriophage plaques on a solid medium.

When a vat of skim milk intended for cottage cheese was contaminated slightly with bacteriophage active against the culture employed, acid formation was very slow for about 24 hrs. after setting. During this same period the bacteria count showed a slight increase, then a large decrease, and finally a large increase. The bacteriophage titer increased for 7 to 12 hrs. following setting and then remained practically constant. When secondary growth occurred (usually after 24 hrs.), acid production proceeded normally.

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THE MANUFACTURE OF STERILIZED CARAMEL MILK

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The evaporated milk industry during World War II was interested in methods of preparing canned milk drinks of pleasing flavor and long storage life for the armed forces. The beverages were to be used hot or cold and without dilution with water and they were to act as a quick source of energy on invasion beachheads when appetites were sluggish. The caramel-flavored milk described in this paper was the best of a wide variety of milks which were studied in these laboratories in cooperation with an evaporated milk manufacturer who produced several commercial size batches.

EXPERIMENTAL

Test mixtures were prepared by adding the flavor base or concentrate to the milk, then homogenizing, canning and sterilizing the products. Sterilization was accomplished in a pilot evaporated milk sterilizer at 240° F. for 15 minutes, with the reel revolving at 4 r.p.m. Pilot plant tests of promising formulas were conducted in an evaporated milk plant by the cooperating manufacturer.

An important phase of the problem was the development of a suitable caramel base for flavoring the milk. The bases were prepared by following conventional caramel making procedures. The caramel mix was cooked in a steam-jacketed candy kettle equipped with a double action stirrer.

Viscosity determinations were made at 86° F., the storage temperature, with a McMichael viscosimeter equipped with standardized wires.

RESULTS

Preliminary tests indicated that milks flavored with fruits, maple and sweetened vanilla were less attractive or possessed poorer storage qualities than did chocolate or caramel milks. Work was centered on caramel flavor because caramel is present to some extent in all sterilized milk and since there appeared to be a possibility of developing a new and pleasing caramel-flavored milk drink.

It was found that a pronounced caramel flavor could not be developed during the sterilization of a milk sweetened with dextrose or sucrose. Such milks had a cooked flavor similar to that of evaporated milk. More heat and higher concentrations of proteins and sugars than in normal processing were necessary to produce a caramel flavor. When milk protein was partially hydrolyzed by continuously heating it in an acid medium (below pH 6.3) a

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cooked meat flavor was produced, but when a sugar was present in the mixture a caramel flavor resulted. The best caramel flavor was developed when a milk and sugar mixture was concentrated by boiling in an open kettle by methods used by caramel manufacturers.

Experiments were directed toward the preparation of a caramel base which would be suitable for use in the manufacture of caramel milk. The flavoring base finally produced was similar to a caramel topping. It was more fluid than caramel candy. The formula for this base is given in table 1. Combinations of various dairy products were used to fill the fat, milk-solids-not-fat and sugar needs of the formula. A sweeter mix was produced when the corn sirup was decreased about 25 per cent and the sugar increased as much as 80 per cent of the values given in table 1. If the fat content of the base was decreased and the milk-solids-not-fat content increased until the

TABLE 1

Formula for caramel flavor base

Ingredient	Wt. of ingredient	Weights of components		
		Fat	SNF	T.S.
	lbs.	*lbs.*	*lbs.*	*lbs.*
Cream (30% fat)	33.3	10	2.1	12.1
Condensed skim milk (30% solids)	15.0	.....	4.5	4.5
Corn sirup	45.0	.....	.....	36.0
Sucrose	14.3	.....	.....	14.3
Salt	0.7	.....	.....	0.7
Total	108.3	10	6.6	67.6

Heat the complete mixture with stirring to 160° F., and homogenize it at 2500 lbs. pressure. Cook in a candy kettle with double action stirrer to 238° F., cool slightly and add 8¼ lbs. of water and vanilla flavoring to suit the taste. Stir well and pour into a suitable receiver. Approximately 84 pounds of base containing 20% water will be recovered.

two values were equal, the base was inferior to the high-fat base in flavor but otherwise it was satisfactory. Caramel bases to which less water was added after cooking were made but these were too heavy to flow easily. When the caramel was not diluted with water after cooking, it contained about 89 per cent total solids.

Caramel milk was manufactured according to the formula of table 2. The simplest method of preparing trial batches was to mix 14 pounds of base with 42½ pounds of water and 43½ pounds of 26 per cent evaporated milk that had not been sterilized. The body and flavor of the product were better when the proper concentrations of plain and concentrated milks were used in place of water and 26 per cent solids milk. A satisfactory procedure was to supplement a plain milk with one concentrated to 15 or 20 per cent solids content. Under such conditions approximately one-third of the milk would be partially concentrated milk from a regular evaporated milk operation while the other two-thirds would be untreated whole milk. The milk

solids requirement of the formula of table 2 was also satisfield when the 86 pounds of milk in the formula were added as milk containing 4.07 per cent fat and 9.18 per cent solids-not-fat.

The forewarming treatment given the milk before it was mixed with the caramel base affected the heat stability of the finished product as shown in

TABLE 2

Formula for caramel milk

Ingredient	Weight of ingredient	Weights of components				
		Fat	M.S.N.F.	Sucrose	Corn sirup solids	Total solids
	lbs.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
Caramel base (table 1)	14	1.7	1.1	2.3	6.0	11.1
Milk	86	3.5	7.9	.....	.....	11.4
Total	100	5.2	9.0	2.3	6.0	22.5

TABLE 3

The effect of the heat treatment of milk upon the heat stability of caramel milk. Milk of 4.0 per cent fat and 9.2 per cent solids-not-fat was used. Homogenization was at 2500 pounds per sq. in. pressure

Forewarming treatment		Condensed to T.S.	Preparation of mixture				Heat stability at 240° F.
			Composition			Mixing and homogenization temperature	
Temp.	Time		Milk	Water	Caramel (table 1)		
°F.	*min.*	%	*lbs.*	*lbs.*	*lbs.*	°F.	*min.*
203	10	26	43½	42½	14	140	58
None	.....	Not condensed	86	0	14	140	51
203	10	Not condensed	86	0	14	180	90

TABLE 4

The effect of storage at 86° F. upon the viscosity of commercial samples of evaporated milk and of caramel flavored milk

Milk sample*	Fat	T.S.	Heat stability at 240° F.†	Viscosity at 86° F.					
				1 day	10 days	30 days	80 days	200 days	365 days
	%	%	*min.*	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*	*cp.*
Evap.	7.96	26.05	12	51	43	30	27	22	25
Caramel 1	4.92	23.39	30	12	11	10	10	11	13
Caramel 2	4.93	22.93	10	51	57	55	56	55	57

* Each of the three batches were sterilized at 240° F. for 15 minutes. Samples were received and placed in storage at 86° F., 15 to 20 days after date of manufacture.

† The heat stability figures are estimated from the appearance and viscosity of the milk examined after sterilization. Facilities were not available for making accurate heat stability tests on these milks.

table 3. The milks used in this experiment were more heat stable than the commercial milks of Table 4.

A comparison of the viscosity changes of normal evaporated milk and of caramel milk during storage at 86° F. is given in table 4. Caramel milk #1 was compounded from 44 parts of 26 per cent evaporated milk (not sterilized), 14 parts of caramel base (table 1) and 42 parts of water. Caramel milk #2 was made from a batch which contained 96 pounds of a heavy caramel base (T.S. 89%), 224 pounds of concentrated milk (T.S. 20%) and 480 pounds of raw fresh milk (T.S. 12%).

DISCUSSION

The caramel flavor of the finished milk was strong enough to overcome the cooked flavor which developed during sterilization. Caramel milk was found to possess an attractive flavor when it was used either hot or cold. Bases made with fats other than milk fat did not give the finished milk the delicate milk flavor produced by milk-fat bases. The fat content of caramel milks was varied from 2 per cent to 5 per cent but the flavor was superior in the high-fat milks. The vanilla added to the caramel base helped to point up the flavor of the milk.

The viscosity of caramel milk ranged from 8 to 65 centipoises at 86° F., about 25 centipoises being the optimum viscosity for a free flowing beverage. However, the more viscous milks were protected from fat separation and caramel precipitation much better than the thin ones. Caramel milk 1, table 4, was low in viscosity. After storage for a year at 86° F. it showed definite fat separation and there was a quarter-inch layer of precipitate in the bottom of the can. Caramel milk 2 was more viscous and had neither fat separation at the top nor sediment at the bottom of the can after storage under similar conditions. A viscosity in excess of 50 centipoises at 86° F. was required to prevent separation in milks which were held in storage for long periods.

The viscosity of the finished milk was controlled by adjusting the heat stability of the milk before sterilization as is done in the manufacture of evaporated milk (1). Forewarming the raw milk to high temperatures produced high heat stability (coagulation at 240° F. only after 30 minutes or longer) and a low viscosity in the sterilized milk, while low forewarming temperatures had the opposite effects.

The persistence of viscosity in caramel milks during storage was of particular interest. The viscosities of evaporated milks, illustrated by the sample shown in table 4, decreased to about one-half their initial values during the first few months' storage at temperatures of about 86° F. or higher. The viscosities of four samples of commercially produced caramel milk which were placed in storage at 86° F. within 3 weeks of the date of manufacture did not decrease further during one year. Data on two of these samples appear in table 4. The viscosity of four samples of caramel

milk prepared in the Research Laboratories and held at 86° F. showed an average decrease to 84 per cent of their initial viscosity from the date of manufacture to one year thereafter.

The factors responsible for preserving the viscosity in caramel milk were not determined nor are the causes of the change in evaporated milk understood.

SUMMARY

A process was developed for the preparation of a caramel-flavored sterilized milk for use as a beverage by the armed forces. The milk was made by mixing a caramel base with plain and concentrated milk to produce a product containing 5 per cent milk fat and 22 per cent total solids. The mixture was canned and processed by the same procedure as is used for evaporated milk. Some caramel milks were more stable than samples of evaporated milk in flavor, viscosity and body during storage for one year at 86° F.

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DIGESTIBILITY OF KOBE LESPEDEZA HAY

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Louisiana and other southern states have made greater usage of lespedeza for pastures and hay in recent years. Common or Japanese lespedeza (*Lespedeza striata*) is one of the most extensively grown legumes. Kobe lespedeza, a variety of common lespedeza, is gaining in popularity, especially because of its higher yield of hay.

This paper reports the digestibility of Kobe lespedeza hay cut at three stages of maturity.

MATERIAL AND PROCEDURE

Kobe lespedeza hay, approximately 90 per cent pure, was obtained in 1945 from a farm near Baskin in Franklin Parish. The soil on which the hay was grown is of medium fertility. The field was fertilized with 400 pounds of 4–12–4 fertilizer before oat-planting and the Kobe lespedeza was seeded during late winter in the oats. The first cutting of hay was made slightly earlier than the full-bloom stage, the second cutting was made during early-seed stage, and the third in the full-seed stage. This last cutting produced very poor quality hay. The hay was chopped to about one-inch lengths for feeding. Four dairy steers weighing from 400 to 500 pounds were used as experimental animals in the digestion trials.

The procedure used in management of the animals and in obtaining samples of hay and excreta has been reported in a recent paper (3). In general, it included the use of a 10-day preliminary period and a 10-day collection period. The feces were collected in a canvas collection bag. A 1/50 aliquot was taken from each day's fecal output for each steer and stored in a refrigerator at 0° C. until completion of the collection period. Nitrogen determinations were made on aliquots of the mixed fresh excreta, while dried excretum samples were used for the other analyses. The A.O.A.C. methods (2) were employed for the usual chemical analyses of hay and excreta, while lignin and cellulose were determined by the method of Crampton and Maynard (1).

Nine to eleven pounds of hay was fed daily, with very little feed being refused. The steers maintained their weights throughout the experiment.

RESULTS AND DISCUSSION

The composition, coefficients of digestibility, and digestible nutrients of Kobe lespedeza hay at the bloom, early-seed, and full-seed stages are presented in table 1.

The bloom-stage hay was the most desirable because of its higher percentages of crude protein, nitrogen-free extract, and ash. This hay was also

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higher in digestible protein and total digestible nutrients. The percentages of crude fiber and lignin increased with advance in stage of maturity of the hay, while the nitrogen-free extract decreased. The more matured hay was a relatively poor source of nutrients, particularly of protein.

A comparison of values found for Kobe lespedeza hay in this study and common lespedeza hay reported previously (3) shows that at similar stages of maturity the composition and digestible nutrients are almost identical. The percentages of crude protein and total digestible nutrients for the Kobe lespedeza in the early-cut stage (bloom) were 10.48 and 50.06, as compared to 10.52 and 50.06 for common lespedeza hay. In the early-seed or intermediate stage the values for protein and total digestible nutrients for Kobe lespedeza were 8.21 and 49.22, while those of the common lespedeza were 8.55

TABLE 1

The composition, digestion coefficients, and digestible nutrients of Kobe lespedeza hay at three stages of maturity (dry basis)

Stage of hay	Dry matter	Crude protein	Crude fiber	N-free extract	Crude fat	Lignin	Cellulose	Ash
	%	%	%	%	%	%	%	%
Bloom	94.30	10.48	42.09	41.60	1.60	26.04	37.47	4.23
Early-seed	92.07	8.21	45.88	40.57	1.41	27.10	41.34	3.93
Late-seed	93.51	6.15	50.35	38.76	1.57	30.20	36.25	3.16
Digestion coefficients								
Bloom		47.55	46.78	65.37	31.99	18.00	49.54	
Early-seed		32.29	45.11	63.26	7.08	20.00	57.70	
Late-seed		3.60	36.74	53.96	30.99	13.00	36.16	
Digestible nutrients								
						T.D.N.		
Bloom		4.98	18.00	26.11	0.43	50.06		
Early-seed		2.65	20.69	25.66	0.10	49.22		
Late-seed		0.22	18.50	20.91	0.48	40.70		

and 48.28. Kobe lespedeza hay cut in the very late stage (full-seed) contained 6.15 per cent protein and 40.70 total digestible nutrients. The coefficient of digestibility and percentage of digestible crude protein for this stage of maturity were surprisingly low, being 3.60 and 0.22 per cent, respectively, as compared to 47.55 and 4.98 per cent when the hay was cut in the bloom stage.

The values for the late-cut mature hay are unreasonably low and difficult to explain. It was expected that the values for the coefficient of digestibility and digestible protein would approximate 34.53 and 2.14 per cent, the values for low quality, late-cut native grass hay (4). This grass hay showed a protein content of 6.21 per cent on the dry basis and a total digestible nutrient value of 40.26, which are practically the same as the values for the late-cut Kobe lespedeza hay. The relatively low crude protein, however, definitely classifies this late-cut lespedeza hay as of inferior quality.

In a previous paper (3) a comparison was made of the digestibility values reported for common lespedeza and Korean lespedeza hay (5) at similar stages of maturity. The figures reported for percentage of crude protein in the Korean lespedeza are slightly higher than those for either the Kobe or common lespedeza at the same stage of maturity, *i.e.*, intermediate stage 11.84, 10.52, and 10.48, respectively. One explanation for this might be the practice of the Louisiana farmer, because of a long growing season, to postpone haying until fall when more favorable hay-curing weather exists. The rainy weather conditions make early cutting of hay more hazardous.

The total digestible nutrients on the dry basis for Kobe lespedeza, common lespedeza (3), and Korean lespedeza (5) at the same stages of maturity are very similar. In the bloom stage the values are 50.06, 50.06, and 48.51, respectively, and in the late stage of maturity the values are 48.22, 48.28, and 43.66, respectively.

The lignin and cellulose values for Kobe lespedeza hay are higher than those reported for Korean (5) and common lespedeza hay (3). The possible relationship between lignin content and feed utilization is again demonstrated in this study, for with an increase in lignin value there was a decrease in total digestible nutrients.

SUMMARY

Kobe lespedeza hay cut at three stages of maturity—bloom, early-seed, and late-seed—was used in three digestion trials with four dairy steers. Percentages of crude protein on the dry basis were 10.48, 8.21, and 6.15; percentages of digestible protein were 4.98, 2.65, and 0.22; and the total digestible nutrients were 50.06, 49.22, and 40.70 for the bloom, early-seed, and late-seed stages, respectively. The early-cut hay proved more valuable because of its higher nutritive value. These values are very similar to those of common lespedeza hay at the same stages of maturity.

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STUDIES ON MILK FEVER IN DAIRY COWS[1]
I. THE POSSIBLE ROLE OF VITAMIN D IN MILK FEVER

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Since the early 1920's milk fever, or parturient paresis, in dairy cows has been the subject of considerable research and theoretical discussion. Numerous theories regarding the etiology of milk fever have been advanced, namely anaphylaxis, circulatory disfunction, the presence of air in the blood, cerebral anemia, anhydremia (16) infection (29), auto-intoxication (18, 25), defective oxidation in the tissues (7, 8), excess oxytocic principle in the blood after parturition (4), hypoglycemia (2, 6, 24, 32, 33, 34, 38, 39), and hypocalcemia associated with disturbed mineral metabolism (3, 5, 8, 9, 10, 12, 13, 14, 15, 21, 23, 31, 36, 37, 40). A review of theories up to 1926 is presented by Little and Wright (22).

Little experimental support is offered for any of these theories, except for the hypoglycemic and hypocalcemic theories. Several workers have published results which would tend to disprove the hypoglycemic theory (7, 17, 26, 27). Therefore, it appears that the answer to the question of the basic cause of milk fever must lie in the realm of disturbed mineral metabolism.

This view is further substantiated by the changes occurring in the blood at parturition and during the milk fever attack. A marked decrease in both total calcium (1, 3, 8, 9, 10, 11, 12, 14, 21, 23, 35, 37, 40) and ionized calcium (12, 23, 31, 37) has been reported. Phosphorus is greatly decreased (3, 9, 10, 11, 12, 23, 28, 35, 37, 40) in milk fever and in contrast to calcium and phosphorus, magnesium is said to increase (1, 3, 12, 28, 30, 31, 37).

Furthermore, milk fever treatment, whether it be udder inflation or intravenous injection of calcium salts, is primarily concerned with elevating the blood calcium to the normal level. It would seem, therefore, that any prophylactic method, to be effective, should prevent the fall of blood calcium below the critical level.

That vitamin D may be a factor in milk fever is suggested by the observation that the highest incidence is reported to occur in the winter and early spring months (19, 26) when solar irradiation is the least.

The role of vitamin D in calcium and phosphorus metabolism has been recognized for many years. Since vitamin D is known to have calcemic properties and because it is now available in cheap, abundant quantities it

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[2] N. E. Van Demark assisted in obtaining the data from The Ohio State University herd.

seemed reasonable that the feeding of large amounts of vitamin D prior to parturition might prove beneficial in the control of milk fever. Greig (14) and Sjollema (36) have suggested the feeding of vitamin D as a possible preventive measure in milk fever but give no experimental evidence of its value. An increase in blood calcium in cows receiving amounts of vitamin D above their actual needs is reported by Hess *et al.* (20). The authors report no pathological effects in the tissues of cows fed 1,500,000 units of vitamin D per day.

Herein reported are the results of experiments designed to determine whether or not the feeding of massive doses of vitamin D prior to parturition will lower the incidence of milk fever.

The results of the effect of vitamin D feeding on the blood changes at parturition and in milk fever will be presented in another paper.

EXPERIMENTAL

In a preliminary experiment, six cows were fed 1 million units of vitamin D daily in the form of type (7 F) irradiated dry yeast[3] for four weeks before the expected date of parturition and for one week following parturition. Although two of these cows had previous histories of milk fever, none of them developed milk fever. Two of the five control animals developed milk fever. Both of these cows had previous histories of milk fever.

As a result of this preliminary trial a more extensive experiment was planned in which the main Experiment Station, the Station Pasture Farm, and the Ohio State University herds were used. During the first 2 years (1941–43) all cows exclusive of first-calf heifers were included. Later (1943–45) only the two Experiment Station herds were used and only Jersey cows that had had at least two previous parturitions were included.

Beginning September 15, 1941, the cows included in the experiment were divided into two equal groups as nearly comparable as possible, based on breed, age, expected freshening date, and previous milk fever histories. One group was fed vitamin D and the other, which served as a control, was not fed vitamin D. At each successive freshening, the cows were assigned to the opposite group. Thus each cow served as her own control for several freshenings, if she remained in the herd.

Hay, silage, grain, and pasture were fed throughout the year according to supplies available and the practice commonly employed in the various herds. All cows in each herd were fed and managed alike during the dry period and after parturition except for the yeast supplement.

In this experiment vitamin D was supplied in the form of type (9F) irradiated dry yeast,[4] 110 grams being required to supply 1 million U.S.P. units.

[3] Supplied by Standard Brands Incorporated, New York City.

[4] Supplied by Standard Brands Incorporated, New York City.

TABLE 1

The effect of irradiated-yeast feeding on the incidence of milk fever in different breeds of dairy cows

	Total parturitions	Yeast-fed	Control
Ayrshire			
Fresh, normally	18	8	10
Milk fever	3	2	1
Total parturitions	21	10	11
Per cent incidence	14.3	20.0	9.1
Guernsey			
Fresh, normally	13	6	7
Milk fever	2	2	0
Total parturitions	15	8	7
Per cent incidence	6.7	25.0	0.0
Holstein			
Fresh, normally	35	12	23
Milk fever	2	1	1
Total parturitions	37	13	24
Per cent incidence	5.4	7.8	4.2
Jersey			
Fresh, normally	70	36	34
Milk fever	35	17	18
Total parturitions	105	53	52
Per cent incidence	33.3	32.1	34.6
All Breeds			
Fresh, normally	136	62	74
Milk fever	42	22	20
Total parturitions	178	84	94
Per cent incidence	23.6	26.2	21.3

Beginning 4 weeks before the expected date of parturition and continuing for 1 week following parturition, 1 million U.S.P. units of vitamin D were fed daily by sprinkling one half of the allowance on the grain at each feeding. In a very few cases, the cows were slow at first in eating their grain which contained the irradiated yeast but most of them ate it readily from the start.

A careful record was kept of the occurrence of milk fever, based on the diagnosis of a veterinarian and on blood analyses. The results of feeding the previously indicated amount of vitamin D in the form of irradiated dry yeast on milk fever incidence are indicated in tables 1 and 2.

The seasonal incidence of milk fever based on the 105 parturitions in

TABLE 2

The effect of irradiated yeast feeding on the incidence of milk fever in Jersey cows with previous milk fever histories

	Total parturitions	Yeast-fed	Control
Fresh, normally	19	13	6
Milk fever	21	10	11
Total parturitions	40	23	17
Per cent incidence	52.5	43.5	64.7

mature Jersey cows included in this study is presented in table 3. It will be seen that essentially the same per cent incidence of milk fever occurred in the period from May through September as in the period October through April.

This observation is at variance with that of Metzger and Morrison (26) and Henderson (19) who report a higher per cent incidence of milk fever in the winter than in the summer. No explanation is evident for this difference; however, it seems reasonable that solar irradiation may not have as much effect on lowering milk fever incidence as is commonly believed since

TABLE 3

Seasonal incidence of milk fever in mature Jersey cows

	Normal	Milk fever	Total	Per cent milk fever
January	5	1	6	16.7
February	16	10	26	38.4
March	20	9	29	31.0
April	7	3	10	30.0
May	3	1	4	25.0
June	3	1	4	25.0
July	1	1	2	50.0
August	3	1	4	25.0
September	3	3	6	50.0
October	2	2	4	50.0
November	3	2	5	40.0
December	4	1	5	20.0
Total	70	35	105	33.3
May–September	13	7	20	35.0
October–April	57	28	85	33.0

the highest vitamin D potency of both blood and milk under summer pasture conditions is considerably less than when 1 million units of vitamin D is administered daily in the form of irradiated yeast.

DISCUSSION

It will be noted that the incidence of milk fever is much higher in the Jersey breed than in the other breeds. The average per cent incidence of milk fever in breeds other than Jerseys was 9.6 compared to 33.3 in the Jerseys. This is in agreement with data published by Metzger and Morrison 1936 (26) and Henderson 1938 (19).

All the data involving Ayrshires and Guernseys, plus 16 of the 35 Holstein cows, were obtained from the Ohio State University herd. All except five Jersey parturitions occurred in the Experiment Station herd. The milk fever cases in the Holstein, Guernsey, and Ayrshire breeds occurred in the Ohio State University herd. Milk fever has not been observed in the Experiment Station Holstein herd in recent years.

An examination of the data from all four breeds shows that the feeding of 1 million units of vitamin D in the form of irradiated yeast did not pre-

vent milk fever. The difference in per cent incidence between yeast-fed and control cows of the Ayrshire and Guernsey breeds is not considered to be significant due to the small numbers involved.

In considering the results when limited to Jersey cows with previous milk fever histories, it appears that some beneficial effect can be attributed to the treatment. Of 40 such parturitions, only 43.5 per cent of the cows in the yeast-fed group had milk fever as compared to 64.7 per cent in the control group.

An examination of the data regarding the effect of irradiated yeast feeding on the blood calcium and phosphorus, to be presented in another paper, indicates no significant difference between the yeast-fed and the control group. This substantiates the results of the incidence study.

The results of this experiment are not interpreted to mean that vitamin D has no place in the control of milk fever. It is entirely possible that if larger amounts of vitamin D had been consumed, the effect would have been greater. Preliminary studies with larger amounts of vitamin D indicate that it takes more than 1 million units daily to raise the calcium and phosphorus levels of the blood materially. It is possible that with higher levels of vitamin D feeding milk fever incidence could be reduced. Such studies are now in progress.

SUMMARY AND CONCLUSIONS

1. The feeding of 1 million units of vitamin D daily in the form of irradiated yeast for 4 weeks prior to and one week following parturition did not reduce the incidence of milk fever in an experiment involving 178 parturitions in four breeds of dairy cows.

2. The highest incidence of milk fever was observed in Jersey cows.

3. Milk fever occurred only in cows with at least two previous parturitions. The percent incidence in mature Jersey cows was found to be equally as high in summer as in winter.

4. The irradiated yeast treatment reduced the incidence of milk fever somewhat in Jersey cows which had previous histories of milk fever.

Experiments to investigate the effect of feeding larger amounts of vitamin D are in progress.

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ADDITIONAL OBSERVATIONS ON THE STABILITY OF ASCORBIC ACID AND SODIUM L-ASCORBATE IN EVAPORATED MILK*

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Previous studies have been published dealing with the ascorbic acid content of commercially manufactured evaporated milk (1) and with the stability of the vitamin in fortified and unfortified evaporated milk, sealed normally and after removal of the air from the can (2, 3). Storage results were given up to 12 months at room temperature in the latter studies. Extra samples of a number of the batches made were available and have since been analyzed after 24 and 28 months of holding, thus extending the data significantly.

One study, utilizing sodium l-ascorbate in place of ascorbic acid, has now been carried to 12 months of storage and the data can be compared with the previously obtained results. The sodium salt was used in an effort to avoid the destabilizing effect of the ascorbic acid on the milk protein when fortification at high levels (100 mg./l. and over, fluid basis) was attempted. This effect manifests itself in a flaking of the protein during the sterilization of the milk and requires additional quantities of stabilizing salts (di-sodium phosphate or sodium citrate) to overcome it.

Methods and procedures employed in the studies have been described in the previous publications and will not be given here.

In the accompanying figure, the average reduced ascorbic acid levels of the variously treated batches of evaporated milk are plotted against storage time in months at room temperature. The curves depicting the loss of the vitamin on holding are remarkably uniform, and the rates of loss nominal. Vacuum sealed milk containing 106.5 mg./l. (fluid basis) of ascorbic acid after sterilizing still retained 71.2 mg., 24 months later. Similar milk with 58.6 mg. to begin with had 32.6 mg., 28 months later. These data further emphasize the suitability of evaporated milk as a medium for fortification with and storage of vitamin C.

The loss of ascorbic acid in evaporated milk in milligrams per month is higher for milk rich in ascorbic acid and lower in milk poor in the vitamin, as can be noted from the curves. After the first two to four months, during which time the free oxygen in the container apparently reacts with the ascorbic acid and particularly with the heat-generated reducing substances (3), the rate of loss of the vitamin becomes much slower. The loss per interval

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of time, however, seems to be proportional to the quantity of ascorbic acid present. This is made clearer in table 1 where the losses suffered by a number of variously treated batches of evaporated milk during the last twelve months of storage are shown. The percentage loss on all these batches ranges from 11.4 to 16.6 which is considered quite uniform and rather significant in view of the diversity of treatment. It is apparent, of course, that this rate of loss, approximately 14 per cent, applies only to the storage period subsequent to the first two to four months of more rapid loss as is evident in the figure. Even in the first period, however, the loss of ascorbic acid appears to be more closely related to the amount present than to the available oxygen since the normally sealed, unfortified, evaporated milk

TABLE 1

The loss of ascorbic acid in evaporated milk during the last twelve months of storage at room temperature

Treatment of milk	Total time stored (months)	Ascorbic acid (mg./l.—fluid basis) last 12 months of period			
		Beginning	End	Loss	Per cent loss
Not fortified					
1. Normal seal	18	7.0	6.2	0.8	11.4
2. Vacuum seal	18	10.1	8.9	1.2	12.0
50 mg./l. fortification					
3. Normal seal	28	32.5	27.5	5.0	15.4
4. Normal seal (sodium salt)	12	36.5	31.5*	5.0	13.7
5. Vacuum seal	28	42.0	35.0	7.0	16.6
100 mg./l. fortification					
6. Normal seal (underfilled)	24	40.5	33.8	6.7	16.5
7. Normal seal	24	67.1	57.0	10.1	15.0
8. Normal seal (sodium salt)	12	75.4	65.0*	10.4	13.8
9. Vacuum seal	24	81.3	71.0	10.3	12.7

* These data were obtained by extrapolating the values for the last six months.

exhibited only a small loss in milligrams compared to the normally sealed fortified milk and the vacuum-sealed fortified milk showed a greater loss than the normally sealed unfortified milk. Thus, it appears that the oxidation of reduced ascorbic acid in evaporated milk is not a quantitative reaction with free oxygen as has been found true with sealed samples of fluid milk by Sharp *et al.* (4) and Noll and Supplee (5). The results presented in the figure and in table 1 show very conclusively that vacuum sealing has no effect on the rate of loss after the first two to four months period.

Sodium *l*-ascorbate was found to be more satisfactory as a fortifying substance for addition to evaporated milk than the acid form of the vitamin because it does not destabilize the milk proteins toward heat and create sterilizing difficulties when levels of 100 mg./l. (fluid basis) and above are used. This is indicated by the data in table 2. A batch of milk was con-

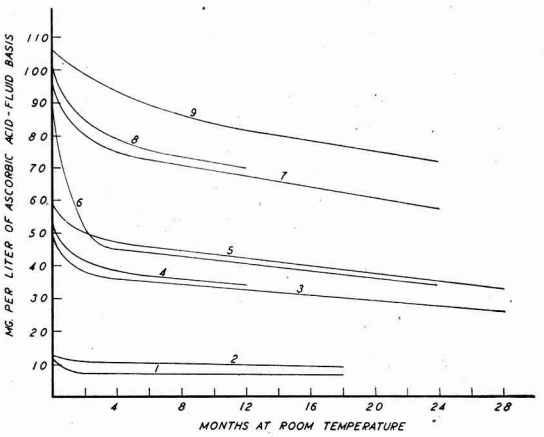

FIG. 1. Effect of storage at room temperature on the ascorbic acid content of variously treated evaporated milk. 1. Not fortified—normal seal. 2. Not fortified—vacuum seal. 3. Fortified (50 mg./1. ascorbic acid)—normal seal. 4. Fortified (50 mg./1. sodium *l*-ascorbate)—normal seal. 5. Fortified (50 mg./1. ascorbic acid)—vacuum seal. 6. Fortified (100 mg./1. ascorbic acid)—underfilled—normal seal. 7. Fortified (100 mg./1. ascorbic acid)—normal seal. 8. Fortified (100 mg./1. sodium *l*-ascorbate)—normal seal. 9. Fortified (100 mg./1. ascorbic acid)—vacuum seal.

centrated to a point representing the threshold of coagulation at 240° F. for 15 minutes. It was then partitioned and fortified with 50, 100, and 150 mg./1. of ascorbic acid respectively, using the acid form of the vitamin and the sodium salt. The cans were sealed and sterilized normally.

The data reveal that no detectable change in the visible amount of coagulation occurred when sodium *l*-ascorbate was used in evaporated milk as the fortifying agent, whereas the ascorbic acid aggravated the coagulation very

TABLE 2

Effect on sterilizing characteristics of evaporated milk when fortification is accomplished with ascorbic acid and with sodium l-ascorbate.

Treatment of milk	Ascorbic acid (fluid basis)		Degree of coagulation	pH
	Before sterilization	After sterilization		
	mg./1.	*mg./1.*		
Control*	11.9	9.8	±	6.19
50 mg./1. ascorbic acid	58.8	53.2	+	6.19
100 mg./1. ascorbic acid	109.0	99.2	++	6.18
150 mg./1. ascorbic acid	156.9	144.5	+++	6.18
50 mg./1. sodium *l*-ascorbate	58.5†	53.6	±	6.19
100 mg./1. sodium *l*-ascorbate	109.3	102.0	±	6.19
150 mg./1. sodium *l*-ascorbate	157.9	143.0	±	6.20

* Milk was concentrated to 19.92 per cent solids not fat.

† Titration indicated the sodium salt to contain 88.4 per cent ascorbic acid, the amount used therefore was 1.131 times the amount of the acid.

definitely as the concentration of the vitamin was increased. Variations in pH of the milk as a result of the vitamin additions were hardly in excess of the sensitivity of the instrument used (Beckman pH meter). Table 2 shows no significant differences in the effect of the sterilizing treatment on the vitamin, whether ascorbic acid or its sodium salt was employed for fortification and the curves in the figure indicate that the storage losses follow an identical trend with the previously studied batches of milk.

FINAL CONCLUSIONS

Evaporated milk is a highly suitable medium for fortification with ascorbic acid (vitamin C) inasmuch as the losses during storage are small and predictable.

The disappearance of ascorbic acid in evaporated milk after the first two to four months of storage is uniform and proportional to the amounts present.

Oxidation of ascorbic acid in evaporated milk is not a quantitative reaction with the free oxygen present as is apparently the case with sealed samples of fluid milk.

The sodium salt of ascorbic acid is a more satisfactory form of the vitamin to use for fortifying evaporated milk inasmuch as it does not effect the stability of the porteins toward sterilization and in all other respects behaves identically with the acid.

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ABSTRACTS OF LITERATURE

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The Royal Technical College, Copenhagen, Denmark

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ABSTRACTS OF LITERATURE

BOOK REVIEWS

294. **The Bacterial Cell: in its relation to problems of virulence, immunity and chemotherapy.** RENE J. DUBOS. With an Addendum by C. F. ROBINOW. Harvard University Press, Cambridge, i–xix, 460 pp. 1945.

Dr. Dubos' presentation of the bacterial cell is an extremely interesting one. He gives briefly and matter-of-factly the physical structures, based on judicious choice from the early literature and the latest electron micrography. One is impressed with the considerable literature on the subject within the last 5 years; it is a field many of us take as little developed. The discussion of staining is particularly good, as it relates to the physicochemical basis of staining reactions. Much emphasis is given to the Gram stain, in anticipation of later reference to the serological and other biochemical differences between the Gram positive and Gram negative bacteria.

The remainder of the book deals with the physiological significance of cellular structures. Analyses by enzymatic and immunological and bacteriophage methods are cited and interpreted in terms of what they reveal about surface and internal reactive groupings within the protoplasm. Inevitably there must follow a chapter on bacterial variability, for loss of flagella, loss of capsules, loss of specific antigens come up for discussion. The opinions expressed on nontransmissible and transmissible modifications and the possible mechanism of hereditary variaiton are cautious indeed. "In the absence of some process of fusion and segregation, it is difficult to account at the present time for the observed phenomena of bacterial variation . . ." (p. 175). And yet there follows a critique of the claims of life cycles and transformation of pneumococcal types, ending with the cryptic remark: "If the transformation thus induced is described as a genetic mutation, it offers an authentic case of specific mutation brought about by a specific treatment, a feat which geneticists have vainly tried to accomplish in higher organisms" (p. 187).

The last half of the book deals with the vastly important problems of nature of virulence, immunization against bacterial infection, and the various types of mechanisms of bacteriostatic and bactericidal agents. These subjects are certainly timely in this day of new and better therapeutic agents. The many new workers in the antibiotic and general chemotherapeutic field will find the discussion most informative.

E.M.

295. Disinfection and Sterilization. E. C. McCulloch. Lee and Febiger, Philadelphia. Sec. Ed. 1945. 472 pp. Illus. $6.50.

This book represents a thorough revision of the first edition. It includes a history of our knowledge of disinfection and sterilization, and the part played by natural agencies and the defensive mechanisms of the body. The effects of the better known physical and chemical agents together with factors affecting their activity are discussed thoroughly. A chapter on the dynamics of disinfection presents a theoretical discussion as well as a report on factors affecting disinfection in general. Methods of water purification, sewage treatment and air disinfection are discussed also.

The final chapter on factors to consider in selecting a disinfectant for various specific purposes should be quite valuable for the research and practical worker alike.

Of special interest to dairy workers are the chapters on heat, including pasteurization and heating for sanitizing of food equipment, and the discussion on factors affecting activity of chlorine compounds. The sections on antibiotics and cationic germicides unfortunately do not contain much of the information that has appeared within the last few years. The section on methods of air purification is not complete.

This book should be valuable to teachers and research workers in bacteriology and related fields. It is the only available publication that combines in one volume the various phases of disinfection and sterilization. For the reader benefit numerous references are given to original publications. P.R.E.

296. Microbes of Merit. Otto Rahn. The Jaques Cattell Press, Lancaster, Pennsylvania. 1945. 277 pages, illustrated. $4.00.

In this unusual book the author successfully explains the nature of bacteria in terms understandable to the layman and emphasizes the seldom recognized fact that harmful bacteria comprise only a small fraction of the total microbic population on this earth. The reader will be profoundly impressed by numerous interesting descriptions of the multitude of useful activities performed by microorganisms.

The author has enlivened his descriptions with numerous excellent sketches, illustrations, and photographs. A rare sense of humor throughout adds immeasurably to the discussion. This book should be of interest not only to the layman but also to the scientist, whether he be bacteriologist or otherwise. It should be of value to dairy farmers, plant operators and laboratory workers alike because of its splendid descriptions and remarkable analogies and comparisons employed in telling what bacteria are, how they live and how they affect man's activities. Its approach is of necessity somewhat elementary. Nevertheless, it is one of the most entertaining and also valuable books ever published in the field of microbiology. P.R.E.

BACTERIOLOGY

297. Sterilization of Micro-organisms. OTTO RAHN, Prof. of Bacteriology, Cornell University. Milk Plant Monthly, *34*(12): 24–26, 46, 52. 1945.

Bacteria may be sterilized by physical methods—by the application of heat or light and by chemical methods—by adding disinfectants. The higher temperatures and stronger disinfectants must be used. Heat, drying, freezing, pressure and supersonic waves all have been utilized in destroying bacteria, heat being the best method available to dairymen. Ultra violet light not only kills vegetative cells but spores as well. Of the hundreds of different disinfectants on the market only very few are used in the dairy industry. Any disinfectant must be rejected if it is (a) strongly tasting or smelling, eliminates phenol, cresol, lysol, thymol, formaldehyde, etc., (b) colored, (c) very toxic to man, (d) corrodes the metals, and (e) very expensive. Chemical disinfectants used in the dairy industry are alkalies, chlorine, weak acids and synthetic detergents. High alkalinity may have excellent sterilizing properties, but possess a tendency to corrode tin and produce milk stone. Chlorine is very effective in water or on clean equipment. Its efficiency depends largly upon the degree of cleanliness accomplished before the chlorine is applied. Acid detergents show promising results under proper conditions of use. The non-synthetic wetting agents with decreased surface tension vary in their disinfectant properties depending to some extent on the pH of the solution used. The author believes that the chemical sterilization of dairy equipment is more promising than physical methods. However, the ideal disinfectant, one which can be used for all purposes and applied under all circumstances, has not as yet been found. More data on two new promising methods—the use of weak acids and synthetic detergents—should be obtained. G.M.T.

BUTTER

298. Many Factors Affect the Total Loss of Fat in Buttermilk. L. C. THOMSEN. Canad. Dairy and Ice Cream Jour., *23:* 8. Aug., 1944.

The factors affecting the fat loss in buttermilk are: (1) the amount of dilution of the cream or buttermilk with rinse water in the plant; (2) the richness of the cream; (3) the handling of the cream prior to churning; (4) pasteurizing methods; (5) the condition of the cream before and during pasteurizing; (6) the fullness of the churn; (7) the churning temperature and the temperature the cream was held prior to churning; (8) season of the year, feed of the cows, breed of the cows and period of lactation; (9) the churn may be of minor importance. The four tests used in testing buttermilk are: (a) the Mojonnier or ether extract; (b) the American Association; (c) the Minnesota; (d) the "regular" Babcock. H.P.

299. **Standardizing the pH of Butter with Carbonate Neutralizers.** W. L. DUNKLEY AND F. W. WOOD. Canad. Dairy and Ice Cream Jour., *24:* 9. Sept., 1945.

It is recommended that: (1) The neutralizing process be carried out accurately and consistently; (2) the reduction in acidity be calculated to such a value that the pH of the butter serum will be approximately 7.0; (3) the pH of the butter should be checked from time to time; (4) the pH of the butter serum be within the range 6.7 to 7.2 for best flavor and keeping quality. H.P.

300. **The Flavor of Butter When Manufactured from Rancid Cream.** W. L. DUNKLEY AND F. W. WOOD. Canad. Dairy and Ice Cream Jour., *24:* 7. July, 1945.

The authors believe that it is mainly the capric and lauric acids and not butyric, caproic and caprylic acids that are responsible for the bitter taste of rancid products. Neutralizing rancid cream for acidity will improve the quality of the butter, but cream should be neutralized to a titratable acidity of 0.12 or less. Other foreign flavors tend to become more evident in the butter when neutralized to a low acidity. H.P.

301. **The Effect of Rusty Cream Cans Upon the Quality of Butter.** F. W. HAMILTON. Canad. Dairy and Ice Cream Jour., *24:* 6. June, 1945.

Cream exposed to iron is a factor influencing the development of metallic and other off flavors in butter. With an increase of the iron surface exposed to the cream, the quality of the butter progressively depreciates. A slight increase in acidity was found in cream stored in rusty cans. Cream stored in cans that are rusty and exposes the iron in the cans is definitely deteriorated in proportion to the amount of iron exposed. H.P.

302. **Bacteriology in Relation to Reworking and Printing Butter.** E. G. GOOD. Canad. Dairy and Ice Cream Jour., *24:* 3. March, 1945.

All equipment used in reworking and printing butter should be thoroughly clean and sterile. Reworking (1) disturbs the structure of butter; (2) allows closer contact between microorganisms and food supply; and (3) stimulates or speeds up bacterial growth which may result in defects of a bacteriological nature. Reworking causes an enlargement of the water droplets in the butter, giving bacteria a better chance to develop. H.P.

303. **Some Factors Affecting the Flavor Quality of Butter.** A. H. WHITE. Canad. Dairy and Ice Cream Jour., *23:* 7. July, 1944.

The desirable characteristics of butter are good flavor, firm body, waxy texture, proper incorporation of moisture, even color and salting. The factors affecting flavor quality are: (1) cream quality; (2) enzyme action;

(3) the effect of bacterial activity; (4) chemical changes especially oxidation. The important factors involved in oxidation changes in the butterfat are as follows: (1) excessive acidity in the butter; (2) metallic contamination of heavy metals such as copper and iron; (3) exposure to light; and (4) temperature of storage. The surface deterioration of 45 commercial butters has been determined. The total bacteria counts by the plate method ranged from less than 5,000 to over 2,000,000 per c.c. for both the surface and interior of the butter samples. In general, the bacteria counts were higher on the surface than in the interior of the same sample. There seemed to be close correlation between bacterial numbers and the particular defect appearing on the butter surface, or with the original score of the butter. The copper content of butters which had developed surface defects ranged from .07 to 0.8 p.p.m., while for the butters which had maintained flavor during storage the copper contents varied from 0.09 to 0.16 p.p.m. Iron may also be an important factor in the development of fat oxidation defects. Butters that were degraded for surface defects, the pH values ranged from 5.56 to 7.56, while the pH values of the butters maintaining quality during storage were 5.94 to 7.66. The acidity of cream in relation to butter quality is becoming increasingly evident. Neutralization of cream is one of the most important operations in the creamery. Metallic contamination from bare copper equipment and exposure of butter to light are sources of trouble.

H.P.

304. Treatment of Liners as Related to Shrinkage of Butter in Fibre Boxes. R. W. BROWN AND T. L. FORSTER. Canad. Dairy and Ice Cream Jour., *23:* 10. Oct., 1944.

In a comparison of dry, 12% brine, and saturated brine treatment of liners for fibre butter boxes it was found that 12% brine solution allowed the least shrinkage, while dry liners permitted the largest shrinkage.

H.P.

305. Testing for Yeasts and Molds in Butter Encourages Sanitation. A. G. LEGGATT. Canad. Dairy and Ice Cream Jour., *24:* 1. Feb., 1945.

The presence of yeasts and molds in butter indicates a need for improvement in sanitary conditions. Yeasts and molds must enter the butter after pasteurization from imperfectly cleaned equipment. H.P.

306. Overrun and Moisture Control in Canadian Creamery Butter. G. E. TURNER AND V. E. GRAHAM. Canad. Dairy and Ice Cream Jour., *24:* 8. Aug., 1945.

The most important sources of the losses which tend to reduce factory overrun are: (1) inaccurate weighing; (2) inaccurate testing; (3) fat used

in sampling and setting; (4) incomplete drainage of cans; (5) leaks in pipe lines, valves, churns, etc.; (6) accidental spilling; (7) fat losses in buttermilk; (8) remnants of butter left in the churn; (9) butter soiled in packing; (10) shrinkage allowance. Churn overrun may be reduced by lack of attention to some of the points listed above, especially 5, 6, 7 and 8. To secure proper moisture and salt content of the finished butter five requirements must be met; (1) a churn that will produce butter of uniform composition throughout; (2) the buttermaker must know exactly how much fat there is in each churning; (3) accurate moisture tests; (4) the physical condition of the butter must be such that it can be worked to the desired extent without harm to its texture; (5) an accurate method of determining the amount of water to add. The amount of salt added to butter depends upon (1) percentage of salt desired; (2) the texture of the butter. Only 0.1 percent of the salt added is normally lost during the working process. Tables are given that (1) estimate the amount of salt to add to butter and (2) estimate the water to add to butter. H.P.

307. Control of Leakiness in Butter Gives More Profitable Returns. G. H. WILSTER. Canad. Dairy and Ice Cream Jour., *23:* 9. Sept., 1944.

Control of leakiness in butter is essential for the following reasons: (1) economic loss either to the creamery or to the buyer and distributor on account of short weight; (2) it is necessary to compensate for loss in weight of the printed leaky butter by printing overweight units; (3) with dry wraps, leaky butter causes an unsightly wrinkled appearance of the parchment; (4) leakiness favors the growth of molds and bacteria; (5) restaurant operators and housewives object to leaky butter because they think the butter contains an excessive amount of moisture; (6) when leaky butter is exposed to air, evaporation of the moisture takes place, leaving white salt crystals; (7) the butter has a briny, harsh taste; (8) when leaky butter is spread on bread or toast, brine may spurt out to the surprise and irritation of the customer. Butter for printing should have a waxy body—not too hard and possess a well knit texture. Moisture must be thoroughly incorporated to lower shrinkage in weight. H.P.

308. New Concept About Butter Revealed by Research. W. R. BLOOR, Univ. of Rochester, Rochester, New York. Certified Milk, *20,* No. 234: 5. Oct., 1945.

Feeding studies with rats have shown that the fatty acids of butterfat, which have special growth promoting values, are found in the liquid or unsaturated fractions. Weight gains similar to those induced by whole butterfat were observed where the liquid fatty acids were fed. The fatty acids of the volatile group were considerably less effective than the liquid acids in promoting growth. The relationship between body growth and

the vitamin A content of the liver was also observed. The animals which had received the liquid fatty acids grew best and stored about twice as much vitamin A in their livers as did the animals which had received the solid fatty acids. Those animals which had been fed the volatile acid not only made the poorest growth, but also stored the least amount of vitamin A. This preliminary research report indicates definitely that the chemical composition of a food fat helps to determine the nutritive efficiency of other foods. It is highly probable, therefore, that some fats are more efficient than others in so far as their influence on utilization of the carotene of a mixed diet is concerned. W.S.M.

309. **Estimation of Salt in Butter and New Cheese by a Mercurimetric Method.** DR. W. S. ARBUCKLE, Texas Agr. Expt. Station, College Station. Natl. Butter and Cheese Jour., *37*, No. 5 : 41. May, 1946.

The reagents used are: (a) 0.1711 N mercuric nitrate solution which contains 40 ml. of 2 N nitric acid per liter; (b) s-Diphenylcarbazone (Eastman 4459) indicator made with 100 mg. in 100 ml. of neutral ethyl alcohol (keep cold and in dark); and (c) 0.1 N sodium chloride to standardize the mercuric nitrate solution.

To estimate salt in butter, use the residue of the 10 gm. sample of butter remaining after moisture and fat determination by the Kohman method. Rinse the dry residue into a 250 ml. volumetric flask with three separate 30 ml. portions of distilled water. Cool rinsings and dilute to 250 ml. Pipet 25 ml. into 125 ml. Erlenmeyer flask. Add 0.6 ml. of indicator; titrate slowly with mercuric nitrate until one drop gives a pale violet. The mls. of 0.1711 N mercuric nitrate solution equal the percentage of salt.

To estimate salt in new cheese and cottage cheese, prepare sample by grinding it to a homogeneous consistency. Weigh 10 gm. into 400 ml. beaker. Add 250 ml. distilled water and heat to 150°–160° F. Mix thoroughly and cool to room temperature. Remove a 25 ml. portion of the clear solution, place it in a 125 ml. Erlenmeyer flask and titrate as for butter. The mls. of 0.1711 N mercuric nitrate used equal the percentage of salt in the sample.

This method is delicate, gives accurate results and has a sharp, permanent end point as compared to titration with silver nitrate and potassium chromate as indicator. The method is not adaptable to procedures requiring digestion of the sample. W.V.P.

BREEDING

310. **Fertility and "Pregnancy Percentage."** (Translated title) BERGE, S. NORDISK Jordbrugsforskning, pp. 214–224. 1942.

A discussion of various bases for computing conception rates; *i.e.* per year, per animal bred, per service, per fertile female, etc. The data were

from the herd of the Norwegian Agricultural College. They include 869 cows mated a total of 6458 times. The cows were born in the years from 1885 to 1937. Therefore the possibility of some time trends in management and other conditions is present. In the whole period the percentages of cows remaining not pregnant after various numbers of services were: 38.3 after one service; 20.3 after two services; 13.7 after three services; and 10.7 after four services. Corresponding percentages for cows born in 1931 to 1937 when the health conditions were better, were 29.4%, 12.1%, 7.9%, and 5.7%. There was little difference between cows and heifers. It is recommended that cows be mated four times before they are considered barren, unless they also show other symptoms of barrenness. The repeatability of conception rates at different calvings of the same cow was .22 ± .05. This is interpreted as measuring the importance of genetic differences between cows in causing differences in their conception rates but it may have included something from time trends in environmental conditions. J.L.L.

CHEESE

311. **Should Cheese be Priced on a Solids and Butterfat Basis?** ARTHUR B. EREKSON, Lakeshire-Marty Co., Plymouth, Wis. Natl. Butter and Cheese Jour., *37*, No. 7: 41. July, 1946.

Wisconsin cheese manufacturers claim they cannot compete with manufacturers in states where standardization of milk for cheese is permitted. Three methods are described for calculating the value of cheese with more than the minimum fat content: (1) The value of the extra fat in a pound of high-fat cheese is determined by multiplying the amount of fat by the value of a pound of fat in cream. From this amount is deducted the value of the decreased amount of solids-not-fat in the high-fat cheese. The difference represents the extra value of the high-fat cheese and it is added to the market price for cheese with legal minimum fat and maximum moisture. (2) The amount and value of legal-minimum-fat-cheese in a pound of high-fat cheese is calculated. To this amount is added the value of the extra fat. (3) The difference in price between a pound of cheese solids and a pound of fat in cream is calculated. The amount of the extra fat multiplied by this difference determines the extra value to be added to the market price of cheese with the legal minimum of fat and maximum moisture. Three tables are given to illustrate methods of calculation and results.

In Wisconsin, where the amounts of extra fat in cheese are not as great as in some other areas, the gains accruing from pricing cheese on a fat-and-solids basis might not be great enough to offset the costs of analyses and computations; gains from standardizing would not be appreciable. But problems of merchandising might make it very difficult to pass on to the consumer the increase in price representing the extra value of high-fat

cheese. These facts must be carefully considered before decisions are reached. W.V.P.

312. **Should Cheese be Priced on a Solids and Butterfat Basis?** W. V. PRICE, University of Wisconsin, Madison. Natl. Butter and Cheese Jour., *37*, No. 7: 40. July, 1946.

Cheese made from whole milk contains more than the legal minimum amount of fat. Such high-fat cheese might be paid for on the basis of its fat and solids-not-fat content when standardization of the milk is not permitted or is not desirable. The law commonly requires that the dry matter of Cheddar cheese be half fat and half solids-not-fat. Any fat in excess of this "50–50" dry matter is extra; it should be paid for according to its market value in butter or in other competitive outlets. The value of "50–50" dry matter is the price per pound of cheese divided by 0.61 (the weight of dry matter in a pound of cheese with minimum dry matter content). The value of the extra fat per pound of cheese plus the value of the "50–50" solids in a pound of cheese gives the value of the cheese. Tables and a scheme of calculations are given to simplify these calculations.

The consumer, who probably cannot tell the difference between cheeses made from whole- or standardized-milk, probably would not pay a premium for the extra fat in whole milk cheese. Manufacturers of process cheese need high-fat cheese in order to produce a finished product with 50% fat in the dry matter. It is reasonable for cheese manufacturers to expect a greater return for cheese with extra fat if they are not permitted to make the most efficient use of the milk fat by standardization. W.V.P.

313. **The Value of Whey as a Food for Livestock.** W. V. PRICE, G. BOHSTEDT, AND I. W. RUPEL. Canad. Dairy and Ice Cream Jour., *24:* 9. Sept., 1945.

Whey contains 6–7% dry matter that is of high nutritional value. The whey proteins are of the highest quality and the most easily digested. The milk sugar is a carbohydrate and has nutritive values that other sugars lack. The minerals of whey are easily assimilated. The vitamines A, B, B_2, C, found in whey are important in good nutrition. Whey makes a good feed for livestock like pigs and calves. Whey can be used as a substitute for mineral acid or molasses in making grass silage. H.P.

314. **Manufacturing Cheddar Cheese From Pasteurized Milk.** G. H. WILSTER. Canad. Dairy and Ice Cream Jour., *23:* 10. Oct., 1944.

Many states have adopted and other states are considering adopting compulsary pasteurization of cheese-milk as a health safeguard. The advantages of pasteurization for cheese are: (1) pathogenic bacteria, if present,

are destroyed by pasteurization; (2) gas-producing bacteria and other undesirable bacteria are either destroyed or greatly reduced in number; (3) there is easier control of the manufacturing procedure; (4) the cured cheese is generally of better flavor; (5) the cheese is uniform from day to day; (6) the cheese can be ripened at a higher temperature; (7) the yield is increased; (8) better quality reduces financial loss in storage; (9) more premium grade cheese is made scoring 92 to 93.

The objections to pasteurization are: (1) the cost of manufacture is increased 0.2 to 0.3 cents a pound of cheese; (2) pasteurized milk cheese ripens slower so it must be held longer; (3) the sharp flavor does not develop. H.P.

315. **Considerations Governing Cooking Temperatures for Cheddar Cheese.** W. H. SPROULE. Canad. Dairy and Ice Cream Jour., *24:* 1. Jan., 1945.

The cooking temperature of cheddar cheese is governed by: (1) rate at which starter is used; (2) length of milk ripening time; (3) fineness of cutting; (4) method of applying heat; (5) length of time curds are in the whey; (6) amount of agitation; (7) running acidity; (8) amount of stirring given the curd; (9) rate at which salt is applied; and (10) temperature of storage during early ripening. H.P.

316. **Determination of Extraneous Matter in Cheddar Cheese.** E. G. HOOD AND W. H. SPROULE. Canad. Dairy and Ice Cream Jour., *23:* 6. June, 1944.

The reagent used in the test is a 10 per cent solution of sodium citrate, filtered, made by adding 100 grams of citrate to 900 ml. of distilled water. The determination is as follows: (1) weigh 227 grams (8 oz.) of cheddar cheese curd into a clean Waring Blendor jar and add approximately 500 ml. of 10 per cent sodium citrate solution at a temperature of 45° C. Disintegrate the mixture until homogenous consistency is obtained (30 sec. or more). Transfer contents to a 2 litre white enamel measuring graduate used for heating and agitating the sample. Rinse the Blendor jar twice with additional 250 ml. and 100 ml. portions of citrate and add to the cheese citrate mixture; (2) place measuring graduate on hot plate, immerse stirrer, agitate and heat to 65° to 70° C. and continue stirring after moisture is up to temperature; (3) remove and wash off stirrer with hot distilled water catching the rinsing in the measuring graduate; (4) apply suction and transfer the mixture to the metal filter funnel; (5) wash out measuring graduate with several rinsings of hot distilled water and add to funnel; (6) wash down filter funnel when empty; (7) remove disc and heat dry in a 37° C. incubator; (8) mount discs with cellophane covering on individual cards and grade clean, fairly clean, dirty or very dirty. H.P.

317. **The pH of Cheese and Its Relation to Quality.** O. R. IRVINE. Canad. Dairy and Ice Cream Jour., *23:* 7. July, 1944.

The expression of acidity in terms of pH is used more and more in the cheddar cheese industry. Compact, easily operated instruments have been designed that give reliable results anywhere. Its relation to acidity in a batch of cheddar from the time the starter is added until the curd is salted shows close correlation. The discussion is presented to acquaint cheesemakers with a method which is at present finding wide application in food research work and it is at present not advocated that pH determinations be used in place of titratable acidity values as a guide in cheesemaking. H.P.

318. **The Occurrence and Survival of *Brucella Abortus* in Cheddar and Limburger Cheese.** A. C. DAHLBERG, Cornell University, Ithaca, N. Y. Natl. Butter & Cheese Jour., *37,* No. 5: 43. June, 1946.

See H. L. Gilman, A. C. Dahlberg and J. C. Marquardt. *The Occurrence and Survival of Brucella Abortus in Cheddar and Limburger Cheese,* JOURNAL OF DAIRY SCIENCE *29,* No. 2: 71. February, 1946. W.V.P.

319. **Cheese as the Cause of Epidemics.** F. W. FABIAN, Dept. of Bacteriology and Public Health, Michigan State College, East Lansing, Michigan. Jour. Milk Technol., *9,* No. 3, 129–143. May–June, 1946.

Many cheese borne epidemics of disease have been reported. *Eberthella typhosa,* certain species of the Salmonella group and *Brucella meletensis* constitute the main group of organisms associated with many of the epidemics. *Clostridium botulinum* has been reported in a few instances. No cases of undulant fever caused by *Brucella abortus* or septic sore throat streptococci have been contracted as the result of eating cheese, although the raw milk may contain these organisms prior to the cheese making.

The survival of pathogenic bacteria in cheese varies over a wide period of time. In view of the experimental evidence, it would appear that the 60 day holding period is too short a time. It was suggested that a 90 day holding period should be the minimum time required to give the cheese an opportunity to ripen and thus destroy or attenuate the pathogenic bacteria that may be present. Pasteurization of the milk for cheese making was recommended. It was assumed that pathogenic bacteria in the cheese would die off more rapidly if the cheese was ripened at 60° F. instead of 40° F. or lower and thereby shorten the ripening period.

A combination of pasteurization and a 90 day holding period would be desirable and would produce a safe as well as a mature cheese. H.H.W.

CHEMISTRY

320. Chemistry of Butterfat Shows Many Practical Applications. W. J. WILEY. Canad. Dairy and Ice Cream Jour., *23:* 6. June, 1944.

Composed of soft and harder fats, butterfat requires special treatment according to the percentage of fats contained, and in summer with the extra percentage of softer fats, shock chilling of cream after pasteurization gives a better quality in texture and flavor to the finished butter. Fast cooling causes the absorption of the soft fats by the harder ones. Tropical spread is made by rapidly cooling molten fat to a temperature at least 20° F. below its softening point and immediately tinned. Formation of the mass of tiny crystals is sufficiently delayed to enable it to flow into the tins where it sets to a smooth spreadable solid. In order for a spread to be used as a substitute for butter: (1) it should look and taste as much like butter as possible and should possess the nutritive value of butter; (2) it should retain normal firmness and spreadability at higher temperatures; (3) it should not be subject to rapid flavor deterioration at high temperatures. H.P.

CONCENTRATED AND DRY MILK: BY-PRODUCTS

321. Antioxidants in the Manufacture and Storage of Dry Whole Milk. S. T. COULTER. Canad. Dairy and Ice Cream Jour., *23:* 10. Oct., 1944.

The effectiveness of various antioxidants in dry whole milk based on the published experimental work are as follows: (1) two per cent oat flour delays onset of tallowiness; (2) hydroquinone in amounts equivalent to 0.01% of the weight of the milk solids is effective; (3) wheat germ oil and wheat germ oil plus citric acid are effective; (4) ascorbic acid at the rate of about 0.1% of the weight of the milk solids retards oxidation; (5) gum guaiac and nordihydroguaiaretic acid are effective but may cause fruity flavor development. H.P.

322. Fresh Liquid Buttermilk Valuable in Making Good Bread. R. W. BROWN. Canad. Dairy and Ice Cream Jour., *23:* 7. July, 1944.

Experimental work in the laboratory and practical tests by bakers show that an excellent quality of bread can be made with the use of liquid buttermilk instead of the customary milk powders. H.P.

323. Dried Milk Powder II. Factors Affecting the Sorption of Carbon Dioxide. JESSE A. PEARCE, Natl. Res. Laboratories, Ottawa. Canad. Jour. Res., *23,* No. 6: Sec. F: 327. 1945.

Sorption of carbon dioxide by fresh, spray-dried powder in a closed system at 35° C. and at approximately 74 cm. of mercury was observed to

be greater than 0.4 c.c. per gram after 150 hours while only 0.012 c.c. of nitrogen was absorbed per gram after 70 hours. A straight line relationship between the logarithm of the amount of gas absorbed and the logarithm of time was demonstrated. Sorption curves for whole milk powder were higher than for skim powders. Great variation was observed in the sorption behaviour of powders from different plants and in powders produced at different plants and in powders produced at different times in the same plant. Temperature differences within the range of 25° to 40° C. had no effect on sorption. Palatability and the gas absorbing properties of a powder were shown to be correlated. (From author's abstract.) O.R.I.

324. Dried Milk Powder III. The Effect of Light on Keeping Quality. JESSE A. PEARCE AND W. A. BRYCE, Natl. Res. Laboratories, Ottawa. Canad. Jour. Res., *23*, No. 6: Sec. F: 334. 1945.

Exposure of both whole and skim milk to sunlight caused more rapid deterioration in quality than occurred in the dark. Ultraviolet with a principal wave-length of 3800Å accelerated the deterioration in whole milk powder stored at 38° C. but had no significant effect on skim milk powders; the effect of this light was less pronounced than that produced by sunlight. Storage of samples at 38° C. under different light intensities (produced by incandescent lamp) indicated that the difference between ultraviolet and sunlight were the result of the difference of total energy of light falling upon the sample, rather than the difference of wave-length of the activating light. (From author's abstract.) O.R.I.

325. Dried Milk Powder IV. The Effect of Storage Temperature, Moisture Content and Plant Source on the Keeping Quality of Milk Powders of Different Fat Levels. W. A. BRYCE AND J. A. PEARCE, Natl. Res. Laboratories, Ottawa. Canad. Jour. Res., *24*, No. 1: Sec. F: 61. 1946.

Milk powders with fat contents of 1, 26, 28, and 30 per cent from two plants were tempered to moisture contents of 2, 3, and 5 per cent and stored for periods up to 16 weeks at temperatures of from 40° to 140° F. Palatability deteriorated in the whole milk powders stored at 60° F. or higher, although the product from two plants varied somewhat. Palatability of skim-milk powders increased greatly during the early part of storage but later decreased when held at higher temperatures. In general a moisture content of 3 per cent was preferable for both whole and skim-milk powders. (From authors' abstract.) O.R.I.

326. Dried Milk Powder V. The Photolysis of Riboflavin in Milk Powder. W. A. BRYCE, Nat. Res. Laboratories, Ottawa, Canada. Canad. Jour. Res., *24*, No. 2: Sec. F: 123. 1946.

Exposure of milk powders to sunlight resulted in a much greater destruc-

tion of riboflavin than did exposure to ultraviolet light in the range 3200–4200Å. The rate of photolysis was greater for skim-milk powders than for whole milk powders. Increased intensities of visible light accelerated riboflavin destruction. In the spectral region of 4200 to 5600Å the band causing the greatest destruction in liquid skim milk had a principal wave-length of 4450Å, which corresponded to a maximum in the absorption spectrum of riboflavin. The rate of photolysis of riboflavin was a function of both wave-length and intensity of impinging energy. (From author's abstract.)
O.R.I.

327. **The Effect of Wheat Germ Oil Antioxidants and Natural Reducing Substances on the Stability of Whole Milk Powder.** R. A. CHAPMAN AND W. D. MCFARLANE, Macdonald College, Quebec. Canad. Jour. Res., *24*, No. 1: Sec. F: 47. 1946.

Storage trials have been conducted on a large number of roller and spray dried whole milk powders. Accelerated tests at 65° C. were found to give an accurate indication of the relative keeping qualities where the latter were assessed by a peroxide test. Wheat germ oil antioxidants were found effective in inhibiting deterioration due to copper. Reducing substances that develop in milk powders during storage in moist atmosphere or at elevated temperatures are strong antioxidants and may offset the effect of added antioxidants. The riboflavin content of several powders with a high concentration of reducing groups decreased appreciably during storage. (From author's abstract.) O.R.I.

328. **The Keeping Quality of Dehydrated Mixtures of Egg and Milk.** JESSE A. PEARCE, Natl. Res. Laboratories, Ottawa. Canad. Jour. Res., *24*, No. 1: Sec. F: 70. 1946.

The storage life of a dehydrated mixture of egg and milk, when assessed by both palatability and fluorescence measurements, was shorter than the life of milk powder of similar protein, fat and carbohydrate content. Increased quantities of egg in the mixture decreased the quality of the mixture both initially and after 16 weeks storage. Those effects were noticeable at all temperatures between 40° and 140° F. but most marked above 80° F. After 16 weeks at 80° F., material packed under carbon dioxide usually had better palatability than air-packed products. The effect of added sugar was most noticeable at 120° and 140° F. Lactose had a slightly beneficial effect; sucrose was more effective. (From author's abstract.) O.R.I.

329. **Control of Composition and Quality of Condensed Milk.** DR. O. F. HUNZIKER, La Grange, Ill. Natl. Butter and Cheese Jour., *37*, No. 6: 92. June, 1946.

Control of composition depends in part on concentration of the batch.

This can be best accomplished in practice by using the Baume scale. Formulas necessary for general practice are:

(1) Specific gravity of sweetened condensed $= \dfrac{100}{\dfrac{\%\ \text{Fat}}{\text{Sp. Gr.}} + \dfrac{\%\ \text{SNF}}{\text{Sp. Gr.}} + \dfrac{\%\ \text{Sugar}}{\text{Sp. Gr.}} + \dfrac{\%\ \text{Water}}{\text{Sp. Gr.}}}$

(2) Degrees Baume at 60° F. $= 145 - \dfrac{145}{\text{Sp. Gr.}}$

In equation (1) Sp. Gr. is the specific gravity of the constituent in that fraction. Thus: $\dfrac{\%\ \text{Fat}}{\text{Sp. Gr.}}$ equals $\dfrac{\%\ \text{Fat}}{0.93}$. The specific gravity of SNF is variable but approximates 1.608; that of sugar is 1.589; and that of water is taken as 1. In equation (2) Sp. Gr. stands for specific gravity of the finished product. These formulas can be used for either sweetened or unsweetened condensed.

Control of quality requires fresh, clean milk of good flavor, satisfactory acidity and methylene blue tests. Stainless steel equipment and vacuum pan sanitation are essential. These factors determine the keeping quality of frozen or non-frozen unsweetened condensed. Prolonged freezing of condensed milk destabilizes the proteins and the proteins of superheated condensed are the most susceptible. At 0° F., three months of storage does not damage plain condensed skim milk but 1 month will affect the superheated product. Sweetened condensed commands a good market here and abroad and since it is held before use its quality must be carefully controlled. Forewarming all milk to 170° F. for 10 minutes is necessary to prevent rancidity and mold buttons. Control of mold buttons depends also upon plant sanitation and storage of the product at 60° F. or below. W.V.P.

DISEASE

330. Resazurin and Methylene Blue Tests Influenced by Udder Cells. S. B. Thomas and D. A. Bowie. Canad. Dairy and Ice Cream Jour., *23:* 7. July, 1944.

In order to obtain a "general picture" of the frequency distribution of udder cells in market milk, a series of 4,918 bulk herd samples were examined regularly, during the course of three years. The results show that the majority of samples (45%) had a cellular content varying between 250,000 and 750,000. Approximately 25% had less than 250,000 and 8% had a count above 1½ million. The results show that cellular reducing activity had quite a marked effect on the results of the prescribed methylene blue test. Eight per cent of the samples having a cellular content of 750,001 to 1,500,000 reduced methylene blue within 5½ hours; 25% of the heavily infected mastitis and late lactation milk reduced methylene blue within 5½ hours;

66% of the very abnormal milk samples (over 3,000,000 cells) were reduced within 5½ hours.

No sample of late lactation milk and mastitis milk, of low bacterial content and normal in appearance, were reduced below disc 4 on the 10-minute resazurin test. A number of samples with high cellular contents were reduced to disc 4. Milk heavily infected with mastitis or containing a high proportion of end of lactation milk (leucocyte content over 1½ million) was generally detected by the routine resazurin test; 65% being degraded to catgory B and 10% to category C. Twenty-five per cent of these samples reduced methylene blue within 5½ hours. H.P.

331. **The Differential Diagnosis of Bovine Brucellosis From the Bactercidal Action of Blood Plasma.** I. FOREST HUDDLESON, EVELYN WOOD AND AUDREY CRESSMAN, Michigan State College, East Lansing, Michigan. Certified Milk, *20,* No. 236: 10. December, 1945.

In a comprehensive vitro study of the bactericidal and growth-inhibiting action of bovine blood plasma for Br. abortus, sufficient differences were found in the action of plasma from infected and noninfected cows to differentiate one from the other regardless of the agglutination titers. With this observation as a basis a growth inhibition test was developed, which is described in detail. Thus far, the test has proved to be a highly accurate means of identifying both young and adult cows that are infected with Br. abortus, and whose agglutination titers range from 1:25 to 1:5000. The chief advantage of this test is that it can be easily developed into a routine laboratory procedure and by its application bring about the retention of many cattle that might otherwise be disposed of because of the possibility of infecting other animals. W.S.M.

332. **Recent Developments in the Control of Mastitis.** M. G. FINCHER, New York State Veterinary College, Ithaca, New York. Milk Plant Monthly, *34*(12): 40, 82. 1945.

In the control of mastitis two methods are considered, namely, recognition of infected cows for curing or eliminating them, and practice management which tends to minimize existing infection. While available chemicals and antibiotics have proven effective, only by a combination of this control procedure with management can best results be obtained. Mastitis control based on managed milking and proper housing of cows is preferable to an attempt to effect a miraculous cure in cows with badly diseased udders. G.M.T.

FOOD VALUE OF DAIRY PRODUCTS

333. **Butterfat Favors Vitamin-Producing Bacteria in Digestive Tract.** E. B. HART, University of Wisconsin, Madison, Wisconsin. Certified Milk, *21,* No. 237: 5. Jan., 1946.

Ten different kinds of carbohydrate foods were fed to as many different groups of rats. Each of the ten groups was divided—part of them getting corn oil as the fatty portion of their ration and the others receiving butterfat. Some rats in each group were fed various levels of vitamin B. In almost all cases the rats getting the butterfat outgained those on corn oil. This was especially true of those on the normal vitamin level. Since butterfat itself contains only a negligible amount of vitamin B, it is concluded that butterfat in combination with most carbohydrates brings about a condition in the digestive tract which encourages growth of those bacteria which help produce B growth vitamins. An important possible implication of this study is the importance of butterfat in infant feeding. W.S.M.

MILK

334. Clarification Lessens Sediment in Homogenized Milk. I. I. PETERS AND G. M. TROUT. Canad. Dairy and Ice Cream Jour., *24:* 3. March, 1945.

Clean milk clarified and pasteurized before homogenization, removes leucocytes and other matter that forms a sediment in the bottled milk. The problem of sedimentation is aggravated by every-other-day delivery, longer home refrigerator storage and stacking of bottles horizontally during storage. Clean low-leucocyte milk may be homogenized, without clarification. Clarification may be done effectively even when the fat is in a solid state. The pasteurization temperature appears to have no significant influence on sediment formation. Sedimentation of nonclarified milk is enhanced by heat-shocking and agitation. H.P.

335. Future Operations in the Market Milk Industry. P. H. TRACY, Canad. Dairy and Ice Cream Jour., *23:* 6. June, 1944.

The writer gives in detail what we can expect in the future operations in the market milk industry. The transition from war to peace will continue the demand for fluid milk. Consumer demand will be at a high level for some time due to depleted supply of many commodities. Efficiency in the processing plant will have to be maintained as it will become increasingly difficult for the inefficient to survive because of the narrow margin of profit per unit that will exist. More milk will be sold through stores. Some high operating costs are due to: (1) plant arrangement; (2) obsolete equipment and methods; (3) excessive man hours for the amount of milk handled; (4) high fat loss; (5) high glass bottle loss; (6) returned milk; (7) delivery expense high; (8) office expense high; (9) maintaining too many grades of milk and cream; (10) special delivery; (11) not enough attention paid to personnel problems. Thirty-one factors for conditions for greater efficiency are listed. H.P.

336. Control of Mold Growth in Composite Milk Samples. J. M. FRAYER. Canad. Dairy and Ice Cream Jour., *23:* 8. Aug., 1944.

Mold growth is commonly first observed on the stopper. It may be effectively controlled by thorough cleaning and scalding the bottles and by soaking the well-cleaned stoppers overnight in a 50–50 formalin solution between each testing period. Rubber stoppers should be used since they withstand hard usage and can be sterilized. Adequate sample refrigeration is absolutely essential (50° F. or less). Covered trays or boxes, perferably of metal, easily cleaned, should be provided and thoroughly cleaned and sterilized between testing periods. Sample should be promptly refrigerated, kept cool until they are tested and held cool during the specified retest period.

Mold in composite samples (1) may test too low; and (2) are hard to pipette. Mold get into composite sample bottles (1) from the milk, (2) from the sampler's hands and clothes; (3) from the sample bottles and stoppers; (4) from the sample storage boxes; (5) from the refrigerator walls, ceilings and air. H.P.

337. An Appraisal of Inspection Problems in Sanitation. R. S. BREED. Canad. Dairy and Ice Cream Jour., *23:* 8. Aug., 1944.

The farm problems are: (1) labor shortages; (2) dirty stables; (3) dirty cows; (4) poor ventilation and light in cow barns and milk houses; (5) the presence and housing of animals other than cows in the cow barn; (6) dirty milking stools; (7) improper milk methods; (8) improper storage of milking machine and other utensils; (9) lack of suitable toilet facilities near milk house or barn; (10) wash tanks and hot water; (11) unsafe water supply; (12) lack of cooling facilities; (13) replacement of damaged or defective utensils and other equipment; (14) mastitis; (15) delay in milk deliveries; and (16) rewashing of milk cans on the farm.

The plant problems are: (1) shortage of skilled man-power; (2) inability to get new equipment; (3) inability to get repair parts for old equipment; (4) the production of quality milk under present regulations. H.P.

338. Causes of the Variations in the Percentages of Fat in Cream. R. W. BROWN. Canad. Dairy and Ice Cream Jour., *23:* 10. Oct., 1944.

Some of the causes of variations in the percentage of fat in cream are: (1) position of the cream and skimmilk screw; (2) the speed and true running of the separator; (3) the temperature of the milk; (4) the amount of milk in the separator supply tank; (5) the amount and kind of flush (whether water or skimmilk); (6) the cleanliness of the separator bowl; (7) the feed of the cows; (8) the period of lactation and (9) the speed at which the separator is turned. H.P.

339. **The Source of Acidity of Fresh Milk from Jersey Cows.** ALLEN D. ROBINSON AND HERBERT S. SAMSON, University of Manitoba, Winnipeg, Canada. Canad. Jour. Res., *24*, No. 1: Sec. B: 5. 1946.

Thirty samples of Jersey milk were analyzed for each of titratable acidity, free carbon dioxide, carbonates, citric acid and citrates, casein, lactalbumin and lactoglobulin, and inorganic phosphates. Partial correlation coefficients were calculated for titratable acidity with each of the other variables. The only significant one was that between titratable acidity and inorganic phosphates and it is concluded that inorganic phosphates are the primary cause of the acidity of fresh milk. (From author's abstract.)

O.R.I.

340. **Etude d'une Reaction Péroxydasique Appropriée pour la Detection de L'eau Oxygénée dans les Laits de Consummation.** (Study of a Peroxidase Reaction Suitable for the Detection of Hydrogen Peroxide in Market Milk.) A. EGARD AND R. J. JOURFRET. Le Lait, *23*, No. 224–226: 141. 1943.

The detection of added hydrogen peroxide is very difficult in raw or pasteurized milk except within a short time after it has been added. A test based on the development of a blue color with guiacol and gum guiac in alcohol is described which revealed the presence of hydrogen peroxide up until approximately 7 hours for raw milk and over 30 hours for pasteurized milk.

O.R.I.

341. **La Signification de la Reaction de Storch, de la Vitesse de Montee de la Creme, Ainsi que de la Determination des Phosphases Pour de Controle de la Pasteurisation du Lait.** (The Significance of the Storch Reaction and the Speed of Cream Rising Compared with the Determination of Phosphatases for the Control of Milk Pasteurization.) A. K. VAN BEVER AND J. STRAUB, Amsterdam Food Products Inspection Laboratory. Le Lait, *23*, No. 224–226: 97 and No. 227–228. 1943.

The necessity for evolving accurate means of control for use with pasteurization techniques now in use is pointed out. The work of European investigators on the Storch reaction and on cream rising is reviewed. A test based on peroxidase activity of improved accuracy is described, but the test is rejected since milk flavors are affected before the test is useful and also because the addition of raw milk to pasteurized milk is not detectable in amounts of less than 10%. An accurate method of determining the rate of cream rising is described, and the effect of heat on this phenomenon discussed. Curves based on values found in the literature for destruction of tubercle bacilli, denaturation of milk proteins, phosphatase activity and

cream agglutinin are treated mathematically and a formula developed showing limits of safety allowable for continuous methods of pasteurization. The authors reject the standards of Kay and insist that phosphatase activity be completely destroyed. See Enzymologia *11;* 7–8, 1943. O.R.I.

342. **Milk Containers.** R. B. STOLTZ, Ohio State University, Columbus, Ohio. Milk Plant Monthly, *34*(12): 49, 53. 1945.

Economy in milk distribution is in part effected by the kind of milk container used. Glass bottles average normally about 40 trips. Average bottle trippage in Columbus, Ohio is 80. Paper bottles may be more economical when glass bottles make seven trips or less. The cost of containers in glass depend upon some following factors: (1) number of trips that a bottle makes, (2) cost of bottle exchange, (3) cost of sorting bottles, (4) bottle deposit enforcement, and (5) method of handling bottles. Dealers in Columbus, Ohio using a universal bottle since 1934 have changed from the 22½ oz. 56 mm. bottle to the 17¾ oz. 48 mm. square bottle and have effected marked material savings. The inauguration of a three-day a week delivery made necessary the conservation of refrigerator space, which was accomplished in part by the use of the square bottle. It is recommended that every milk distributor ascertain his container costs by ascertaining bottle trippage. G.M.T.

PHYSIOLOGY

343. **Influence of Dietary Factors and Sex on the Toxicity of Carbon Tetrachloride in Rats.** PAUL GYORGY, JOSEPH SEIFTER, RUDOLPH TOMARELLI AND HARRY GOLDBLATT, School of Medicine, University of Pennsylvania, Wyeth Institute of Applied Biochemistry, Philadelphia, and School of Medicine, Western Reserve University, Cleveland. Jour. Expt. Med., *83,* No. 6: 449–462. June, 1946.

Six groups of rats fed different diets were exposed to the inhalation of 300 p.p.m. of carbon tetrachloride for 150 days. The rats maintained on a low protein diet showed greater susceptibility than animals kept on a high protein diet. Methionine can be substituted for protein (casein) in the diet satisfactorily. A high fat and low carbohydrate intake was noticeable in the rats, especially if combined with a low protein diet.

Intoxication of the rats inhaling carbon tetrachloride showed evidence of necrotizing nephrosis and certain hepatic changes such as necrosis and cirrhosis.

Dietary factors (methionine containing protein) as well as low fat intake usually prevented renal injury.

Under comparable dietary conditions, especially with high fat intake, the male rats were more susceptible to carbon tetrachloride than the female animals. H.H.W.

MISCELLANEOUS

344. Thermometers, Their Manufacture and Industrial Usages. E. E. R. PENFOLD. Canad. Dairy and Ice Cream Jour., *24:* 6. June, 1945.

Thousands of operations in the dairy industry demand that accurate temperatures be maintained and this calls for thermometers that are precision manufactured and individually tested before being placed in operation. The three thermometers that are recognized as standard and are in universal use today are the Fahrenheit, the Centigrade and the Reaumur, the first two named being most used in dairies and in dairy investigating laboratories. All glass for thermometers used in America is made by the Corning Glass Works, Corning, N. Y. Glass for thermometers must expand or contract quickly. In testing thermometers, it is important that the medium in which the testing is done is thoroughly agitated. It is also important to supply vertical agitation to prevent the hot liquid from collecting at the top. Water is the best medium for testing thermometers whenever the temperature permits. Oil may be used from 212° F. to 550° F. Sufficient time must be allowed for the thermometer to reach the temperature of the liquid. Mercury thermometers are more accurate than red spirit thermometers. Recording thermometers are used extensively in the dairy field today. H.P.

345. At Last the Fly Has Met Its Master. JOHN G. MATTHYSSO, Geigy Co., Inc., New York City. Certified Milk, *21,* No. 237: 3. Jan., 1946.

Experiments on the use of DDT were conducted at the Walker-Gordon Certified Milk Farm at Plainsboro, which comprises some 1500 cows in 33 similar barns. It was found that 21 sprayed barns became relatively fly-free at once, a reduction of 70 to 80 per cent in the fly population still being noted 20 days after application. In 30 days the comparison was outstanding, averaging from 0.1 to 0.5 flies on 10 cows in sprayed barns to 16 on 10 cows in unsprayed barns, a reduction of from 97 to 99 per cent. At 85 days there was no difference; the spray deposits were no longer effective. Another benefit from the fly control program was the absence of a single case of "pink eye" (a fly borne disease of cattle) in the milking herd. For application of the DDT to walls, ceilings, posts, etc., a power sprayer such as an orchard sprayer or power white-washing unit is recommended. A three or four nozzle broom type gun with No. 3 discs is preferable. In the latitude of New Jersey and Pennsylvania and North two sprayings a year will give effective control of flies in barns. The first application should be made when the flies first appear and the second application between July 15 and August 1. It is pointed out that DDT is not a substitute for farm sanitation and that manure disposal practices should be continued.

W.S.M.

346. Apprenticeship Training Applied to the Dairy Industry. W. F. SIMON. Canad. Dairy and Ice Cream Jour., *23:* 6. June, 1944.

Indentured apprenticeship training has been in effect in Wisconsin since 1911. Skilled trades are learned by young men under an apprenticeship agreement. The agreement covers (1) the terms of training (2 years); (the first four months is a trial during which either party can void the indenture) (2) the kind of work the apprentice is to perform; (3) at least four hours weekly must be spent in school instruction regardless of the trade; (4) a wage scale must be specified for the full term of training. The author states that this is probably the best way to get qualified trained men for certain kinds of skilled trades in the dairy industry. H.P.

347. Use of New Insecticides in Dairy Plants. E. H. FISHER, University of Wisconsin, Madison. Natl. Butter and Cheese Jour., *37,* No. 7: 50. July, 1946.

Sanitation in the dairy plant must be habitual and must precede effectual use of insecticides. DDT is efficient in controlling more insects than any other conventional insecticide and remains effective longer after application. It must be applied with precautions for the safety of the user. Food products must be protected from insects affected but not promptly killed by the DDT. DDT in wettable powder sprays leaves a white residue and is useful on porous surfaces because it remains on the surface. Oil-in-water emulsions soak in somewhat on porous surfaces but not as much as solutions of DDT in deodorized kerosene or similar oil base solutions. DDT paints have not proven economical. DDT dusts can be placed in cracks. For flies DDT is used in 5% solution. Cockroaches can be treated with 10% DDT dust, 5% DDT spray, sodium fluoride dust, pyrethrum dust, Lethane A–70 dust (10%), phosphorus paste, moistened baits with toxicants like DDT or sodium fluoride, or by fumigation. Ants can be treated with DDT dust around the ant hill, by putting carbon bisulfide in the hill, and by poisoned foods containing tartar emetic, sodium arsenate, or other poisons. Cheese mites can be destroyed by fumigation with cyanide or methyl bromide. Detailed instructions and precautions for the application of these insecticides are given. W.V.P.

348. A New Germicide for the Food Industries. W. E. BOTWRIGHT, Vestal Laboratories, Inc., St. Louis, Missouri. Jour. Milk Technol., *9,* No. 2: 101–106. March–April, 1946.

The problem of controlling bacteria, yeasts and molds in food and beverage industries is very important in order to prevent spoilage of the product, to prevent illness caused by microbial growth in these products and to prevent the transmission of the diseases by utensils.

Obviously, the cleansing and sanitizations of all equipment and utensils used in the processing and dispensing of food and beverage products is

highly desirable. There are two procedures generally used in the sanitization of these materials: (1) heat treatment, such as water at 170° F., steam or dry heat and (2) immersion in a chemical germicide. Sanitarians are aware of the limitations and disadvantages of these methods.

Quaternary ammonium germicides are gaining in popularity in the dairy and food industries as effective germicides. Investigations show that these compounds have many advantages over the compounds now in general use. H.H.W.

349. Packaging III. Effect of Mold Growth and Ageing on the Water-Vapor Transmission of Packaging Materials. C. G. LAVERS AND W. I. ILLMAN, Natl. Res. Laboratories, Ottawa, Canada. Canad. Jour. Res., *24*, No. 2: Sec. F: 117. 1946.

Packaging materials were dusted with mold spores and stored in a cabinet at 95° F. and 95–100% relative humidity for periods of one to eight weeks. M.S.T. and M.S.A.T. "Cellophane" were attacked only slightly by mold but deterioration of the heat-sealing, moisture-proof lacquer occurred during storage under conditions suitable for optimum mold growth. Molds grew abundantly on M.S.Y.T. Cellophane. Wax-coated materials supported abundant mold growth and their water-vapor transmission values increased when wax peeled from the surface of the sheet. The transmission rate of laminated materials having metal foil as one layer was not greatly affected by mold growth or de-lamination of the layers. Abundant mold growth developed on most samples of kraft, and on glassine. Very little developed on cellulose acetate, pliofilm, or vinyl-film. (From author's abstract.) O.R.I.

350. The Newer Dairy Cleaners. H. A. TREBLER, Sealtest, Inc., Baltimore, Md. Milk Plant Monthly, *34*(2): 47–48. 1945.

In cleaning dairy equipment the availability of a sufficient, suitable water supply is very important. The function of dairy cleaners is simply to modify the water, thus improving its natural ability to dissolve protein, suspend or emulsify dirt. A good dairy cleaner whether acid, neutral or alkaline should (1) help the water dissolve milk proteins, (2) reduce interfacial tension and (3) should make possible free rinsing. Alkaline cleaners obtain good results in can washing and general cleaning when they maintain in the solution (1) a temperature over 110° F., (2) an active alkalinity of .02 to .03%, (3) a wetting agent concentration (Nacconal N R or equivalent) of .008% (80 p.p.m.) and (4) a slight surplus of calcium sequestering agent. With acid cleaner at pH of 6.5 to 6.8, calcium and magnesium precipitates will not be formed. Addition of 5% pyrophosphate results in obtaining brighter bottles with minimum carry over in the bottle washing machine. Quadrofos or Calgon and one-half wetting agent, appears to be the best cleaner for cleaning milking machines. G.M.T.

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