JOURNAL OF DAIRY SCIENCE

Contents

Vol. XXV, No. 3, March, 1942

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Published at
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The Journal of Dairy Science is issued monthly. Subscription is by the volume and one volume is issued per year.

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JOURNAL OF DAIRY SCIENCE

VOLUME XXV MARCH, 1942 NUMBER 3

THE DANGER OF HYDROCHLORIC ACID GAS POISONING WHEN TESTING SALT-TREATED CREAM

H. C. HANSEN AND R. S. SNYDER[1]

INTRODUCTION

Several investigators have reported the use of common salt in cream in fairly high concentrations (5 to 13 per cent) in order to delay souring during storage on the farm or while on long shipments and thus maintain a better quality of cream for butter and ice cream manufacture.

REVIEW OF LITERATURE

A patent was granted to O. E. Williams (1) of the United States Department of Agriculture on January 3, 1939, for a new method of preserving cream by the use of sodium chloride. By this method, it was claimed, cream held at room temperature for a considerable length of time would make as high scoring butter as fresh cream.

Thompson and Macy (5) in a study of the "Effect of Salt on the Microflora and Acidity of Cream" using 5.0, 7.5, and 10.0 per cent sodium chloride found that ". . . in general, the results indicate, with increasing salt concentrations in cream, the growth of bacteria and especially yeast was quite effectively checked if the cream was maintained at reasonably low temperatures and as a consequence the acidity of the cream did not increase materially during the 10-day period of storage."

Caulfield, Nelson, and Martin (3) found that ". . . the amount of salt necessary to effectively prevent deterioration in cream was dependent upon the time and temperature of storage. The addition of 13 per cent salt to cream held at 70° F. for three or more days before the salt was added did not prevent further deterioration of the cream." This limited the method largely to farm use. They suggested that the possible effects of prolonged exposure of the metallic cream containers to salted cream and the corrosive action of the brine on the can, which might shorten the life of the can and

Received for publication October 11, 1941.

[1] Assistant Dairy Husbandman and Acting Agricultural Chemist, Idaho Agricultural Experiment Station, respectively.

Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 193.

damage the flavor and keeping quality of the cream and of the resulting butter, be given further consideration. A modified Babcock test for butterfat was given because of foaming of the salted cream and the formation of a grayish-brown deposit at the base of the fat column which interfered with the reading. This modified test was more time-consuming than the conventional Babcock test.

Castell and Garrard (2) found that butter produced from salted cream stored for 8 days at 60 to 77° F. was superior to butter made from unsalted cream stored at 50° F. for 8 days. They stated that fresh cream containing 7 per cent salt could be held in satisfactory condition for 8 days at 77° F.

EXPERIMENTAL

Samples of sodium-chloride-treated cream were analyzed according to a modified method developed at the University of Idaho Agricultural Experiment Station (6) which would determine the kind and amounts of gasses released, whether chlorine or hydrochloric acid gas. The first tests were made upon a freshly prepared cream-salt solution of 9.09 per cent sodium chloride. The results are shown in figure 1.

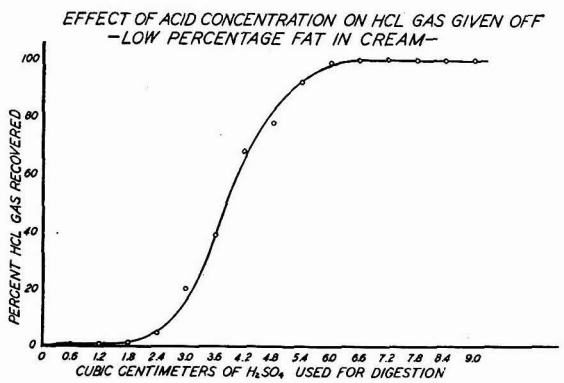

FIG. 1.

It is evident from figure 1 that in 30 per cent cream the gas given off is hydrochloric acid gas and that it is entirely released from 9 grams of cream by as little as 6.6 cc. of concentrated sulfuric acid. With higher percentages of fat in the cream it was found necessary to add to the cream up to and including an equal volume of water in order to release all the hydrochloric acid gas. This is shown in figures 2 and 3.

Apparently with high percentage cream there is either some absorption of the sodium chloride by the fat or else there is not sufficient water in the sample to hold all the salt in solution. When more water is added the hydrochloric acid gas is completely released.

DISCUSSION

Samples of cream received from individual farmers must be tested for fat content in order that the correct price may be given for their product. When the samples were tested by the Babcock method the sulfuric acid reacted with the sodium chloride not only to produce excessive foaming but also to release relatively large amounts of hydrochloric acid gas at a concentration which might cause dangerous accumulations in the air of small poorly ventilated laboratories such as are often found in many creameries.

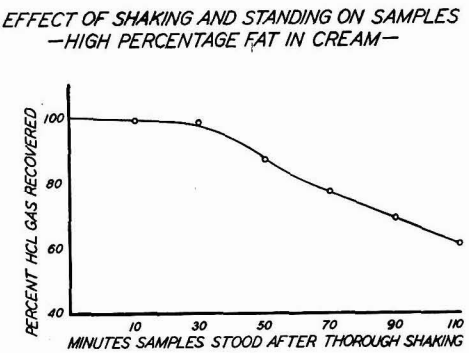

FIG. 2.

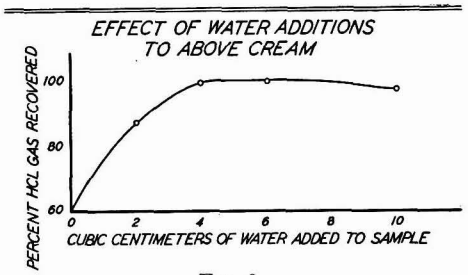

FIG. 3.

Hydrochloric acid gas is an irritant which, because it is readily soluble, acts primarily upon the upper respiratory tract. As little as 2,000 to 5,000 parts per million of the gas in air will produce clouding of the cornea and, after an hour, violent inflammation of the lining of the nose and throat and congestion and hemorrhages in the lungs. With only one-tenth of the above concentrations bronchial catarrh can be produced. Henderson and Haggard (4) give the following:

Physiological responses to various concentrations of hydrochloric acid gas	HCl gas in p.p.m. of air
Maximum concentration allowable for prolonged exposure	10
Maximum concentration allowable for ½ to 1 hour exposure	50
Dangerous for even short exposure	1,000–2,000

Calculating the amounts of hydrochloric acid gas released from various salt concentrations in cream we find that a 13 per cent salted cream will release 0.7920 gram of HCl or approximately 487 cc. of gas while a 10 per cent salted cream will release 0.5612 gram or about 345 cc. of gas. Likewise, 7.5 per cent will release 0.4209 gram or 260 cc. and 5 per cent 0.2806 gram or 173 cc. of HCl gas.

TABLE 1

Hydrochloric acid gas allowable compared with gas released from salted cream

HCl gas allowable according to Henderson and Haggard (4)		Idaho experimental data		
	HCl gas in p.p.m. of air	Concentration of salted cream	Diffusion of HCl gas from 1 sample in room of 1000 cu. ft. capac.	Diffusion of HCl gas from 24 samples in room of 1000 cu. ft. capac.
		per cent	*p.p.m.*	*p.p.m.*
Maximum allowable for prolonged exposure	10	13.0	17.2	413
Maximum allowable for ½ to 1 hour exposure	50	10.0	12.2	292
Dangerous for even short exposures	1000–2000	7.5	9.15	220
		5.0	6.1	146

Assuming a laboratory of 1,000 cubic feet capacity, we find, as shown in table 1, that a single sample of salted cream, even if completely diffused, will cause a concentration of 17.2 p.p.m. in the air from a 13 per cent solution; 12.2 p.p.m. from a 10 per cent solution; 9.15 p.p.m. from a 7.5 per cent solution; and 6.1 p.p.m. from a 5 per cent solution. Since the maximum concentration allowable for prolonged exposure is 10 p.p.m., the release of hydrochloric acid gas from even one sample is dangerous.

Several conditions increase this danger. First, hydrochloric acid gas has a specific gravity of 1.278 when air equals 1.000. Thus the rate of diffusion is slow and the gas does not rise rapidly but remains in heavy concentration on the table in the immediate vicinity of the operator. Second, the operator usually does not make a single determination but rather runs them in sets of 12 or 24 at a time and, in the larger creameries, several times a day. Should the samples of salted cream be segregated and tested separately a set of 24 samples of 13 per cent salted cream would cause a concentration of approximately 413 p.p.m. of gas in a room of 1,000 cubic feet capacity if completely diffused; 293 p.p.m. from the 10 per cent salted cream, and equivalent amounts from the lower concentrations. This would cause dangerous exposures even for short lengths of time and when several sets of determinations are run each day, one can readily understand the increasing danger. Third, many times the testing laboratory does not have a capacity

of 1,000 cubic feet but is smaller, thus increasing the concentration of the gas. Fourth, even though the laboratory were large the slow rate of diffusion would cause high concentrations of the gas and the necessity for the operator to work over a large set of samples for a considerable period of time would be an extremely dangerous practice.

Caulfield, Nelson and Martin (3) have given a modified method for the Babcock test to minimize the effect of foaming by adding an equal volume of water to the sample and then adding the sulfuric acid in three equal volumes with 10 and 5 minute intervals between additions. As shown in figure 3, the addition of an equal volume of water to the cream causes a complete release of the hydrochloric acid gas. The longer standing increases the time the operator must be in contact with the fumes and thus increases the danger of injury.

The installation of well ventilated hoods has been suggested for the creamery laboratory so that the gas fumes will be carried away as fast as formed. Although this is expensive, some such procedure must be followed if the practice of salting cream is to come into general use. The smallness of many laboratories as well as the cost of equipment will make such installation difficult and expensive and it is questionable whether it would be done.

Even with installed hoods, there is always the ever constant possibility that the liberated fumes of hydrochloric acid gas may be breathed at any time while testing for butter-fat content with resultant danger to throat and lungs. The operator is not always aware of the destroying action of these fumes and may become affected by them before realizing their harm.

CONCLUSIONS

1. Salted creams of 5 to 13 per cent concentrations, when treated with sulfuric acid for the determination of fat content by the Babcock method, release the fumes of hydrochloric acid gas which are dangerous to health.

2. Single samples of salted cream of 7.5, 10.0, and 13 per cent concentrations release hydrochloric acid gas in amounts above the maximum allowable for prolonged exposure.

3. Sets of 12 to 24 samples in any of the concentrations tested, released hydrochloric acid gas above the maximum allowable for even short exposure ($\frac{1}{2}$ to 1 hour).

4. The slow rate of diffusion causes high concentrations of gas in the immediate vicinity of the operator, thus increasing the danger of injury.

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EFFECT OF HOLDING CREAM IN THE BUYING STATION UPON THE MOLD CONTENT AND CERTAIN OTHER QUALITY FACTORS[1]

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The activities of the Federal Food and Drug Administration in condemning butter containing excessive amounts of mold as determined by the Wildman microscopic method (9) have encouraged the use of the Parsons visual mold test (6) as a means of detecting unfit cream. This extended usage of the visual mold test has made it desirable to have more information concerning the conditions under which the test may be used as a reliable indication of the fitness of cream for buttermaking.

The amount of mold in cream has been shown to be an indication of the conditions under which the cream has been produced and handled on the farm (1, 3, 4, 6, 7, 8). Many creameries are now using the visual mold test on cream which has been collected in cream buying stations and held for varying periods of time before shipment to the central plants. Parfitt and Galema (5) have reported that holding cream in airtight containers for 72 hours at temperatures of 80° to 90° F. resulted in a marked reduction in mold content compared to cream held in open containers. The cream held in closed containers was found to be more desirable in flavor and to make a better flavored butter than would cream held with free access to air. They also stated that such cream showed less protein decomposition. More information is needed concerning the value of the visual mold test as a measure of the quality of cream after it has been held without adequate refrigeration in the buying station. The studies herein reported were designed to obtain more information regarding changes which occur in cream held in a representative cream station.

METHODS

This investigation was conducted during the month of May, 1941. During the period in which cream samples were collected air temperature usually was in the high 80's and occasionally in the low 90's, and the minimum temperature each day usually was in the low 60's and occasionally in the high 50's. In the station under observation, cream was held in 10-gallon cans in a small, partially insulated room kept about 10° F. below atmospheric temperature by the use of a small fan to blow air over a small piece of ice. The cream in each can usually was a mixture from several farms.

Received for publication October 30, 1941.

[1] Contribution No. 139, Department of Dairy Husbandry and contribution No. 208, Department of Bacteriology.

Samples were taken from each can at the close of buying activities for the day, and again from the same cans immediately before they were shipped to the creamery. The cream was thoroughly agitated and the samples taken in sterile jars. The samples were immediately cooled and held at 40° F., or below, until analyses could be made. The temperature of the cream and the amount of air space between the surface of the cream and the closed lid were observed in each case after the samples had been secured.

The acidity of each cream sample was determined by titrating a 9.0 gram sample, plus 9.0 milliliters of distilled water, with tenth-normal sodium hydroxide, using phenolphthalein as the indicator. The results were calculated as per cent lactic acid. The mold content of the cream was estimated by two methods, the Parsons modification (6) of the Wildman methylene-blue-borax visual mold test (9), and the plate count method using acidified potato dextrose agar according to the procedure outlined in Standard Methods for Examination of Dairy Products (2). Yeasts and molds were counted separately.

The standards used for evaluating the results of the visual mold tests were somewhat different from those proposed by the American Butter Institute, seven standards being employed instead of four, thus making more detailed classification possible. A comparison of the American Butter Institute standards and those used in this study is made in table 1. The cream samples also were graded organoleptically by two or more judges.

TABLE 1

Comparison of visual mold standards used in this study with those proposed by the American Butter Institute

Class	Standards used in this study	Corresponding American Butter Institute Standards
Good	1	1
	2	.....
Fair	3	2
Doubtful	4	3
Excessive	5	4
	6	.....
	7	.....

RESULTS

In the first part of this study 75 cans of cream were examined before and after holding either one or two days in the station. During the holding period the average visual mold score increased only 0.03 units, indicating that, for the entire series, no significant change in mold score had occurred. The titratable acidities were determined on only 46 of these lots of cream and an average increase of 0.15 per cent was noted. These results indicate that the cream may change appreciably in other respects while the visual mold remains essentially constant.

TABLE 2

Changes taking place during holding of cream in a cream buying station

Sample No.	Days held	Temperature		Grade		Per cent titratable acidity			Mold count—plate method			Yeast count—plate method			Visual mold score	
									Thousands per ml.		Per cent change	Thousands per ml.		Per cent change		
		In ° F.	Out ° F.	In	Out	In	Out	Increase	In	Out		In	Out		In	Out
1	2	70	.....	2	2	0.62	0.91	0.29	115	100	−13	850	420	−51	3	2
2	2	70	75	2	3	0.64	0.83	0.19	1,650	1,450	−12	2,950	2,500	−15	5	4
3	2	70	76	2	2	0.64	0.79	0.15	950	1,000	+5	1,565	2,650	+69	4	3
4	2	70	.....	1−	2	0.54	0.93	0.39	125	65	−48	1,030	690	−33	3	2
5	2	70	75	1	1	0.54	0.66	0.12	17	0.1	−99	16	2	−86	1	1
6	2	70	74	1	1−	0.58	0.70	0.12	113	81	−28	140	160	+14	2	2
7	2	69	.....	1	1−	0.56	0.67	0.11	165	265	+61	55	32	−43	3	2
8	2	70	74	1	1−	0.55	0.64	0.09	135	120	−11	50	65	+30	3	2
9	2	68	74	1	2	0.62	0.89	0.27	150	215	+43	305	1,000	+228	3	3
10	2	68	80	2	3	0.86	1.04	0.18	40	45	+12	5,700	8,900	+56	4	3
11	2	70	75	2	2	0.65	1.00	0.35	495	360	−27	40	21	−47	3	3
12	2	70	76	2	2	0.66	0.96	0.30	200	140	−30	2	14	+575	3	3
13	2	70	.....	1	2	0.66	1.04	0.38	140	145	+4	15	19	+31	3	3
14	2	72	74	1	2	0.56	1.05	0.49	145	145	None	11	20	+82	3	3
15	2	72	74	1	2	0.59	0.88	0.29	205	100	−51	2,150	2,250	+5	3	3
16	2	68	74	1−	2	0.57	0.76	0.19	90	40	−56	1,570	830	−47	3	2
17	2	75	76	1	2	0.52	0.65	0.13	0.7	73	+10,329	14	56	+296	1	1
18	2	74	76	1	2	0.53	0.78	0.25	30	70	+133	1,090	715	−34	2	2
19	2	76	76	1	2	0.54	0.66	0.12	14	180	+1,233	32	275	+759	1	1
20	2	76	76	1	1	0.59	0.68	0.09	36	135	+275	540	1,275	+136	2	3
21	2	76	74	1	1	0.55	0.66	0.11	80	128	+59	30	49	+62	3	3
22	2	76	76	1	2	0.68	1.04	0.36	280	260	−7	525	750	+45	3	3
23	2	76	76	1	2	0.72	1.35	0.63	130	74	−43	9	19	+124	3	3
24	2	100	77	1−	2	0.53	1.13	0.60	60	25	−58	500	595	+19	4	4
25	2	78	76	1	1−	0.48	0.69	0.21	0.5	90	+1,790	18	17	−6	1	2
26	2	72	76	1−	2	0.57	0.78	0.21	18	46	+156	73	110	+51	1	2
27	1	82	78	1	1	0.65	0.77	0.12	21	37	+74	340	645	+90	1	2
28	1	78	78	1	1	0.56	0.94	0.38	1,005	530	−47	80	200	+150	4	3
29	1	80	78	1	1	0.57	0.77	0.20	55	315	+473	550	40	−93	2	3
30	1	78	78	1	1	0.57	0.63	0.06	30	435	+1,350	135	425	+215	1	1
31	1	78	78	2	2	0.74	1.08	0.34	110	190	+73	755	1,425	+89	2	2
32	1	80	78	1−	1−	0.65	0.74	0.09	30	37	+22	680	650	−4	2	2
33	1	80	78	1	2	0.67	0.96	0.29	70	36	−49	145	365	+152	2	2
34	1	80	78	1	1	0.59	0.98	0.39	59	120	+105	167	475	+185	2	3
35	1	78	80	1	1−	0.64	0.76	0.12	113	140	+24	90	265	+194	2	3
36	1	76	78	1	2	0.55	1.05	0.50	420	485	+15	155	190	+23	3	3
37	1	78	78	2	2	0.66	0.73	0.07	73	105	+44	280	880	+214	3	3
38	1	78	78	1	2	0.56	0.70	0.14	9	100	+1,111	44	85	+93	1	2

Following these preliminary studies a more detailed examination was made of 38 cans of cream and the results are presented in table 2. Changes in grade occurred frequently. At the beginning of the holding period 25 cans of cream were graded as first, 5 cans poor first, and 8 cans second. At the close of the holding period, 8 cans were considered first grade, 6 poor first, 22 second, and 2 third. In no case did the quality of the cream change more than one full grade during holding. The defects which developed to cause these changes in grade were of a considerable variety of types, no one defect or group of defects being characteristic. These data show that an appreciable increase in acidity occurred in all instances. The minimum increase was 0.06 per cent in a can of cream held one day, and the maximum increase was 0.63 per cent in a can of cream held two days. The average increase of the 38 cans of cream was 0.24 per cent.

The visual mold scores on the 38 lots of cream were found to remain unchanged in 21 instances, while increases in score occurred in 8 cans and decreases were noted in 9 cans. The maximum change in mold score was only one point. The number of cans of cream with a mold score of 1 decreased from 8 to 4, while the number of cans with a mold score of 2 increased from 9 to 14. Although five lots of cream were classed as doubtful or excessive (mold score 4 or 5) by the visual mold test when they were placed in holding, only two were so classified at the time the cream was shipped. Both lots of cream which were third grade at the end of the holding period improved one point in visual mold score during storage, the changes being from 5 to 4 and 4 to 3. Even in a few instances where mold mats appeared on the surface of the cream, the mold score on the mass of the cream was less at the end of the holding period than at the beginning. The results indicate that the mold content of cream originally containing only small amounts of mold hyphae tends to increase, while the mold content of cream containing large amounts of mold hyphae tends to decrease during holding.

The changes in visual mold score were paralleled reasonably well by the changes in mold plate count, although some discrepancies were encountered. The mold plate count of sample 7 increased from 165,000 to 265,000 per milliliter during holding, although the visual mold score dropped from 3 to 2. The increase in mold plate count from 14,000 to 180,000 per milliliter which occurred in sample 19 was in no way reflected in an increased visual mold score. This is especially significant since the cream dropped from first to second grade during the holding period. The visual mold scores on samples 10 and 24 were much higher than would be expected from the mold plate counts and really reflected the quality of the cream better than did the mold plate counts. Changes in yeast plate counts and mold plate counts were not parallel, either in direction or magnitude, in many cases, indicating that the numbers of each vary more or less independently.

TABLE 3

Summary of microbiological data on cream before and after holding in the cream station

Organoleptic grade	No. of samples	No. of samples in each grade with visual mold score of					Number of samples in each grade with mold plate counts per ml. of						Number of samples in each grade with yeast plate counts per ml. of					
		1	2	3	4	5	Less than 10M	10–30M	31–100M	101–300M	301–1000M	More than 1000M	Less than 10M	10–30M	31–100M	101–300M	301–1000M	More than 1000M
Results from cream as it was placed in holding																		
1	30	8	8	12	2	0	3	7	7	11	1	1	1	6	7	5	7	4
2	8	0	1	4	2	1	0	0	2	3	2	1	1	0	1	1	2	3
Results from cream as it was removed from holding																		
1	14	3	5	6	0	0	1	0	4	6	3	0	1	1	4	3	4	1
2	22	3	7	11	1	0	0	1	10	8	3	0	0	5	2	3	9	3
3	2	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	2

Some of the microbiological data from table 2 are summarized in table 3. Among the samples obtained prior to holding, a tendency for a greater fraction of the samples grading number one to be placed in mold score classes 1 and 2 than in classes 4 and 5 was apparent, while more of the second grade samples were placed in the poor than in the good mold classes. After holding in the station, distribution on the basis of visual mold score was approximately the same for both first and second grade cream samples. The number of third grade samples was too small to permit the drawing of conclusions relative to them. The situation was similar with regard to distribution of samples according to mold or yeast plate counts, some relationship between count and grade being apparent before but not after holding. The data show that the tendency toward a relationship between organoleptic grade and visual mold score, mold plate count or yeast plate count which was observed before the cream was placed in holding was not evident at the end of the holding period. The microbiological changes observed failed to reflect the changes which had occurred in the organoleptically-determined quality of the cream during the holding period. These results indicate that the visual mold test in particular, but also the mold and yeast plate counts, are not as satisfactory for aiding in the grading of cream which has been held in the station as they are for the grading of producers' cream. This is a shortcoming of the visual mold test which apparently has not been recognized before.

The air space in the top of the cream cans was found to be fairly constant at 2 or 3 inches and differences apparently were not large enough to affect the results significantly.

DISCUSSION

Most investigators agree that the common dairy mold, *Oospora lactis*, which is usually the dominant mold in cream for buttermaking purposes, has little or no part in the development of the more serious flavor and aroma defects of cream. Most of the serious cream defects of microbial origin are the result of development of bacteria, although yeasts sometimes are involved. The value of the mold test lies in the fact that the conditions which permit molds to develop also will permit bacteria and yeasts to develop. Mold is easily detectable, while more complicated methods are necessary for approximate quantitative determination of bacteria and yeasts. If undesirable types of bacteria and yeasts are present they will produce defects under the same conditions that permit the molds to grow. Occasionally the molds may develop to a considerable extent while undesirable bacteria and yeasts do not develop. This may be because organisms of undesirable types were not present in the first place or because conditions were not satisfactory for development of organisms capable of causing pronounced defects. Such situations are potentially injurious to the quality of the cream, and the mold

test performs a definite service in indicating such possible sources of trouble, even though the situation may be under satisfactory control at the time the test is made.

Far more important from the standpoint of the evaluation of the mold test are the cases when poor cream may be missed when the mold test is employed as the only quality test. Molds require air for their development and most bacteria and yeasts grow satisfactorily in the absence of air. Under circumstances where the air supply is limited or lacking, mold development would be restricted markedly while development of bacteria and yeasts could continue unabated if other conditions were satisfactory. Under the anaerobic conditions in the depth of a large can of cream, mold could not develop and autolysis of the mold hyphae undoubtedly would occur. This would account for the reduction in mold count or visual mold observed during these investigations in some lots of cream originally high in mold content. This would also account for the greater tendency toward reduction of mold content after 2 days than was observed after one day. Under the conditions of this study, lack of air supply in the depths of the cans undoubtedly accounted for much of the discrepancy between mold content and quality of cream held in the cream station without adequate refrigeration.

Although the point is not important with regard to this study, the possible effect of temperature on comparative development of microorganisms should be mentioned. The rate of development of *O. lactis* is relatively rapid in the range from a little above 70° F. up to about 90° F. Above and below these temperature limits organisms responsible for more serious microbial defects of cream and butter could develop at a comparatively much more rapid rate than would the mold. This would seriously interfere with the correlation between mold content and quality of cream or butter.

The results of this study indicate that the mold test must be used with discretion, and in conjunction with other tests for the proper evaluation of cream quality. Unquestionably the test has considerable value for the grading of cream as it comes from the farm. The test has only limited applicability for grading cream which has been held for even twenty-four hours without adequate refrigeration in cream stations, because conditions in such stations usually are not favorable for appreciable mold development but definitely are favorable for the development of bacteria and sometimes yeasts.

SUMMARY AND CONCLUSIONS

The effect of holding cream in the buying station on the mold content and the quality of cream was studied. The cream was held in 10-gallon cans for one or two days at slightly below atmospheric temperature. A total of 113 lots of cream was examined.

The results indicate that the visual mold test used as an index of the

quality of cream for buttermaking does not reflect the changes which occur during holding in the cream station. The quality of cream as indicated by grade and acidity was found to decrease rapidly during holding in the cream station, while the visual mold score frequently did not reflect the deterioration in quality which occurred.

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DEVICES FOR MEASURING PHYSICAL PROPERTIES OF CHEESE

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Each variety of cheese has certain typical physical characteristics. For example, Swiss cheese should have a pliable and elastic curd, sufficiently close-grained to hold the gas formed during ripening and capable of stretching so that eyes are formed with smooth, glistening surfaces. Failure to obtain this texture is indicated by irregular eyes with rough or "nut like" surfaces, an obviously tough curd, or a weak curd which cracks when the eyes are formed. These characteristics are easily recognized and roughly evaluated by the experienced cheesemaker or dealer, but in experimental work it is desirable to have a means of measurement of these properties and to be able to express this measure in mathematical terms.

For determining the firmness of curd at the time of cutting, Scott Blair (4) devised an instrument to measure the depression of the curd under a 300-gram weight held in a light tray and the recovery of the curd when the weight is removed. Firmness of curd at various later stages in the making process was determined by Vas (7) by means of a "coagulometer," which measures the distance through which a flat plate sinks into a 20-gram sample of curd, contained in a perforated chamber, in 5 minutes under a pressure of 500 grams. A device for measuring the consistency in terms of superficial density in Cheddar and other varieties during the heating process has been used by Scott Blair and Coppen (5) as a means of establishing uniformity in "pitching" time (stage at which curd is allowed to settle).

For measuring physical properties of cheese, a penetrometer which indicates firmness in terms of the distance that a plunger sinks into a sample under a definite pressure has been devised by Koestler (2) for Emmentaler and similar varieties, and one which shows the weight in grams required to push a cone-tipped shaft into a sample has been devised by Roundy and Price (3) for measuring the consistency or "body" of cream cheese. Devices for measuring the amount of deformation occurring in a small block of cheese when subjected to a definite pressure, and the amount of elastic recovery when the pressure is removed, have been used by Koestler (2) and also by Davis (1), who described the basic, rheological principles concerned in the measurement of body and texture in cheese, butter, etc. A device and technique have been described by Scott Blair and Coppen (6) for use with cured cheese to measure the deformation produced by pressing a spherical skewer 1.5 inches in diameter with a weight of 36 pounds against the top surface of the cheese—a method designed to imitate the pressure of the

Received for publication November 10, 1941.

thumb on the cheese as a measure of cheese "body." A device has been described by Koestler (2) for measuring the amount of elastic stretch occurring in a rectangular, bar-shaped sample when the ends are pulled in opposite directions and also the amount of subsequent recovery when the stretching force is removed.

It has been found desirable in our work to establish a definite standard of firmness of curd at the time of cutting, by a method which would be more sensitive than the one mentioned above, and whose results would be less subject to variations caused by differences in the size of the container (beaker, vat-or kettle) and less masked by the buoyancy of the liquid. Such type of measurement is obtained with the Hill curd tester (American Curd-O-Meter), but it is not suitable for use on a vat of milk and not sufficiently sensitive to measure the small differences existing in milks in the early stages of curdling. In measuring plasticity of cheese in terms of firmness, difficulty was encountered in securing a method applicable to samples varying greatly in consistency, and to samples of different varieties. In measuring elasticity it was difficult to prevent slippage when attempts were made to fasten each end of a bar-shaped sample in holding devices, and samples both sufficiently large and free of "weak" areas were difficult to secure from Swiss cheese which contained small eyes or cracks. The three instruments described below were designed in an attempt to overcome the difficulties mentioned.

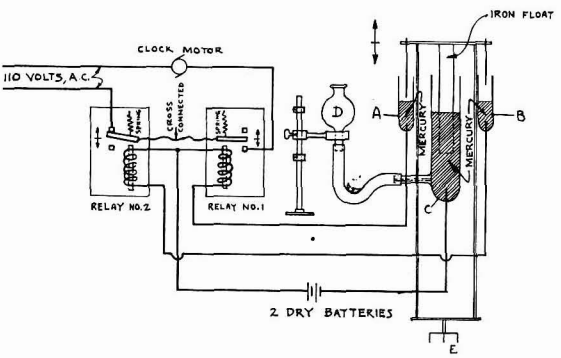

FIG. 1. Instrument for measuring the firmness of curd at cutting time.

CURD TENSION METER FOR VAT OR KETTLE MILK

The instrument is a modification of the Hill meter and includes the standard knife or cutting "head" of this instrument. Firmness of rennet-coagulated curd is determined by measuring automatically the time required for the cutter, when actuated by a controlled force, to move a definite distance through the coagulating milk in either a beaker or a vat or kettle. The construction is shown diagrammatically in figure 1. An iron rod weigh-

ing about 200 grams floats freely in mercury in a glass cylinder and supports a yoke which carries the cutter (E) below the cylinder. The level of the mercury in the cylinder, and consequently the position of the float, is regulated by a leveling bulb (D) connected to the cylinder through a capillary. The leveling bulb is supported on a rod with stops which limit its vertical movement. The measuring device is mounted, with a ball and socket joint to permit leveling, on a rod fastened to a suitable base so that it can be supported over a cheese kettle and so adjusted that the cutter, in its upper position, is just clear of the surface of the milk.

When the leveling bulb is at its upper position, the mercury flows into the cylinder and raises the float and the cutter. When it is dropped to its lower position, the mercury runs slowly from the cylinder into the leveling bulb and the cutter moves downward through the curd until the float is again in equilibrium with the mercury. The internal friction is negligible and, since the pressure on the cutter caused by the falling of the mercury level is under positive control, the rate of movement of the float and cutter is a direct function of the weight applied and an inverse function of the resistance offered to the cutter by the curd.

The time required for the cutter to move through a certain distance is measured automatically through contact wires on the yoke of the float so adjusted that one makes contact in a mercury cup (A) at the beginning of the movement and the other makes contact in a second mercury cup (B) and closes another circuit at any predetermined point in the fall of the float. These mercury cups are connected by wires with two relays, of which No. 1 is normally open and No. 2 normally closed. The relays are connected and mounted in a cabinet with an electric timer which has a dial graduated to $\frac{1}{5}$ second and the graduations so spaced that $\frac{1}{10}$ second may be estimated accurately.

The mercury level in cup A is so adjusted that the contact wire is 2 or 3 mm. above the mercury when the leveling bulb is in its upper position. When the bulb is lowered to the bottom stop, the mercury flows slowly through the capillary and the downward movement of the float closes the circuit through cup A, thus activating relay No. 1 and starting the clock. When the contact is made in cup B, relay No. 2 is opened and the clock is stopped.

The sensitivity of the instrument is decreased but a firmer curd may be measured if the bottom stop is lowered. This has the effect of putting a larger proportion of the weight of the float on the cutter and forcing it through a curd in which it would otherwise stall. For measuring the firmness of the curd at cutting we have found satisfactory a movement of the float of $1\frac{3}{4}$ inches and a rate of flow through the capillary that will require 16 to 18 seconds between the time the contacts are made in A and in B. With this adjustment incipient coagulation will be indicated by a more or

less marked increase in the time required for the cutter to pass through the sample. The measurements are relative and may be expressed as the number obtained by dividing the time required for the cutter to move a certain distance in milk or curd (A) by the time required to move the same distance in air (B) ($\frac{A}{B}$ = firmness of curd).

The readings obtained on a kettle of typical Swiss cheese milk are shown in figure 2.

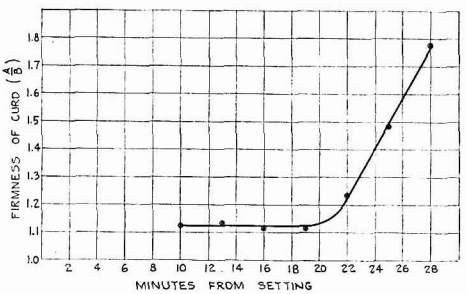

FIG. 2. Increasing firmness of curd under the action of rennet as measured in a typical kettle of Swiss cheese milk.

ELASTOMETER FOR CHEESE

Of the various methods by which elasticity in terms of ability to stretch may be measured, the most direct is to measure the elongation of a beam of curd under a definite pull. An instrument was devised to do this, and results obtained with it were reasonably consistent and, in most cases, correlated satisfactorily with other characteristics of the cheese. It was necessary to cut from a plug of cheese a dumbbell-shaped bar of curd free from cracks or other defects, which could be held without slippage or danger of crushing. In overset or otherwise defective cheese it was difficult, and frequently impossible, to secure samples which would meet these requirements.

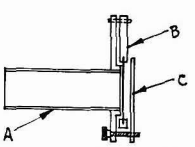

FIG. 3. Device for cutting disks of uniform thickness from a plug of cheese.

A second instrument was constructed which required a disk of curd 18 mm. in diameter and of uniform thickness. Disks of suitable dimensions were secured by cutting a plug of the required diameter with a cork borer and cutting disks from it with a special cutter (fig. 3) consisting of a tube (A) through which the plug of cheese is pushed against an adjustable stop (C), and a thin, sharp blade (B) which swings on a pivot and bears against

the end of the tube. To measure elasticity, the disk-shaped sample (G, fig. 4) is held in place in the top of a metal chamber (A) by a collar secured by two set screws, preventing leakage of air. The chamber, which is supported on a stand so that its position is adjustable, is then raised so that the surface of the disk touches the foot of a thickness gauge (B) with the indicator at zero. The weight of the moving parts of the gauge is balanced on a pulley with a light cord and a counterweight. Air is admitted into the chamber by opening a stopcock (D) and the amount of deformation of the sample is read on the gauge, which is graduated to 0.001 inch. Since the bulging of

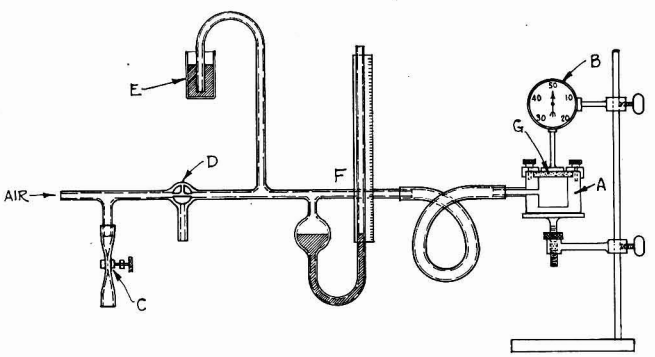

FIG. 4. Instrument for measuring the elasticity of Swiss cheese.

the sample usually continues until it is ruptured, it is necessary to read the gauge at the end of a definite time from the instant at which air has been admitted. Uniform pressure is obtained through a glass connection provided with an adjustable leak (C) which holds the pressure within safe limits, a mercury leak (E) by means of which the pressure in the chamber (A) may be maintained at any desired point, and a manometer (F). The

TABLE 1

Variations in physical properties of Swiss cheese made from milks differently treated

Treatment of milk	Plasticity of cheese		Elasticity of cheese
	Green	Cured	Cured
	pounds	*pounds*	*0.001 inch*
Control	.....	26.5	147
1% concentrated whey added	.....	11.3	63
Control	26.2	17.5	65
25% whey added	20.0	12.2	157
Control	26.4	17.0	95
25% whey added	25.0	11.6	120
Control	.....	23.0	31
L. casei culture added	.....	15.8	166

measurements are made in a constant-temperature room in which the cheese samples have been held long enough to be sure that their temperature will have reached that of the room.

Examples of results obtained with typical experimental cheese are shown in table 1. These readings were obtained at a temperature of 20° C. on disks 2 mm. thick exposed to a pressure of 2.5 cm. of mercury for 1 minute.

PLASTOMETER FOR CHEESE

One of the most significant physical characteristics of Swiss cheese is the property usually called toughness, but which we refer to as relative plastic-

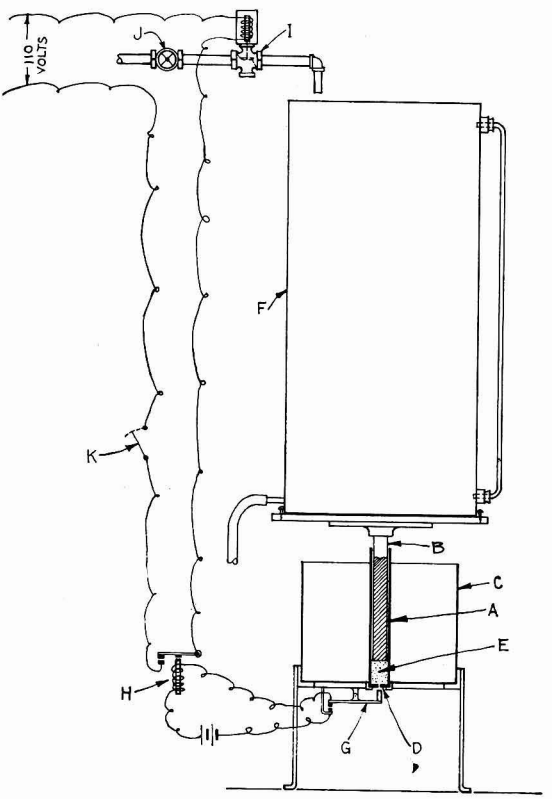

FIG. 5. Plastometer for measuring the plasticity or toughness of Swiss and other varieties of cheese.

ity. It may be evaluated by a penetrometer test, and we have used such an instrument to some extent. However, we have found more satisfactory a special instrument by which small differences in toughness may be readily

detected, regardless of the presence of small gas holes or cracks, and expressed in mathematical terms.

The essential parts of this apparatus, which is shown in figure 5, are a cylinder (A) in which a plug of cheese is subjected to pressure sufficient to cause it to flow, a detachable base plate (D) containing an orifice through which the cheese flows, and a piston or plunger (B) to supply pressure on the sample. In the method as first used, the cheese was subjected to a definite pressure for a definite time and the amount of cheese which was forced through the opening was determined by weighing it. This method did not permit accurate measurements on samples so soft that the entire plug was forced through the opening, or on those so tough that no cheese went through. The procedure was altered to measure the pressure required to produce the beginning of flow through the orifice, and the equipment can be used, therefore, at any stage of ripening and for all varieties of cheese. As used in our work the cylinder (A) is $\frac{5}{8}$ inch in diameter and $7\frac{1}{2}$ inches long. The base plate (D) is 0.20 inch thick and the orifice in it is 0.063 inch in diameter. The piston (B), which is machined to a good fit, moves freely and supports a circular platform 9 inches in diameter. Pressure is supplied by water running into a can (F) on the platform, and the can has a gauge extending its entire length and calibrated to show directly in pounds the total pressure on the sample. For extremely soft varieties in which the pressure required is less than 5 pounds, the weight of the upper, movable parts (can and plunger) can be balanced by suspending them on a pulley with a cord and a counterweight.

The cylinder is enclosed in a water bath (C) to insure a uniform temperature of the cheese sample (E) previous to and at the moment of testing. Additional samples to be tested are placed in glass tubes in the same water bath. In operating the equipment, a 9-gram plug of cheese, taken with a trier, is placed in the cylinder and its temperature is allowed to reach that of the bath (26–26.5° C.). The piston, lubricated lightly with petrolatum, is inserted above the sample with the instrument set so that the platform is level. Pressure is applied by closing a switch (K) in the 110-volt circuit, thus opening a magnetic valve (1) and causing water to flow into the can at a constant rate of 8 pounds per minute. The rate of flow is regulated by a valve (J).

The pressure increases gradually and eventually becomes sufficient to press cheese through the orifice to push down a switch-arm (G), which is held 0.035 inch below the lower end of the orifice by a spring, permitting movement under a pressure of 1 gram. This opens the low-voltage circuit activating a relay (H) which in turn closes the magnetic valve, stopping the flow of water into the can. The pressure is read on the gauge.

Typical measurements of relative plasticity are shown, with those of elasticity, in table 1. A high plasticity reading indicates relatively great

toughness, while a high elasticity reading shows a high degree of ability to stretch or bend. It will be noted that these two properties are not necessarily correlated but that each is affected very definitely by differences in the making process.

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THE ADVANTAGE OF GRINDING ATLAS SORGHUM GRAIN FOR DAIRY COWS*

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Due to the large increase in acreage of sorghums in Kansas, much interest has arisen among dairy farmers in the use of sorghum grains as a concentrate feed. Atlas sorgo (16) is a sweet sorghum used extensively as a forage crop for silage in Kansas and at the stage of maturity usually cut for silage, it may yield considerable quantities of mature grain (19, 20). It is also grown as a grain crop in certain areas of the state.

Any grain in the dairy cow ration which escapes mastication will pass through the digestive tract as whole grain. Grinding grain for dairy cows is a common practice, the degree of fineness of the grinding depending to some extent upon the kind of grain fed.

Sorghum grain is small and hard and is more apt than some other grains to pass through the cow. The protective hull of the seed must at least be cracked in order to permit the digestive juices to act most effectively upon the nutrients in the grain.

Observation on the whole sorgo grain which passes through the cow, whether fed as silage or as a concentrate, has caused farmers to inquire about the losses involved, the desirability of grinding the grain, and how fine to grind it.

REVIEW OF LITERATURE

Several investigators (5, 6, 7, 10, 12, 14, 15, 17, 18, 19, 20, 21) have reported on the advantages of grinding various grains, such as corn, oats, and barley, as a feed for dairy cattle. As early as 1902, Otis (13) commented on the large amount of kafir corn that passed through six-months-old experimental beef calves.

The value of ground sorghum grains as a feed for dairy cattle has been established (3, 4, 6, 7). Cave and Fitch (3) were the first to present data on the waste resulting from the feeding of sorghum crops. They reported as high as 90 per cent of the seed in sumac silage passed through the cow undigested. When they fed kafir silage they found about 30 per cent passed through. LaMaster and Morrow (11) found that about 38 per cent of the seed in sweet sorghum silage passed through dairy cows unmasticated.

Fitch and Wolberg (8) reported that the seeds in Kansas Orange sorgo and Atlas sorgo silages were utilized slightly better by dairy cows than were the seeds from these plants when fed as whole grain. When Kansas Orange

Received for publication November 25, 1941.
* Contribution No. 140, Department of Dairy Husbandry.

silage was fed with alfalfa hay and a grain mixture an average of 43 per cent of the seed in the silage was recovered in the feces; while an average of 36 per cent of the seed in Atlas sorgo silage was recovered. When fed as the only concentrate with alfalfa hay, an average of 62 per cent of the Kansas Orange seed was recovered, and 51 per cent of the Atlas sorgo seed. When Atlas sorgo silage was fed as the only feed the recovery averaged 30 per cent. The effect of the other feeds fed is of doubtful significance because the difference between the average recovery of Atlas sorgo seed from silage (36 as compared with 30) was not so great as the differences between individual cows in each trial.

Darnell and Copeland (6, 7) reported an average grain recovery in the feces of dairy cows of 67.8 per cent when whole milo was fed, 30.5 per cent when whole corn was fed, and no satisfactory recovery from whole oats. They concluded that, ". . . size of the grain is a factor in the amount of whole grain masticated." No other published data were found pertaining to measured losses of sorghum grain when fed to livestock.

Hogs usually chew their grain more thoroughly than cattle, but even with hogs, Hale (9) found that when they were hand-fed on whole kafir, 10 per cent of the feed was recovered as whole grain in the feces. When the hogs were self-fed, 2 per cent of the seed passed through unmasticated.

Although, as mentioned above, several investigators have reported on the feeding value of ground sorghum grains as a feed for dairy cattle, while others have presented data on the loss of whole grains in feces, no publications have come to the attention of the writers in which data on the savings due to grinding were presented.

EXPERIMENTAL PROCEDURE

The effect of fineness of grinding on the per cent of sorgo grain apparently passing through the cow was determined by feeding Atlas sorgo grain as whole grain, coarsely ground, and finely ground.

Two dry cows were selected, one Holstein and one Jersey, which had previously been fed on the normal herd ration. They were fed through three ten-day periods on a ration of alfalfa hay *ad libitum*, and sorgo grain at the rate of about ten pounds per head daily. During the first period whole grain was fed; in the second, coarse ground or cracked grain; and in the third, finely ground grain.

All the feces voided during the last three days of each ten-day period were collected. Grain was recovered from the feces by working and washing in a deep barrel and allowing the grain to settle, then decanting the liquid refuse. This washing and decanting process was repeated until the grain became fairly clean. It was then necessary to air-dry the grain and again repeat the washing and decanting in order to remove all of the foreign material. After the final washing the grain was air-dried and weighed.

Undoubtedly some finer particles of the grain were lost in the washing and decanting process. The amount of grain found in the feces represents a minimum amount that passed through the cow.

In Kansas, many farmers feed cows almost exclusively on the sorghum plant, using the fodder as dry roughage, either with or without sorgo silage, and the sorgo grain as the major or exclusive grain feed. Field observations and experiments in progress indicate that cows on such rations become unthrifty; and the question arose whether cows on such rations would utilize the sorgo grains to more or less extent than cows on better balanced rations. Three groups of cows which had been fed fixed rations for more than a year were available. Group I had been fed Atlas sorgo fodder, Atlas sorgo silage, and a concentrate of Atlas sorgo grain only. Group II was fed the same, except enough cottonseed meal and bone meal were fed to meet the protein and mineral requirements of Morrison's standards. Group III had been fed alfalfa hay, sorgo silage, and a grain mixture consisting of 400 pounds of ground Atlas sorgo grain, 200 pounds of wheat bran, and 50 pounds of cottonseed meal.

Cows in groups I and II were in an extremely thin condition, having lost from one-fourth to one-third of their body weight since being put on the experimental rations. The cows in group III were in good condition, apparently normal.

Since it seemed, from the appearance of the feces, that the cows in groups I and II were wasting more of their grain than normal cows, it was decided to study two cows from each of the three groups along with the previously mentioned two cows from the college herd, used as a check.

Because it was not desirable to make any changes that might upset the results of the other experiment, the cows selected from groups I, II, and III were omitted from the first feeding period during which whole grain was fed; the only change made in the rations fed these cows during the second and third feeding periods was to use grain of the same grind that was being fed to the two dry cows.

The amount of grain fed the cows in groups I, II, and III varied considerably due to differences in their feed requirements, while the check cows were fed all they would readily consume.

As a check on the utilization of sorgo grain consumed in silage as compared with grain fed as a concentrate, a dry Jersey cow was fed exclusively on Atlas sorgo silage at the rate of 30 pounds daily. The percentage of grain in the silage was estimated by hand picking the grain from representative samples.

Both the Atlas sorgo grain and the Atlas sorgo silage used in these experiments were grown in the vicinity of Manhattan, during the crop year of 1939. The grain was rather typical, although possibly the seeds were not so large and plump as in some years. The silage was less mature and the

TABLE 1

Utilization of Atlas sorgo seed when fed to dairy cows as whole seed, coarsely ground, finely ground; and as grain feed compared with grain in silage

Groups	Check (dry cows)									I					
Ear tag number and breed	152 Holstein			318A Jersey			Average			374 Jersey		E44 Holstein		Average	
Form of sorgo grain	Whole	Coarse grind	Fine grind	Whole	Coarse grind	Fine grind	Whole	Coarse grind	Fine grind	Coarse grind	Fine grind	Coarse grind	Fine grind	Coarse grind	Fine grind
Trial I															
Sorgo grain consumed daily (lbs.)	8.6	10.0	9.1	7.7	10.0	7.3	8.1	10.0	8.2	4.0	4.0	2.0	2.0	3.0	3.0
Sorgo silage consumed daily (lbs.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.0	13.8	20.0	20.0	17.0	16.9
Grain in silage consumed daily* (lbs.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.18	0.18	0.26	0.26	0.22	0.22
Total grain recovered in feces (lbs.)	3.30	0.37	0.10	3.50	0.60	0.13	3.40	0.48	0.12	1.00	0.33	0.43	0.40	0.71	0.36
Recovered grain originating from silage* (lbs.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.02	0.02	0.03	0.03	0.02	0.02
Total grain recovered, minus grain from silage (lbs.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.98	0.31	0.40	0.37	0.69	0.34
Concentrate grain recovered (%)	38.4	3.7	1.1	45.5	6.0	1.8	42.0	4.8	1.5	24.5	7.8	20.0	18.5	23.0	11.3
Trial II															
Sorgo grain consumed daily (lbs.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.6	4.6	5.4	5.4	5.0	5.0
Grain recovered in feces (lbs.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.0	4.5	1.3	0.7	1.15	0.57
Grain recovered (%)	.....	.....	.....	.....	.....	.....	.....	.....	.....	21.7	9.8	24.1	13.0	23.0	11.4

* Grain in silage was determined by hand picking representative sample (1.3%); grain recovered from silage was computed by using the figure (10.7%) obtained cow fed silage only.

TABLE 1—(*Continued*)

Utilization of Atlas sorgo seed when fed to dairy cows as whole seed, coarsely ground, finely ground; and as grain feed compared with grain in silage

Groups	II						III						Silage fed cow
Ear tag number and breed	492 Guernsey		273 Ayrshire		Average		381 Jersey		495 Guernsey		Average		314A Jersey
Form of sorgo grain	Coarse grind	Fine grind	Coarse grind	Fine grind	Coarse grind	Fine grind	Coarse grind	Fine grind	Coarse grind	Fine grind	Coarse grind	Fine grind	Silage only
Trial I													
Sorgo grain consumed daily (lbs.)	1.2	1.2	4.1	4.1	2.6	2.6	6.0	6.0	6.0	5.0	6.0	5.5	
Sorgo silage consumed daily (lbs.)	20.0	20.0	21.2	16.8	20.6	18.4	20.0	17.7	22.0	18.4	21.0	18.0	30.0
Grain in silage consumed daily* (lbs.)	0.26	0.26	0.28	0.22	0.27	0.24	0.26	0.23	0.29	0.24	0.27	0.23	0.39
Total grain recovered in feces (lbs.)	0.30	0.13	0.60	0.27	0.45	0.20	0.37	0.17	0.16	0.16	0.27	0.17	0.04
Recovered grain originating from silage* (lbs.)	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.03	0.02	0.03	0.02	0.04
Total grain recovered, minus grain from silage (lbs.)	0.27	0.10	0.57	0.25	0.42	0.17	0.34	0.15	0.13	0.14	0.24	0.15	
Concentrate grain recovered (%)	22.5	8.3	14.0	6.1	16.2	6.5	5.7	2.5	2.2	2.8	4.0	2.7	
Trial II													
Sorgo grain consumed daily (lbs.)	3.7	3.7	3.7	3.7	3.7	3.7	6.2	6.8	7.2	7.2	6.7	7.0	
Grain recovered in feces (lbs.)	0.76	0.42	0.7	0.38	0.73	0.4	0.14	0.1	0.2	0.07	0.17	0.08	
Grain recovered (%)	18.9	10.3	18.9	10.3	19.7	10.8	2.3	1.5	2.8	1.0	2.5	1.1	

* Grain in silage was determined by hand picking representative sample (1.3%); grain recovered from silage was computed by using the figure (10.7%) obtained from cow fed silage only.

heads contained much less seed than usual due to deficient rainfall during the growing season.

RESULTS

The Atlas sorgo grain fed to the two dry cows from the college herd, using as a check, resulted in an average of recovery in the feces of 42.0 per cent of the grain when fed whole, 4.8 per cent when the grain was coarsely ground, and 1.5 per cent when finely ground (table 1).

The grain recovered in the feces from the cows in group III, which had been receiving a rather typically normal ration, compared quite closely with the check group in spite of the fact that these cows received silage while the check cows did not. The recovery on coarse ground grain averaged 4.0 per cent, and 2.7 per cent on fine ground. In group II the average recovery for coarse ground grain was much higher, being 16.2 per cent for coarse ground grain, and 6.5 per cent for fine ground. Group I was even less efficient than group II, the average recovery of coarse ground grain being 23.0 per cent, and 11.3 per cent for fine ground. Groups I, II, and III ranked in grain utilization in the same order of their general appearance as to thrift.

After the first feeding trial of three periods was completed, it appeared that the grain in the silage fed to the cows in groups I, II, and III might prevent direct comparison of the results with those obtained from the check cows fed no silage. Therefore, the trial was repeated using the same two cows in groups I, II, and III fed the same rations as before, except that silage was removed from the ration. The Atlas sorgo grain was ground to the same fineness modulus as in the first trial.

Comparison of groups I, II, and III with the check cows was complicated by the fact that the check cows received no silage while the other three groups were fed sorgo silage. It was found that the grain represented only 1.3 per cent of the weight of the silage as fed. When a cow was fed exclusively on this silage at the rate of 30 pounds daily, 10.7 per cent of the grain was recovered in the feces. This figure was used in computing the amount of grain represented by silage which was recovered in the feces of groups I, II, and III in trial I. Due to the small amount of grain in the silage, the cows in these three groups did not receive enough grain from that source to permit comparison with the check group of cows fed no silage.

In the second trial, the quantity of sorgo grain fed was increased. In group III, an average of 2.5 per cent of the grain was recovered in the feces when the grain was coarse ground, and 1.1 per cent when finely ground. In group II, an average of 19.7 per cent of the coarse ground grain was recovered, and 10.8 per cent of the fine ground. The recovery of grain in group I averaged 23.0 per cent for coarse, and 11.4 per cent for fine. The three groups utilized their grain in the same order as before and the results checked remarkably close with the previous trial, when silage was fed. In

fact, the average of the two trials checked more closely than did the individual cows within a group. The results, however, as shown by the data on individual cows were quite consistent.

DISCUSSION

When whole sorgo grain is fed as a concentrate, some grain cracked by mastication might also be expected to pass through the digestive tract, since it was shown in these trials that some ground grain passed through. The grain recovered from the feces, however, did not contain any more cracked grain than did the original whole grain fed. Several investigators (1, 7, 8, 11, 14, 17, 21) have reported that no appreciable digestion of whole grain occurs when passing through the cow, as measured by chemical analyses. The results on the recovery of ground grain might be less accurate than for whole grain. Wilbur (21) reported that starch analyses of feces were closely related to the amounts of grain passing through the cows undigested when whole corn and oats were fed. Thallman and Cathcart (17) found that when corn processed in various ways was fed to beef cattle, there was a close relationship between the results measured by grain passing through and by digestion trials. It is safe to conclude, however, that at least the amount reported passed through the cow; and since such a large percentage of whole grain was voided the waste is great; while the loss of ground grain is relatively small, even allowing for error.

The loss of 42 per cent of the grain in the feces when the grain was fed whole indicated the necessity for grinding. The results are in general harmony with the findings of Fitch and Wolberg (8) who reported a waste of 51 per cent for Atlas sorgo fed as a concentrate, and with other investigators (1, 6, 7, 8) using different varieties of sorghums. Differences can be attributed to differences in varieties, maturity of seed, and growing conditions.

Medium ground grain has been recommended for dairy cattle (2, 15, 21). Coarse ground sorgo grain was compared with finely ground grain in these trials in order to make any differences more significant. Also, sorgo seed is so small that coarse grinding, if properly done, would make it typical of medium grinding of some other grains. The finely ground grain represented a fineness modulus of 2.44, which was as fine as it was possible to grind it. The coarse ground grain was ground to a fineness modulus of 3.65. Whole Atlas sorgo grain represents a fineness modulus of about 4.5. A hammer mill was used for the fine grind and a burr mill for the coarse grind. The energy consumption per hundred pounds of grain ground was 0.158 K.W.H. for the coarse grind, and 0.502 K.W.H. for fine grind.[1] The

[1] Grinding of grain to specific fineness modulus was done by June Roberts, Department of Agricultural Engineering, Kansas State College. Data on power requirements for grinding were also furnished by him.

increased cost of fine grinding is typical of reports on the grinding of other grains (2, 15, 21).

Compared with an average waste of 42 per cent when the grain was fed whole, grinding of the grain resulted in a great saving. An average recovery of only 4.8 per cent of the coarsely ground grain from the feces of the check group, and 4.0 per cent for group III when fed silage and 2.5 when silage was omitted; compared with an average recovery of 1.5, 2.7, and 1.1 respectively, for the finely ground grain indicates that coarse grinding is most satisfactory considering cost of grinding, saving of waste, and consistency of feed.

In the group of cows (I) which had been fed for more than a year on an unbalanced ration derived exclusively from the sorgo plant, the grain waste averaged more than five times as much as in the cows fed more normal rations. Group II, which received the same rations as group I, except for the addition of cottonseed meal and bone meal, utilized their grain better but were much more wasteful than the cows fed more normal rations. Why the cows in groups I and II were unable to utilize their grain as well as the cows fed good rations is not known; but this fact is in agreement with the production and appearance of these cows compared with normal herd cows. It also emphasizes the poor economy of such rations.

It is interesting to note that a considerable increase in grain consumption for groups I, II, and III during the second trial, when silage was omitted, did not change significantly the average percentage loss of grain in the feces as compared with the first trial.

The fact that an average of only 10.7 per cent of the grain in the silage was recovered from the feces might lead to the conclusion that the waste of grain in silage is not excessive. Such is not the case, however, as the silage used in this trial was immature, indicated by the fact that grain represented only 1.3 per cent of the silage by weight as fed. Fitch and Wolberg (8) found that 36 per cent of the seed in Atlas sorgo silage, and 43 per cent of the seed in Kansas Orange sorgo silage passed through the digestive tract of the cow and were recovered as whole seed from the feces. Cave and Fitch (3) had previously reported as high as 90 per cent of the sorgo seed in silage passed through the cow undigested. The waste of grain in silage may be so great in good crop years that Weber (19, 20) has investigated the merit in grinding the heads separately and blowing them into the silo with the cut fodder. When fed to beef cattle, the silage containing ground heads resulted in an increased gain of 19 per cent one year, and 12 per cent the next. Stage of maturity, growing conditions, and crop variety would influence the loss of grain when sorgo silage is fed.

SUMMARY AND CONCLUSIONS

Feeding trials with dairy cows were conducted to determine the value of

grinding of Atlas sorgo grain as measured by the amount of grain recovered in the feces. Two dry cows (check group) were fed during three ten-day periods on alfalfa hay plus a concentrate of: 1. Whole Atlas sorgo grain, 2. Coarsely ground sorgo grain, and 3. Finely ground grain. Three other groups (I, II, III) were fed the Atlas sorgo grain, ground to the same fineness modulus, both with and without silage. Group I had been receiving for more than a year an experimental ration restricted to the Atlas sorgo plant—sorgo fodder, sorgo silage, and sorgo grain. Group II had been fed the same except cottonseed meal and bone meal were included. Group III received alfalfa hay, sorgo silage, and a grain mixture of sorgo grain, wheat bran and cottonseed meal. Another cow from the college herd was fed exclusively on silage to determine the amount of grain in silage passing through the cow undigested.

Feeding whole grain resulted in excessive waste while coarse grinding was more satisfactory than fine grinding, considering cost of grinding and consistency of feed. In the check group the recovery of grain in the feces averaged 42 per cent for whole grain, 4.8 per cent for coarsely ground, and 1.5 for finely ground. The grain recovered from cows in Group III averaged 4.0 per cent for coarsely ground and 2.7 per cent for finely ground, when silage was fed; and 2.5 and 1.1 per cent, respectively, when silage was omitted.

Cows receiving non-typical experimental rations did not utilize their grain feed efficiently. In group II, when silage was fed, the recovery of grain in the feces averaged 16.2 per cent for coarse grind, and 6.5 for fine grind; while when silage was omitted, 19.7 and 10.8 per cent, respectively, were recovered. Results on group I showed an average recovery of 23.0 per cent for coarse grind, and 11.3 per cent for fine, when silage was fed. When silage was omitted, the recovery averaged 23.0 and 11.4 per cent, respectively.

Increasing daily grain intake (groups I, II, III) when silage was omitted did not significantly change the percentage of grain recovered from the feces.

The silage fed was immature, the grain content as fed being 1.3 per cent. The recovery of grain from the feces of a cow fed exclusively on this silage averaged 10.7 per cent.

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THE SIGNIFICANCE OF TANNIC SUBSTANCES AND THEOBROMINE IN CHOCOLATE MILK*

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When mineralized chocolate milk contained 2.5 per cent by weight of cocoa powder and was the sole source of food, the average daily consumption of cocoa per rat was approximately 1 gram or 10 grams per kilogram body weight (5). This amount of cocoa was toxic for rats and the toxicity increased with an increase in cocoa intake. Most of the chocolate milk sold commercially contains less than 2.5 per cent cocoa, but as the beverage is prepared in the home it may contain as much as 3 per cent. There are other chocolate or cocoa-milk products which have a cocoa concentration greater than 2.5 per cent. For example, chocolate ice cream may contain 3.5 per cent cocoa, and sweet milk chocolate candy as much as 12 per cent cocoa. On the basis of these percentages the calculated cocoa intake per day for children may be 30 grams or 1 gram per kilogram body weight, when the recommended quart of milk per day is given as chocolate milk and the diet includes other cocoa-containing foods. Thus, the approximate daily cocoa intake per child on the basis of weight is only one-tenth that which was toxic for rats.

To the writer's knowledge no experimental proof is available which shows definitely what constituents of cocoa are chiefly responsible for its toxicity to rats. Theobromine is usually suspected as being the most harmful constituent of cocoa, although it is present in only small quantities (0.7 to 2.7 per cent). However, much that has been written about the harmful effects of this alkaloid is full of contradictions.

Another constituent of cocoa, present in much greater amounts than theobromine, is the group of tannic substances. The chemical properties of these substances and the amount present leads one to suspect that they may be chiefly responsible for the toxicity of cocoa. Kuzmeski and Mueller (3) analyzed eighteen samples of commercial cocoa powder for cacao-red, and found values ranging from 2.62 to 15.59 per cent. According to Knapp (2) the tannic substances in cacao beans after fermentation and drying are: red-brown products, dark-brown products, tannin, and cacao-purple, which is identical to cacao-red. Since comparatively little is known about the group of tannins in cocoa they will be referred to throughout this paper simply as tannin-like or tannic substances.

Since cocoa and chocolate are being consumed in increasing amounts, practical methods by which the toxicity may be overcome seemed desirable. To obtain such information this study was undertaken.

Received for publication November 26, 1941.

* Contribution 417 of the Massachusetts Agricultural Experiment Station.

GENERAL PLAN OF STUDY

To determine the physiological effects, pure crystalline tannic acid and pure theobromine were added to whole milk powder and fed to albino rats. Other groups of rats were fed whole milk powder plus cocoa powder which varied widely in tannic substances content, but were similar in most other respects. Also, a concentrated extract of cocoa powder, which was practically free of tannic substances and theobromine was added to fluid whole milk and fed to rats. The criterion for determining relative toxicity was growth rate, general appearance and well-being of the animals. Hemoglobin content of blood was also determined.

EXPERIMENTAL

Feeding crystalline tannic acid and theobromine. In this study twenty-four young rats, twelve males and twelve females, were divided into eight groups. Each group of three animals consisted of litter mates of the same sex and as nearly as possible of the same weight. The animals were individually caged and placed on the experimental diets shortly after weaning. Up to the time of being placed on the experiment, the rats had received the stock ration of the breeding colony.

TABLE 1

Feed formulas used

Ingredient	Group I Per cent	Group II Per cent	Group III Per cent
When feeding tannic acid and theobromine			
Whole milk powder	63.00	61.74	62.83
Cane sugar	37.00	36.26	36.90
Tannic acid	0.00	2.00	0.00
Theobromine	0.00	0.00	0.27
When feeding cocoa powders			
Whole milk powder	63.00	52.90	52.90
Cane sugar	37.00	31.10	31.10
Cocoa (12.15% tannic substances)	0.00	16.00	0.00
Cocoa (2.67% tannic substances)	0.00	0.00	16.00
When feeding concentrated extract of cocoa			
Fluid whole milk	87.00	87.00	.....
Cane sugar	5.00	5.00	.....
Water	8.00	0.00	.....
Extract of cocoa (7.54% T. S.)	0.00	8.00	.....

NOTE.—Fe, Cu, and Mn were fed to all groups as explained in the text.

Three diets were compounded as shown in table 1, and fed one to each rat in the groups of three individuals, there being eight individuals on each

of the three diets. The rats were fed in accord with the principle of paired feeding, however, in this instance, triplets instead of pairs. Group I was the control group, which was fed the basal diet consisting of whole milk powder and cane sugar. Group II was fed the basal diet with the addition of 2 per cent crystalline tannic acid (C. P. Baker's Analyzed); and group III, the basal diet with the addition of 0.27 per cent theobromine (Eastman Kodak Co.). The amount of tannic acid and theobromine in the diets for groups II and III was equal to that in a ration containing 16 per cent cocoa powder which contains 12.15 per cent tannic substances and 1.7 per cent theobromine. A ration of approximately such a composition was fed in the next experiment.

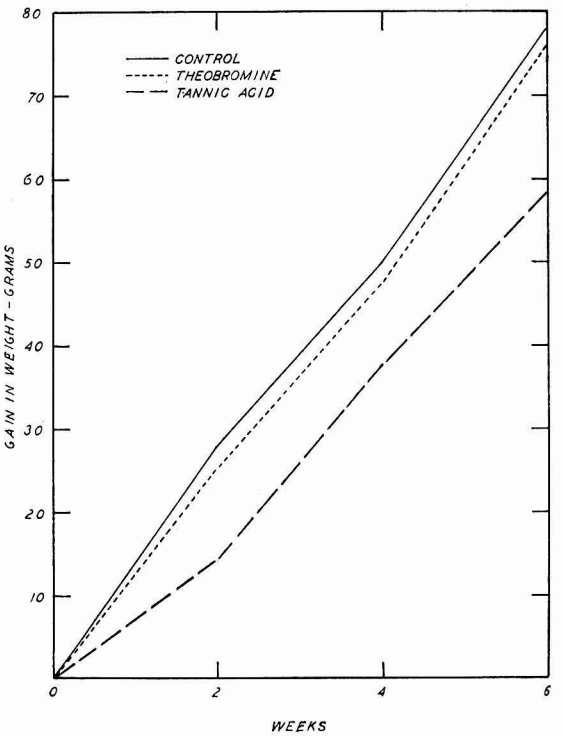

FIG. 1. Comparative growth of rats when feeding tannic acid and theobromine in a basal diet.

Iron, copper, and manganese were fed to all animals in amounts recommended by Elvehjem *et al.* (1). The mineral solutions were added to a 10 per cent sugar solution immediately before feeding, and the total volume of solution fed to each rat daily was 2 cc. The rats had water before them all the time.

Each rat in a group of three was fed the same amount of milk powder

and sugar so that the only variable in the ration was the tannic acid and theobromine. The animals were fed every other day and the amount of feed consumed determined. The quantity of food given to each group of three rats was determined by the quantity consumed by the individual eating the least within the group. Usually the animals receiving the tannic acid diet determined the food intake in all groups. The food was weighed into a

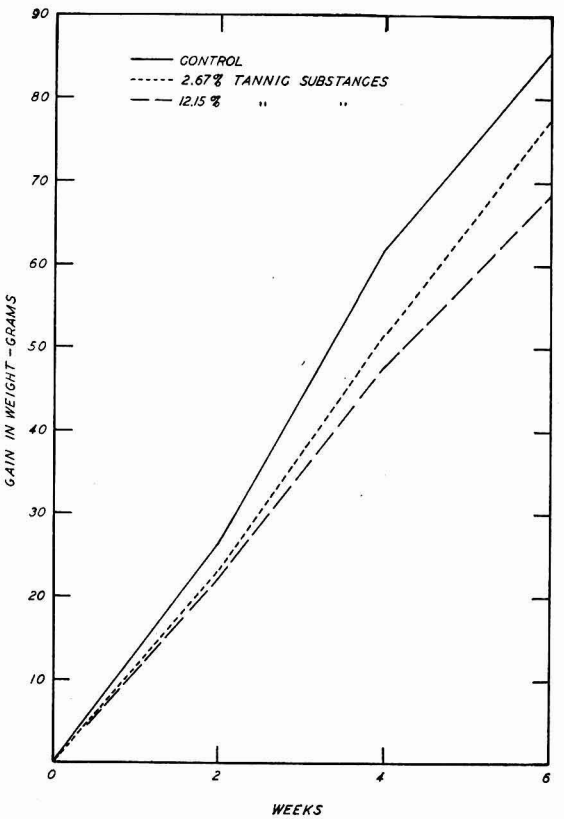

FIG. 2. Comparative growth of rats when feeding cocoa powders of varying tannic substances content in a basal diet.

porcelain feed cup of approximately 75 cc. capacity, which was set in a metal cup and held in place by a metal cover. This arrangement reduced the spillage to a minimum.

The rats remained on the experimental diets for six weeks and were weighed weekly during this time. Blood hemoglobin determinations were made after two and six weeks. The Newcomer method with a Klett colorimeter was used and the solutions were read against a standard Newcomer glass disk.

TABLE 2

Average daily gain in weight and feed consumption during the six week period when feeding tannic acid and theobromine in a basal diet

Ration	Gain in weight	Decrease in weight gain over control		Basic ration intake	Tannic acid intake	Theobromine intake
	gms.	*gms.*	*Per cent*	*gms.*	*mgs.*	*mgs.*
Group I*—Control	1.85			6.07	0.0	0.00
Group II*—Tannic acid	1.38	0.47 (± 0.09) †	25.4	6.07	124.0	0.00
Group III*—Theobromine	1.81	0.04 (± 0.07)	2.1	6.07	0.0	16.40

* Eight rats in each group.
† Standard error of mean difference between control and tannic acid and theobromine.

TABLE 4

Average daily gain in weight and feed consumption during the six week period when feeding cocoa powders, varying in tannic substances content, in a basal diet

Ration	Gain in weight	Decrease in weight gain over control		Basic ration intake	Cocoa intake	Tannic substances intake
	gms.	*gms.*	*per cent*	*gms.*	*gms.*	*mgs.*
Group I*—Control	2.04			6.26	0.00	0.00
Group II*—Cocoa high in tannic substances	1.62	0.42 (± 0.12) †	20.6	6.26	1.19	144.58
Group III*—Cocoa low in tannic substances	1.84	0.20 (± 0.10)	9.8	6.26	1.19	31.77

* Seven rats in each group.
† Standard error of mean difference between control and cocoa powders of varying tannic substances content.

Since the sexes were equally distributed for all rations, the data are presented in figure 1 and table 2 as averages for male and female. The data in table 2 show that the eight rats receiving the control diet gained an average of 0.47 grams more per day than those receiving the tannic acid, and only 0.04 grams more per day than those receiving the theobromine. The standard error being 0.09 and 0.07 grams, respectively, the difference is statistically highly significant for the tannic acid and non-significant for the theobromine.

Frequently throughout the six week experimental period the rats fed tannic acid suffered a peculiar diarrhea. They were somewhat paler and not equal in appearance and well-being to the control rats and those fed theobromine. All three groups of rats had normal content of blood hemoglobin after being on the experimental diets for two and six weeks.

Feeding cocoa powders with a high and a low content of tannic substances. The purpose of this experiment was to determine whether or not the tannic substances in cocoa have the same toxicity as pure crystalline tannic acid. Studies on the toxicity of theobromine were not followed up because feeding the pure alkaloid in the first experiment failed to produce in the rat toxic symptoms which were sufficiently outstanding and definite to provide a base for a plan of experimentation.

The analysis of the two cocoa powders used for this study is given in table 3. The two cocoa powders were chosen after analysis of eighteen commercial powders because they differ greatly in tannic substances content, and yet are similar in many other respects.

TABLE 3

Analyses of cocoa powders

Constituents	Cocoa high in tannic substances	Cocoa low in tannic substances
	Per cent	*Per cent*
Moisture	5.40	4.32
Protein*	22.62	20.31
Theobromine + caffeine	1.87	2.34
Fat	11.23	10.32
Fiber	5.25	5.33
Other N–free matter	35.50	43.11
Ash	5.98	11.60
Tannic substances†	12.15	2.67

* Nitrogen (minus theobromine and caffeine nitrogen) × 6.25.
† Ulrich's method as modified by Kuzmeski and Mueller (3).

Twenty-four young rats, twelve males and twelve females, were used in this experiment. The animals were divided and grouped as in the first experiment and unless otherwise specified the same experimental procedure was used. Three diets were prepared as shown in table 1. Group I was the control group which was fed the basal diet consisting of whole milk powder

and cane sugar. Group II was fed a diet containing the same constituents as the basal diet, but in addition 16 per cent of a cocoa powder that contained a large amount (12.15 per cent) of tannic substances. The diet for group III had the same constituents as for group II, except that the cocoa contained a small amount (2.67 per cent) of tannic substances. On a fluid milk basis the diets for groups II and III contained approximately 3.6 per cent by weight of cocoa powder, and 7 per cent of cane sugar. In most instances for this experiment, the rats that were fed cocoa high in tannic substances determined the food intake in all groups.

There were eight animals on each of the three diets at the beginning of the experiment. Since one male rat which received the cocoa high in tannic substances died after five weeks, from an unknown cause, the remaining two animals in that group are not included in the data.

The data are presented in table 4 and in figure 2, and show that the seven rats receiving the control diet gained an average of 0.42 grams more per day than those receiving the cocoa powder with a high content of tannic substances, and 0.20 grams more per day than those receiving the cocoa powder with a low content of tannic substances. The standard error being 0.12 and 0.10 grams, respectively, the difference is statistically significant for the cocoa high in tannic substances, and almost statistically significant for the cocoa low in tannic substances. Therefore, the toxicity of the latter to rats is questionable.

It should be noted that the diminution in growth of rats fed cocoa high in tannic substances is 20.6 per cent as compared to a 25.4 per cent decrease when crystalline tannic acid was fed in the first experiment. Animals fed cocoa high in tannic substance content were not equal in appearance and well-being to the animals which were fed cocoa low in tannic substances. However, these differences were not as great as one would expect when contrasting rate of growth. No significant differences in hemoglobin content of blood of the rats receiving the three diets were noted after two, four, and six weeks.

Feeding a concentrated extract of cocoa powder which is free from tannic substances. It was desired to test the toxicity of a commercial cocoa powder entirely free of tannic substances. Since such a cocoa powder could not be found, attention was given to extracts of cocoa. Some commercial chocolate-flavored syrups are flavored with an extract of cocoa in place of cocoa or chocolate. Such an extract was obtained from a company manufacturing a commercial chocolate syrup, and upon analysis the tannic substances and theobromine content were found to be practically nil.

Two rations were compounded as given in table 1, and were fed one each to a group of eight rats. The paired feeding method was used and other experimental procedures were similar to those used in the two previous experiments. Group I was the control, which was fed pasteurized whole

milk (approximately 4 per cent butter fat) and cane sugar. Water was added to offset the amount of cocoa extract added to the diet for group II. The diet for group II contained the same constituents as the basal diet, except that 8 per cent by weight of cocoa extract, containing 7.54 per cent solids, was substituted for an equal weight of water. One gram of the concentrated extract contained the extractable material from 0.48 grams of cocoa powder. Thus, the amount of the extract added to the milk was equal to the extractable material from cocoa powder when the latter makes up 3.8 per cent of the whole milk plus sugar ration. The animals were fed daily and the Fe, Cu, and Mn solutions were added to the milk immediately before feeding.

Data in table 5 show that the extract of cocoa was not toxic to rats. Although the percentage gains were slightly greater for the extract than for the control, the difference is not great enough to be statistically significant. Both groups of rats were equal in appearance and general well-being.

TABLE 5

Average daily gain in weight and feed consumption during the ten week period when feeding concentrated extract of cocoa in a basal diet

Ration	Gain in weight	Increase in weight gain over control		Basic ration intake	Cocoa extract intake
	gms.	*gms.*	*%*	*gms.*	*gms.*
Group I*—Control	1.55			34.78	0.00
Group II*—Conc. cocoa extract	1.62	0.07 (± 0.08) †	4.5	34.78	3.28

* Eight rats in each group.

† Standard error of mean difference between control and concentrated extract of cocoa.

DISCUSSION

Investigations of tannins and their significance in food materials other than cocoa may be relevant to results obtained from this study. Lease and Mitchell (4) found the average tannic acid content of four Lespedeza hays to be 7.42 per cent, and they associate this substance with the toxic effect which this hay sometimes has on animals consuming it. These investigators fed various levels of tannic acid, gallic acid, and Lespedezas to white rats. They found that albino rats were able to tolerate 5 per cent of tannic acid mixed in a good ration, but higher levels resulted in decreased growth and the rats were pale and free from the characteristic pink of the normal animals. They also found that the hemoglobin levels of the blood of rats fed crystalline tannic or gallic acid were often 50 to 60 per cent lower than normal. Also gallic acid was found to be more toxic than tannic acid and the tannic acid of the Lespedeza less toxic than pure crystalline tannic acid.

The 25 per cent decrease in growth rate when 2 per cent crystalline tannic

acid was added to the ration in this study is not in accord with the findings of Lease and Mitchell, namely, that rats can tolerate 5 per cent crystalline tannic acid in the diet. The preliminary report by these investigators does not include the feeding procedure used nor the composition of the ration to which the tannic acid was added. Therefore, it is difficult to account for the apparent discrepancy. In this study the tannic substances in cocoa were found to be slightly less toxic than pure crystalline tannic acid. Likewise, Lease and Mitchell found that the tannic acid of the Lespedeza was less toxic than pure tannic acid. These results indicate that the tannic substances in cocoa are partly detoxified by chemical combination with other constituents. The results obtained when two cocoa powders were compared, one low and the other high in tannic substances, show that the toxicity is not directly proportional to the amount of tannic substances present, as determined by the modified Ulrich method. This may be due to the probability that the various tannic substances in cocoa are not equal in toxicity, while the analysis includes both the toxic as well as the non-toxic substances. Speculation on this point seems futile until more is known about the various tannic substances in cocoa.

Although the animals which were fed crystalline tannic acid and cocoa high in tannic substances appeared to have a somewhat paler skin, yet no differences of any significance were noted in the hemoglobin content of the blood. The lack of any reduction in hemoglobin may be due to adding iron to all of the rations. No doubt sufficient excess of iron was present to prevent any marked reduction in hemoglobin by the tannic acid or tannic substances in the diet. Lease and Mitchell also report that both iron and protein to some extent counteracted the toxicity of crystalline tannic acid fed to rats.

Ringrose and Morgan (6) fed day-old chicks a ration containing 2 per cent tannic acid, which resulted in reduced growth but did not cause any mortality. However, the reduced growth was the result of a reduced feed consumption.

SUMMARY AND CONCLUSIONS

1. Pure theobromine was non-toxic to albino rats when the ration contained 0.27 per cent of this alkaloid.

2. Pure crystalline tannic acid was toxic to rats when the ration contained 2 per cent of this substance.

3. A cocoa powder containing 12.15 per cent tannic substances was more toxic to rats than a cocoa powder containing only 2.67 per cent tannic substances when the two cocoa powders had approximately the same theobromine plus caffeine content. The tannic substances from cocoa were less toxic than pure crystalline tannic acid.

4. A concentrated extract of cocoa was non-toxic to rats when the ration contained 8 per cent.

5. The hemoglobin levels of the blood of rats fed theobromine, crystalline tannic acid, and cocoa powder containing varying amounts of tannic substances, did not vary from the normal enough to be of any significance.

6. It is concluded that the toxicity from cocoa can be greatly reduced by selecting a cocoa or chocolate which is low in tannic substance, or preferably using an extract of cocoa as the flavoring material when feasible.

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STUDIES OF LIPASE ACTION

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IV. THE INACTIVATION OF MILK LIPASE BY HEAT

In a previous paper (6), a method was described for following the lipolysis of milk fat by direct titration of the fatty acids in the fat itself. This method seemed particularly suitable for a study of lipolysis in butter as related to time and temperature of pasteurization, since it yielded definite numerical data, and the experiment could be continued for a long period of time, thus revealing the presence of very small amounts of lipase.

Several investigators have studied the thermal destruction of lipase (12, 10, 13, 3, 11, 5, 9) but, in many cases, their methods have been indirect and less sensitive than the method now available.

EXPERIMENTAL

Six series of samples were prepared on six successive days. In each case, the milk was obtained in the morning from the same group of eleven cows which were known to produce milk high in lipase activity. The mixed milk was separated, without cooling, at 91° F. (33° C.) to yield a cream containing 20 per cent of fat. This cream was heated in a water bath to a predetermined temperature (different on each day) and portions were removed after various periods of holding. These portions were stored in ice water for twenty-four hours, and then churned at 58° F. (14° C.) in a battery of motor driven churns immersed in a constant temperature bath.

The butter samples were washed and stored unsalted, in sterile jars. Samples were removed periodically for the determination of free fatty acids. At the end of 58 weeks, the experiment was concluded and Professor E. S. Guthrie was asked to score the butter samples.

The storage temperature was not uniform during the entire period. During the first six weeks and the last eighteen weeks, the butters were held at 0° to 8° F. During the remainder of the period they were held at 28° to 32° F.

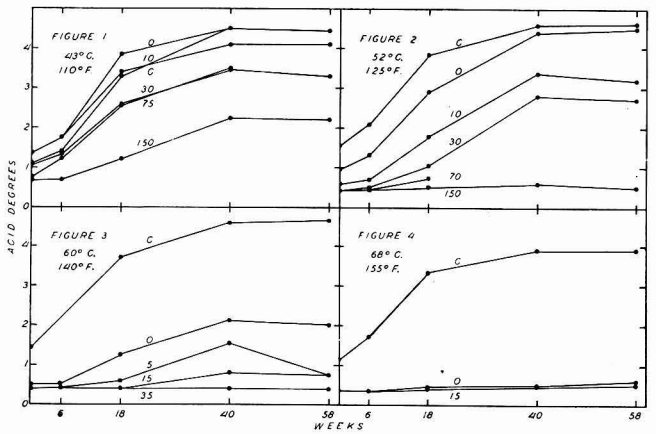
DISCUSSION

Figures 1 to 4 show the progress of lipolysis in these samples. The data for the higher temperatures, 170° F. (77° C.) and 180° F. (82° C.), are omitted because no appreciable lipolysis occurred in any of the samples heated to these temperatures. The slight increase (about 0.2 acid degrees) observed in all of the highly heated samples is possibly due to the normal hydrolysis of fat in contact with water, even in the absence of an enzyme.

Received for publication December 4, 1941.

These data indicate that the destruction of lipase is quite rapid at 155° F. (68° C.). At 140° F. (60° C.), 125° F. (52° C.), and at 110° F. (43° C.), the destruction is slower, and clearly related to the time of exposure to heat. These results are in substantial agreement with those of other investigators.

The curves of figure 1 show an acceleration in lipolysis after six weeks of storage and a cessation after forty weeks. This is apparently due to the change in storage temperature at these times. The data indicate that lipase in butter is inactive at very low temperatures (0° to 8° F.) but active at 28° to 32° F.



FIGS. 1–4 The relation between the temperatures of preheating (°F.) and the length of time (0, 5, 10 . . . 150 min.) the cream was held at various temperatures and the subsequent lipolysis of butter during storage. Storage temperature from the 6th to 40th week was 28° to 32° F.; at other times 0° to 8° F. (Symbol "C" on the graphs indicates unheated samples.)

The initial acid degrees of the unheated samples are above the normal values for fresh milk (6). These high values are due to the agitation during churning, since agitation is known to accelerate lipase action. The high initial values of many of the samples are due to the stimulating effect of agitation upon lipolysis (8). The liberation of free acid during churning had a marked effect upon the churning time (7). For example, in the case of the samples held at 125° F., the churning times were 80, 65, 50, 43, 45, and 43 minutes, while the initial acid degrees of the butters were 1.56, 0.94, 0.58, 0.42, 0.40 and 0.41, respectively.

Table 1 shows the relation between the time and temperature of holding and the acid degree and score of the butter after 58 weeks' storage. The rancid samples are indicated by italics. Some of the other samples were scored down because of a "musty" flavor. These data indicate that a rancid flavor appears in butter between acid degrees of 0.75 and 2.0. The lower

TABLE 1

The acid degrees and judges' scores after 58 weeks in storage

Rancid samples are indicated by italicized scores

Holding temperature	Not heated	Heated, not held	Held 10 minutes	Held 30 minutes		Held 150 minutes
	degree score	*degree score*	*degree score*	*degree score*		*degree score*
110° F.	4.45 — *86*	4.75 — *85*	4.75 — *84*	3.57 — *84*		2.50 — *87*
125° F.	4.62 — *84*	4.50 — *84*	3.20 — *84*	2.70 — *84*		0.50 — 91
			Held 5 minutes	Held 15 minutes	Held 35 minutes	Held 75 minutes
140° F.	4.65 — *84*	2.00 — *84*	.75 — 88	.75 — 91.5	.40 — 92	
155° F.	3.91 — *84*	.59 — 90	.59 — 92	.50 — 92	.45 — 93	.45 — 92
170° F.	4.70 — *85*	.60 — 88	—	.62 — 88	.62 — 88	.62 — 91
180° F.	3.89 — *87*	.40 — 93	.45 — 92	.47 — 92	.44 — 92	.47 — 92

value is believed to be nearer the threshold of rancidity as determined by flavor.

Data have been published recently which show no relation between fat acidity and organoleptic rancidity (4). However, in that study a variety of agents may have been responsible for the rancidity of different samples. In these experiments, involving a uniform substrate and only the enzymes of the milk itself, the two measures of lipolysis seem closely related.

SUMMARY

Butter samples were churned from fresh cream held at 110°, 125°, 140°, 155°, 170°, and 180° F., for periods of time ranging from 0 to 150 minutes. The rate of lipolysis during storage was measured by titration of free acids in the fat.

At 110° F., lipolysis was first activated and then reduced as the holding time was increased. The rate was reduced about $\frac{2}{3}$ by holding 150 minutes.

At 125° F., the rate of lipolysis was reduced about $\frac{1}{2}$ after 20 minutes (estimated) but it was still measurable after 150 minutes.

At 140° F., the rate of lipolysis was reduced more than half at zero holding time. The rate was measurable with a holding period of 15 minutes but not after 35 minutes.

At 155° F., the rate of lipolysis was scarcely measurable after zero minutes of holding.

V. THE EFFECT OF STORAGE TEMPERATURE UPON LIPOLYSIS IN BUTTER

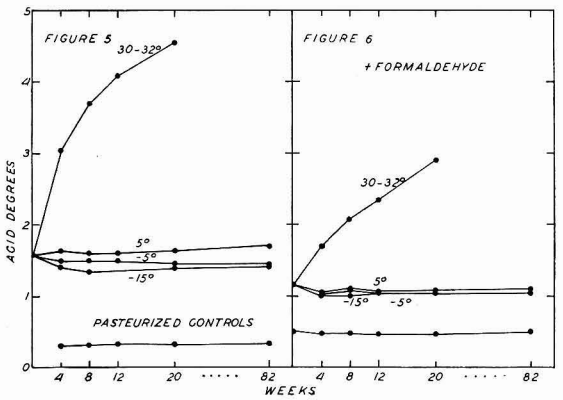
It has been reported that lipases may be active at temperatures as low as −30° C. (1). The rate of lipolysis is dependent upon the nature of the fat (1, 8), and possibly upon the nature of the enzyme. For that reason, it seemed worth while to test the action of the natural lipases of milk upon milk fat at such low temperatures as might be used for the storage of butter, to learn if their action continued at temperatures below 0° C.

EXPERIMENTAL

It was desired to study the formaldehyde sensitive (6) and the formaldehyde tolerant enzymes separately. Consequently, two groups of cows were selected from the University herd. The first produced milk relatively rich in the formaldehyde sensitive enzyme. (The extent of lipolysis during 24 hours was reduced 84 per cent by 0.1 per cent by volume of formalin.) The second group produced milk relatively rich in the formaldehyde tolerant enzyme. (Lipolysis was reduced only 44 per cent by 0.1 per cent by volume of formalin.) When formaldehyde was added to the milk of this second group of cows, subsequent lipolysis could be attributed entirely to the formaldehyde tolerant enzyme. Lipolysis in milk of the other group could be

attributed chiefly, though not entirely, to the sensitive enzyme. Unsalted butters were prepared from these two types of milk, with care to avoid bacterial contamination. Each lot of butter was divided and packed into sterile glass tubes. A number of samples of each of these butters was then stored in a commercial cold storage warehouse, at a series of temperatures, approximating – 15° F., – 5° F., 5° F., and 30–32° F. At the same time, portions of the two milks were pasteurized at 155° F. for 30 min., and control samples of pasteurized butter were prepared and stored in the same way.

Samples of butter were removed from storage at intervals and the acid degree was determined. All samples showing any evidence of mold were discarded. The data are presented in figures 5 and 6. Due to an oversight,



FIGS. 5 and 6. The rate of lipolysis in unpasteurized butters stored at – 15° F., – 5° F., 5° F. and 30–32° F. FIG. 5. Butters prepared from milk in which the sensitive enzyme was predominant. FIG. 6. Butters prepared from milk in which the formaldehyde sensitive enzyme had been destroyed.

the control samples of raw butter were not pasteurized promptly. This accounts for the fact that the initial values recorded are higher than the values for the stored samples. Although this was unfortunate, it does not invalidate the remaining data.

The data for the pasteurized samples are not shown in detail, because all samples of each pasteurized butter yielded the same values (within experimental error) regardless of the time, or temperature of storage. It should be noted that the 30–32° C. series of pasteurized samples was discarded after 20 weeks because all of the remaining samples showed evidence of mold growth.

These data indicate that, in sweet cream butter, the natural lipase of the milk are not appreciably active at temperatures of 5° F. or lower. It seems probable that this sharp reduction in rate is due to the freezing of the water present in the sample. If that is the case, then the slight increase in acidity

which appeared during the first part of the storage period may be explained by assuming that the water dispersed through the fat does not freeze promptly, but remains in a super-cooled state for varying periods of time. Despretz and also Dufour have demonstrated that water may be cooled to $-20°$ C. ($-4°$ F.) without freezing (2). It seems quite likely that much of the water in the samples stored at 30–32° F. never did freeze during the storage period.

SUMMARY

Samples of unsalted sweet cream butter were stored at a series of temperatures ranging from 32° F. to $-15°$ F. for more than one year. The extent of lipolysis was measured at intervals by titration of the free acids in the fat. The data indicate that, in butter, lipolysis by the natural lipases of milk is inhibited at 5° F. or lower, though they are active at 30–32° F.

The data do not reveal any difference in the abilities of the formaldehyde tolerant and the formaldehyde sensitive enzymes to act at low temperatures.

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STUDIES OF LIPASE ACTION. VI.

THE EFFECT OF LIPOLYSIS UPON THE FLAVOR SCORE OF MILK

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In a previous paper (3) it was shown that the very early stages of lipolysis in milk could be followed by titrating the free acids in the fat. Since that time, a great deal of data has been accumulated in terms of fat acidity, and it seemed desirable to interpret these data in terms of flavor, if possible. In particular, we wished to know the "acid degree" at which rancidity could first be recognized as such and, second, we wished to learn the rate at which a judge would reduce the score of the milk as the acidity of the fat increased.

It should be noted that these experiments deal only with lipolysis caused by the natural enzymes of milk. They are not comparable with the experiments of others involving the lipases of bacteria, or molds, or the possible destruction of free fatty acids by microorganisms (1, 2, 5). On the other hand, it is believed that the changes reported here are comparable with those occurring in fluid milk on its way to market.

In this investigation it was desired to obtain judges' scores on a large number of samples of milk of different degrees of rancidity. In order to obtain these samples, the following plan was adopted. Three lots of milk were obtained at milking time from selected cows. The first lot was known to be very low in lipolytic activity, the second was moderately active, while the third was very active. Each of these lots of milk was sub-divided into three portions. One was pasteurized, the second was left in its natural state, while the third was activated by temperature treatment (4) to increase the rate of lipolysis. It was believed that this procedure would yield samples undergoing lipolysis at six different rates.

Eight one-pint samples from each lot of milk were stored at 0–5° C., and one bottle from each set was scored each hour. Immediately after the samples were scored, the remainder of each sample was pasteurized to prevent further lipolysis, and saved for analysis.

The scoring was done by Professor E. S. Guthrie and Mr. S. N. Friedman. In most cases, the samples were examined by both judges but at a few times only one judge could be present. The numbers on the samples gave the judges no indication of the relation between the samples of one set and the samples examined an hour earlier.

Before examining the data, it should be noted that all samples were less

Received for publication December 4, 1941.

than nine hours old when tasted by the judges, and that the milk samples had been held at less than 5° C. during almost the whole of that time.

As the judges recorded their scores, they often added comments such as feedy, old, bitter, etc. Of the terms used, "slightly rancid," "bitter," "rancid," and "bitter-rancid" seemed to refer to some degree of lipolysis. A tabulation of the acidities of the samples described by these terms is shown in table 1. This tabulation shows that the threshold at which rancidity can be recognized is near an acid degree of 0.8. Of twenty-eight samples exceeding this value, only six escaped recognition as rancid; of twenty-seven samples having acid degrees between 0.4 and 0.79, only eight were recognized as rancid. The exact threshold value will, of course, depend upon the presence or absence of other flavors, and upon the individual judge. It may also depend upon the fat content and its composition.

TABLE 1

The frequency with which certain terms were applied to milk containing fats of different rancidities

Acid degrees	Term used			
	"Bitter-Rancid"	"Rancid"	"Slightly Rancid"	Other terms
0.0 – 0.39	.....	.....	1	54
0.4 – 0.79	.....	1	7	19
0.8 – 1.19	.....	3	2	6
1.2 – 1.59	4	.....	1	.....
1.6 – 1.99	4	1	.....	.....
2.0 – 2.39	2	.....	.....	.....
2.4 – 2.79	1	.....	.....	.....
2.8 – 3.19	3	.....	.....	.....
3.2 – 3.59	1	.....	.....	.....

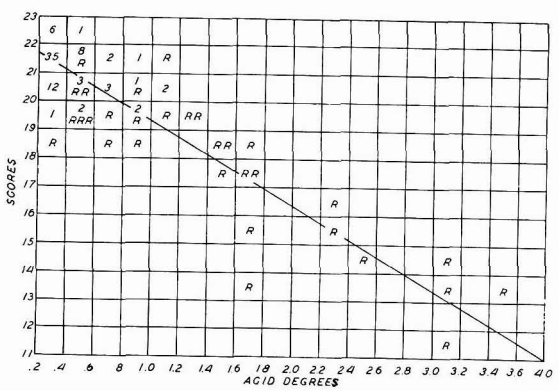

FIG. 1. The frequency with which different scores were assigned to milks containing fats of different acidities. (Samples falling on dividing lines were considered in lower group.) Symbols 1, 6 . . . 35 indicate number of samples escaped recognition as rancid; R indicates one rancid sample.

The relation between the scores reported by the judges and the acid-degree of milk-fat is shown in figure 1. The relationship between lipolysis and the score is quite apparent; in fact, for this particular pair of judges, the relationship appears to be linear. The method of least squares yielded the relationship: flavor score = $22.32 - 3.00 \times$ acid degrees.

These data seem to indicate that judges may lower the score of milk, as a result of lipase action, even before the nature of the defect can be recognized. This seems of practical importance because the degree of lipolysis in some commercial milks (3) is such as to place them in this region where judges may cut their scores without being aware of the real reason for so doing.

It seems of interest to note that no sample having an acid degree above 1.4 received a flavor score above 19.

SUMMARY

A study was made of the relationship between the judges' scores and the "acid degrees" of raw milk within a few hours after milking.

The data indicate a threshold value for the recognition of rancidity at acid-degrees near 0.8. They also indicate that very slight degrees of lipolysis, such as is common in commercial market milk, may influence a judge's score without his being aware of the reason.

In the case of this particular pair of judges, and milk supply, statistical analysis shows that an increase of 0.33 acid degrees corresponded to a decrease of one point in the flavor score of the milk.

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STUDIES OF LIPASE ACTION. VII. THE INFLUENCE OF THE RATE OF COOLING UPON THE SUBSEQUENT RATE OF LIPOLYSIS IN MILK STORED AT LOW TEMPERATURES

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In a previous paper (1), we reported that the rate of lipolysis in milk during storage at low temperatures was greatly influenced by the speed with which the milk had been cooled. By very rapid cooling, the rate of lipolysis during storage was reduced to a third of the value observed when the milk had been cooled more slowly.

Because of the possible value of this phenomenon in controlling rancid and bitter flavors in milk, it was subjected to further investigation. Our observations are reported here.

METHODS

The extent of lipolysis in the different samples was measured by titrating the free acids present in the fat, using the same procedure as before (1). Our results are reported in acid degrees, that is the number of ml. of normal alkali required to neutralize the acid in 100 grams of fat. All samples were pasteurized before churning.

The tubular cooler, used for rapid cooling, consisted of a spiral tube immersed in 25 liters of crushed ice and water. The spiral was made from a 12 foot (3.66 meter) length of $\frac{3}{8}$ inch (.95 cm.) outside diameter aluminum tubing. The portion of the tube immersed in the bath had a capacity of 120 ml. Unless stated otherwise, samples cooled in air, or in ice water, were cooled in $\frac{1}{2}$ pint bottles without agitation.

EXPERIMENT I

As a check on our previous work, a sample of mixed milk, representing a herd of about 80 cows, was taken at milking time and divided into four parts. The first, a control sample, was pasteurized at once, the second was cooled in air at 0° C., the third was cooled in crushed ice and water, and the fourth was cooled to 5° C. with the tubular cooler. When the temperature of each sample reached 5° C., it was transferred to a constant temperature cabinet and held at 5° C. for 48 hours.

The relative speeds of lipolysis are shown by the *increase* in acid degrees of the three samples: air cooled, 0.41; water cooled, 0.37; tube cooled, 0.06. These results are in agreement with our previous observations, though the milk shows less lipase activity.

Received for publication December 4, 1941.

In other experiments we have observed that either the water-cooled or the air-cooled milk may show the greater degree of lipolysis. We suspect that there may be a critical rate of cooling which results in a maximum degree of lipolysis. This rate may depend upon the nature of the milk. This matter has not yet been studied.

EXPERIMENT II

Since rapid cooling seemed to retard lipolysis in raw milk, it was thought worth while to study several rates of cooling in the high speed range.

The experiment presented some difficulties. At first, we proposed to raise the coil part way out of the cooling bath, and then reduce the rate of flow of the milk until we obtained the same final temperature as before. However, this procedure had to be rejected because it would not reduce the rate of cooling of individual particles of the milk. The reduction in speed of flow would almost exactly compensate for the reduction in length of the refrigerated portion of the coil, and the time required for an individual particle of milk to pass over the cold surface would not be changed.

In order to reduce the rate of cooling, we finally coated the tube with a film of paraffin. We were able to secure several rates of cooling by applying coatings of different thicknesses. In each case, the rate of flow was so adjusted that the milk leaving the coil had a temperature of 2° C. $\pm \frac{1}{2}$°. These samples were stored at 5° C. for 48 hours. Samples of the same milk were cooled in air and in water for comparison with those cooled more quickly. The data are shown in table 1.

TABLE 1

The relation between the speed of cooling and the extent of lipolysis during 48 hours' storage at 5° C.

Method of cooling	Time from 33° to 2° C.	Increase in acid degree
Tube	26″*	0.15
Tube	35″*	0.15
Tube	1′ 42″*	0.16
Tube	2′ 35″*	0.21
Tube	2′ 45″*	0.21
Bottle in water	25′	0.73
Bottle in air	140′	0.55

* Actually the time required to discharge a volume equal to the capacity of the coil.

These data are in agreement with all previous observations that the rate of lipolysis is reduced when the milk is cooled very rapidly, and they suggest that a greater reduction might be obtained by a further increase in the rate of cooling.

In order to test this, a new coil was constructed from smaller tubing. The two coils were mounted side by side in the same tank of crushed ice and water. The rates of flow were so adjusted that the milk leaving each coil had

a temperature of 2° C. ± ½°. The average cooling time was calcuated from the known capacity of the coil and the time required to collect a ½ pint sample.

Three separate lots of milk were obtained at milking time and parts of each were cooled in each coil. At the same time, ½ pint samples were cooled in air and in water for purposes of comparison. The data are shown in table 2.

TABLE 2

The relation between the speed of cooling and the extent of lipolysis during 48 hours' storage at 5° C.

	Milk No. 1	Milk No. 2	Milk No. 3
Cooled in water			
Minutes from 32°–2° C.	25	25	25
Increase in acid degree	2.11	1.30	0.77
Cooled in air			
Hours from 32°–2° C.	2	2	2
Increase in acid degree	1.34	0.33	1.39
Cooled in large tube			
Seconds from 32°–2° C.	35	32	30
Increase in acid degree	0.99	0.19	0.23
Cooled in small tube			
Seconds from 32°–2° C.	10	8.5	8.5
Increase in acid degree	0.84	0.14	0.12

EXPERIMENT III

In the experiments reported hitherto, we used natural milk, that is, milk which had not been activated by temperature changes (2). It seemed worth while to determine whether the speed of cooling was a factor in the activation process.

Since "activation" consists of 1. cooling the milk, 2. warming the milk, and 3. recooling the milk, there are two steps in the process where the rate of cooling might be important. In order to study both of these, the following procedure was used.

Approximately thirty liters of warm mixed milk was collected at milking time and divided into three equal parts. One was cooled at 5° C. by passing it through the larger coil, the second was cooled in an aluminum can immersed in ice water, the third was cooled in an aluminum can in air at 0° C. After cooling, each lot was warmed to 30° C. and samples from each lot were cooled in air, and in water. These samples were stored at 5° C. for 48 hours and then examined. The *increase* in free fatty acid during storage is shown in figure 1. Part A shows that, regardless of the method used for the first cooling, the rate of lipolysis was practically the same for all samples cooled in air after warming to 30° C. Part B shows that, regardless of the method used for the first cooling, the rate of lipolysis was approximately the same for all samples cooled in water after heating to 30° C. A comparison of parts

A and B shows a small difference in favor of the air cooling. This small difference has been observed in practically all of our experiments.

In order to show more clearly the effect of rate of cooling during the final stage of the activation process, one lot of milk was pre-cooled to 5° C. in the tube, warmed to 30° C. and then parts of it were cooled by all three methods. The samples were examined after 48 hours' storage at 5° C. The *increases* in

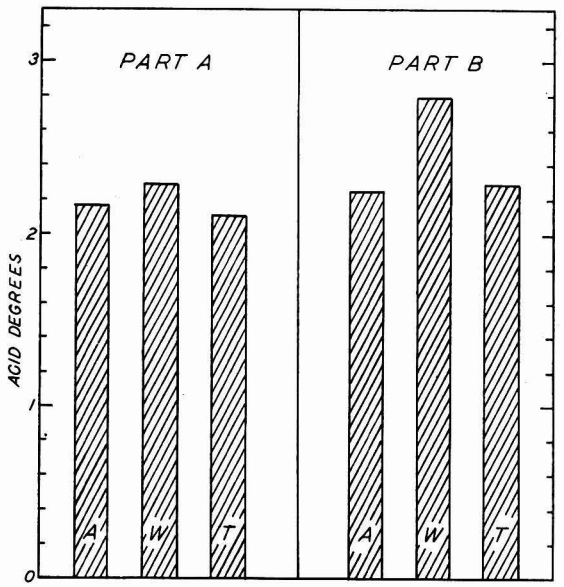

FIG. 1. The effect of the method of precooling upon the rate of lipolysis after temperature activation. Part A, final cooling in air; part B, final cooling in water. (A, precooled in air; W, precooled in water; T, precooled in tubular cooler.) The chart shows *increases* in acid degrees during 48 hours at 0° C.; the initial values have been subtracted.

fat acidity were: Cooled in air, 2.11°; cooled in water, 2.29°; cooled in tube 0.23°. These data are similar to those obtained with unactivated milk but they are much greater in magnitude. They suggest that rapid cooling is even more effective in retarding lipolysis in activated milk than in natural milk.

EXPERIMENT IV

Our experiments have shown that lipolysis at low temperatures can be retarded by cooling rapidly from about 33° C. (as the milk reached the laboratory) to about 5° C. We wished to learn whether it is necessary to cool rapidly throughout this entire range, or whether there is only a narrow range of temperatures in which rapid cooling is essential.

This problem was resolved into two parts: (1) is there an upper range of temperatures where the rate of cooling has little effect, and (2) is there a

lower range of temperatures where rate of cooling has little effect. The second question was studied first.

A supply of fresh warm milk was cooled rapidly from 33° C. to various lower temperatures by passage through the tubular cooler. Each of these samples was subdivided and the cooling to 5° C. was finished more slowly. One part was cooled in water, the other in air. The samples were examined after 48 hours, and the data are shown in figures 2-A and 2-B respectively.

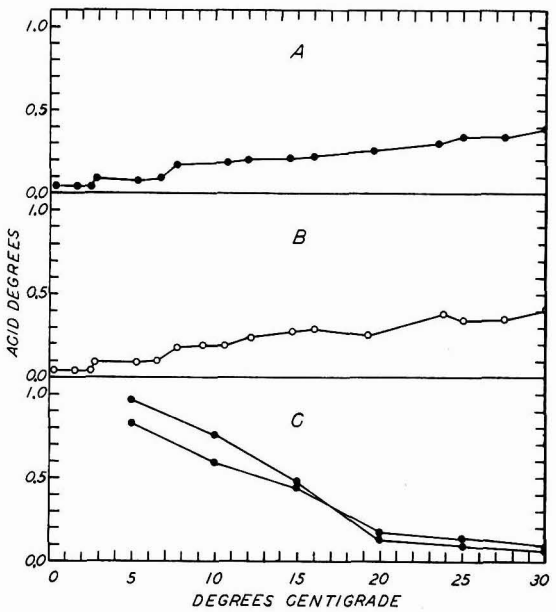

FIG. 2. Parts A and B, lipolysis during 48 hours at 5° C. in normal milk samples cooled quickly to the indicated temperatures and then slowly (in water -A, or in air -B) to the storage temperature; part C, lipolysis during 48 hours' storage at 5° C. in normal milk samples cooled slowly to the indicated temperature and then quickly (tubular cooler) to the storage temperature. The chart shows *increases* in acidity; the initial values have been subtracted.

Within experimental error, the data yield a straight line and cannot be regarded as evidence for a low temperature region where the rate of cooling is unimportant.

In order to answer the other question (Is there an upper range of temperatures where slow cooling is not detrimental?) a supply of fresh warm milk was cooled slowly to various temperatures and then the cooling was completed rapidly with the tubular cooler. The slower cooling was performed by placing the aluminum container in ice water. As usual, the samples were examined after 48 hours at 5° C.

The data for two samples, shown in figure 2-C, reveal that slow cooling in the range from 30° C. to 20° C. is not detrimental. The critical range through which the milk must be cooled rapidly to retard lipolysis extends downward from 20° C.

EXPERIMENT V

The milk used in experiment IV was not activated. The results of experiment III had indicated that the rate of cooling was more important in the case of activated milk. For that reason, experiment IV was repeated with activated milk to determine the critical cooling range for milk of this type.

In order to locate the lower limit of the critical cooling range, about 10 liters of milk was cooled in ice water to 10° C., warmed to 30° C. and then parts of it were cooled rapidly in the coil to various temperatures. The cooling was finished more slowly by cooling part of each sample in ice water and part in air at 0° C. These samples were examined after 48 hours' storage at 5° C.

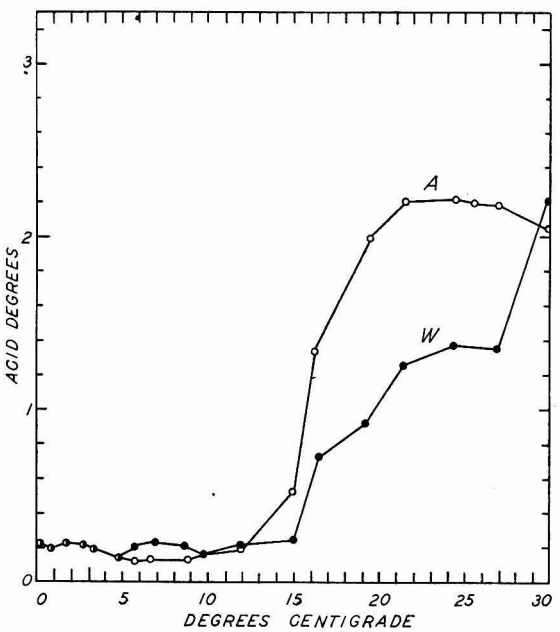

FIG. 3. Lipolysis during 48 hours at 5° C. in activated milk samples cooled quickly to the indicated temperature and then slowly (in air -A, or in water -W) to the storage temperature. The chart shows *increases* in acid degrees.

Figure 3 shows that, in activated milk, the rate of cooling in the range below 12° C. is of much less importance than the rate of cooling in the range

just above that temperature. The importance of cooling rate in this critical region is shown, also, by the spread between the values for the air-cooled and water-cooled samples.

In order to locate the upper limit of the sensitive range, a can of fresh warm milk was cooled slowly in ice water and, at various temperatures, samples were removed which were cooled quickly to $2° \pm ½$ by means of the coil. The data obtained with two different lots of milk are shown in figure 4. They are quite similar to those obtained with unactivated milk

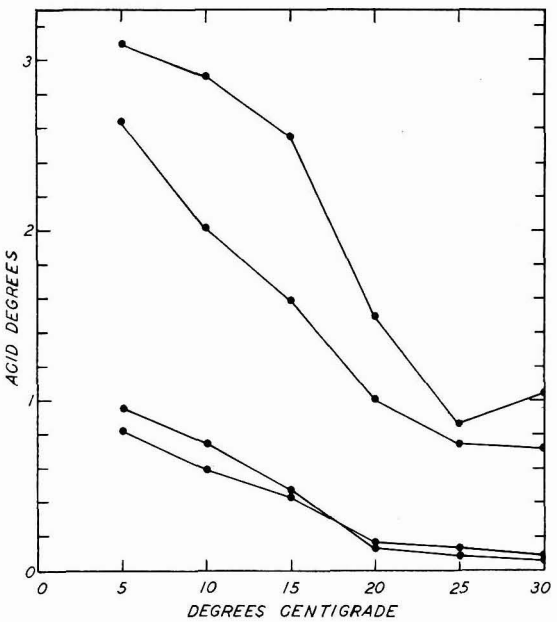

FIG. 4. Lipolysis during 48 hours' storage at 5° C. in activated milk (two upper lines) and normal milk (two lower lines) cooled slowly (in water) to the indicated temperature and then quickly (tubular cooler) to the storage temperature. Only the increase in acidity is shown; initial values have been subtracted.

though the upper limit of the critical cooling range appears to be 25° C. instead of 20° C.

SUMMARY

The rate of lipolysis in milk stored at low temperatures depends upon the rate at which the milk was cooled before the storage period.

To secure a minimum rate of lipolysis, the cooling time should be reduced to a few seconds.

There is a critical temperature range in which the rate of cooling is most

important. The upper limit of this range is approximately 20°–25° C. The lower limit is approximately zero in the case of natural milk, and approximately 10° C. in the case of temperature-activated milk.

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THE RELATION OF THE USE OF CERTAIN ANTIOXIDANTS AND METHODS OF PROCESSING TO THE KEEPING QUALITY OF POWDERED WHOLE MILK*

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The manufacture and utilization of dry milk has greatly increased in recent years as shown by the following production figures of the U. S. Department of Agriculture for the United States:

	1921	1938
Pounds of powdered whole milk	4,242,000	21,496,000
Pounds of powdered skim milk	38,546,000	4,942,000,000

Because milk in its natural form is such a perishable product, the commercial possibilities of dried milk products of good keeping quality have attracted the attention of dairy investigators for a number of years. The use of powdered whole milk and cream has been limited somewhat by certain problems connected with the satisfactory preservation of these products. For example, under certain conditions of storage powdered milk loses its original fresh flavor, decreases in solubility and frequently darkens in color. The most important off-flavor that may develop during storage of dried milk is one involving a chemical change in the butterfat and is termed tallowy or oxidized. The primary purpose of this study was to determine to what extent the antioxidants that have been found to retard or prevent the development of the oxidized flavor in fluid milk products would produce similar results in powdered whole milk. At the same time the relation of certain other factors such as type of container, per cent of moisture, temperature of preheating, and temperature of storage, to the keeping quality of the powdered milks was determined.

REVIEW OF LITERATURE

A great many investigators have studied the problem of oxidized or tallowy flavor in dairy products and the factors pertaining to its development. The terms rancidity and tallowiness have been confused in the literature. Rancidity is a result of the hydrolysis of some of the volatile fatty acids, while tallowiness in dairy products is considered by most investigators (11) to be a result of an oxidation of the fatty substances present.

It has been shown by Holm, Greenbank and Deysher (9) that the clarification of milk before drying results in a definite improvement of the keeping quality of the powder. These same investigators explained the resis-

Received for publication December 9, 1941.

* This study was made possible by a fellowship granted the senior author by the Dairy Industry Supply Association.

tance of skim milk powder to oxidation as the result of the clarification the milk receives during separation. They further state that Supplee (16) reported an increase in resistance to oxidation with an increase in fat content and explain this effect on the centrifugal separation of the cream used in standardizing the milk.

Holm, *et al.*, also suggest that higher than ordinary pasteurizing temperatures (83–85° C. for 30 minutes) improves the keeping quality of whole milk powder. Their results also indicate that there is an improvement in the keeping quality of milk powder when the milk has been homogenized.

Because tallowy flavor is a defect resulting from oxidation of milk fat, it is natural to assume that powders made from whole milk are more susceptible to oxidation than those from skim milk. However, Supplee (16) shows that cream powders were much less susceptible to oxidation than powders with a lower fat content. These results do not agree with those obtained by Holm, Greenbank and Deysher (8).

Experiments by Supplee (16) have demonstrated that the addition of copper salts to milk before drying results in an early manifestation of tallowiness.

Factors such as air, light, temperature and moisture, known to be important in the development of tallowy flavor, have been given consideration in studies on the storage conditions and type of container used in relation to the development of this flavor defect. Holm and Greenbank (7) were able to show a decrease in the rate of oxidation of butter fat when the amount of oxygen in the storage container was reduced. They also point out that the storing of milk powder in inert gases will retard but not prevent the development of tallowiness.

According to the early research of Greenbank and Holm (5) the presence of moisture may retard the rate of oxidation of butterfat at ordinary storage temperatures. Chemical studies of milk fat by Supplee (16), Supplee and Bellis (17), and Holm and Greenbank (4, 10) indicate that oxidation may proceed at an equal rate in high and low moisture powders. From later work Holm, Wright and Greenbank (10) concluded that a high moisture content greatly increases the rate of oxidation, especially at high storage temperatures.

Dahle and Palmer (1) studied the keeping quality of milk powder at different temperatures and found that there was little difference in the powders stored at 4° C. and those stored at 20° C. but there was a marked difference at 37° C. Supplee (16) does not entirely agree with the results of Dahle and Palmer. He found that partially skim milk powder would not develop tallowiness for 18 months at 0° C. but at 20° C. the flavor was noticeable in 5 to 6 months. Holm, Wright and Greenbank (10) found there was no appreciable improvement in keeping quality unless temperatures of below 0° C. are used and that the rate of deterioration goes up rapidly at temperatures above 0° C.

Emery and Henely (2) reported that when lacquered metallic containers were used there was a marked improvement in resistance to oxidation as compared to the plain metal container. Dahle and Palmer (1) did not find any improvement in the keeping quality of milk powder when stored in lacquered tin. They did, however, find that "doubletite" containers prevented the discoloration of the powder at 37° C. and greatly improved the quality at all temperatures.

Supplee (16) and Supplee and Bellis (17) found that when the moisture content was maintained between 3 and 5 per cent there was little change in solubility during storage. Work by Dahle and Palmer (1) indicates that storage at high temperatures results in a marked decrease in solubility. Sharp, Doob and Willmann (14) confirm the results of Supplee, *et al.* and indicate that the browning and marked decrease in solubility of powders is related to a combined effect of moisture and storage temperature. They suggest that a reaction between the lactose and the casein results in the defect.

The effect of antioxidants as a preventive of oxidation in products containing fat have been studied by a number of investigators. Moureau and Dufraisse (12) found that traces of pyrogallol and hydroquinone were effective in preventing oxidation. Grettie (6) found that small amounts of gum guaiac retarded the oxidation of lard and that the antioxidant properties were carried over in bakery goods. He found that this gum produced no toxic effects. Greenbank and Holm (3) found that unsaturated polybasic aliphatic acids are effective as antioxidants and that maleic acid (0.01%) would retard the oxidation of butter oil stored at 42° C. Peters and Musher (13) observed that when 0.25–0.5 per cent of oat flour was added to milk before drying or mixed mechanically with its powder there was a substantial retention of fresh flavor and aroma and oxidation was retarded.

EXPERIMENTAL PROCEDURE

The investigation was divided into five sets of experiments as follows:

a. Use of various antioxidants in whole milk powder.
b. Variations in pasteurizing temperature.
c. Variations in moisture content.
d. Variations in type of container used.
e. Variations in storage temperature.

All milk was received from the University Farm and processed in the stainless steel equipment of the University Creamery.

The milk used in preparation of the samples was processed as follows unless otherwise indicated. The raw milk was preheated to 90° F. and clarified at this temperature, then standardized to 4 per cent fat and pasteurized at 150° F. for 30 minutes. Following pasteurization the milk was

condensed, homogenized at 2,500 lbs. pressure, cooled over a surface cooler and tested for fat by the Mojonnier method.

The milk was dried on a double roll vacuum type drier, equipped with stainless steel pipes, fittings, knives, and rolls. The machine had a capacity of 2–3 pounds of powder per hour. The milk supply tank for the drier consisted of a large Pyrex glass funnel connected to the stainless intake pipe by means of rubber tubing.

In the pasteurizing temperature experiments, the milk was heated and homogenized in stainless steel equipment and then condensed in a laboratory condensing unit. The laboratory condensing equipment consisted of a 22 liter Pyrex glass flask immersed in a hot water bath and connected to a 2 liter suction flask by a 4-foot condenser. The suction flask was connected directly to a water pump and arranged so that vapors and condensate passed out the connecting line, through the water pump and into the drains.

In all experiments the percentage of antioxidants added is given on the basis of unconcentrated 4 per cent milk. The actual additions, however, were made to the concentrated product before drying.

At the time of drying, a solution of $CuSO_4 \cdot 5H_20$ equivalent to 2 p.p.m. of copper, on the weight basis, was added to one-half of each lot of milk in experiments A and D. In experiments B, C, and E, the amount of copper added was reduced to 0.5 p.p.m. All milk was then dried under a vacuum of from 22 to 25 inches. Upon completion of the drying, the powder was ground in an electric food mixer to insure uniformity in particle size.

The following data were obtained on all samples: per cent fat; per cent moisture, peroxide value; solubility, pH of reconstituted sample and flavor of reconstituted sample.

Moisture determinations were made by weighing samples of approximately 1 gram into lead foil dishes with dimension of 5.5 cm. by 1.5 cm. The samples were then heated in the thermostatically controlled vacuum oven of the Mojonnier Tester, under a vacuum of approximately 22 inches, until constant weight was reached. The per cent moisture was then calculated from the loss in weight of the heated samples.

Peroxide values were determined by the method for milk powder as recommended by Smith (15) and the results recorded as M values.[1]

The method of the American Dry Milk Institute (18) was used in determining the solubility index of all powders.

Flavor observations were made on all samples for the degree of tallowiness after reconstitution. The judging was done by the authors assisted by W. J. Corbett. The samples were reconstituted as follows:

Ten grams of the dry milk powder were added to 80 ml. of distilled water which had previously been warmed to 100° F. agitated in a malted milk mixer for 30 seconds then cooled.

[1] M = Millimoles of peroxide per kilogram of fat.

The pH determinations were made on the same sample as was used for the flavor observations.

KEY TO SAMPLES

All samples are designated in the following manner:

Capital letters A, B, C, etc. indicate the experiment.

The various antioxidants are indicated by small numbers 1, 2, 3, etc. and are as follows: 1—Butyl ester of the amino acid tyrosine; 2—Hydroquinone; 3—Gum guaiac; 4—Avenex; 5—Enzylac; 6—Ascorbic acid; 7—Sodium citrate; 8—*S. lactis* starter; 9—Control.

Numbers accompanied by a small c such as 1c, 2c, 3c, etc. indicate an addition of copper to the milk before drying.

Different types of containers are designated as follows: p—plain cardboard; pp—paraffined cardboard; ap—Avenized paper bag; t—plain tin container (friction cap); ct—sanitary enameled (lacquered) tin container (sealed).

EXPERIMENTAL RESULTS

Use of Antioxidants

Raw milk with an acidity of 0.17 per cent was processed in accordance with the general plan and condensed to a ratio of 3.59 : 1.

The weights of the various antioxidants were figured on the basis of 4 per cent milk and the following concentrations were made:

1. Butyl ester of tyrosine	0.03%
2. Hydroquinone*	10 ppm
3. Gum guaiac	5 ppm (dissolved in 5 cc. of ethyl alcohol)
4. Avenex (#9)	0.25%
5. Enzylac	1 part per 25,000 parts of milk
6. Ascorbic acid	0.01%
7. Sodium citrate	0.20%
8. *S. lactis* starter	1 ml per pound
9. Control	No additions

With the exception of the Avenex, Enzylac and *S. lactis* starter, all antioxidants were added at the time of drying. In the case of these products the treated milks were stored at 40° F. for 6–8 hours before drying.

The required weight of Avenex flour was made into a gruel with 50 ml.

* Although a patent has been granted Nitardy (Nitardy, F. W., U. S. Patent No. 1,879,762, Sept. 27, 1932) for the use of hydroquinone as an antioxidant in fat soluble vitamin concentration, the American Medical Association has not approved its use in this manner because of its toxic effect. (Jour. Amer. Med. Assoc., 109: 1454. 1937). The legality of adding any antioxidant material to milk before drying would need to be established before its use could be recommended. The authors' interest in the products studied was mainly scientific, though the practicable possibilities of a study of this nature must always be recognized.

of hot H_2O and then added to the milk. The bottom portion containing the Avenex residue was not included with the milk that was dried.

The Enzylac powder was added to the previously pasteurized and condensed milk at a temperature of from 95°–100° F. The milk was then heated to 150° F. as rapidly as possible and held at that temperature for 30 minutes to inactivate the enzyme.

The *S. lactis* starter was added at the rate of 1 ml. per pound of milk which was then held at 70° F. until an increase of 0.02 per cent in titratable acidity was obtained. Copper sulphate was added to half of each sample as explained under experimental procedure. Sixty grams of each lot of powder, with and without copper, was then packed in a 4 oz. brown glass bottle and sealed with a screw cap. No attempt was made to regulate the moisture content of the powders. All samples were stored at room temperature (thermostatically controlled at 72° F.) and were examined at regular intervals. The fat content of a composite sample of the powders in this experiment tested 29.31 per cent.

TABLE 1

Degree of tallowy flavor in relation to various antioxidants

Sample	Number of days in storage at room temperature					
	45	72	101	134	191	231
	Degree of tallowy flavor*					
A 1	.....	1	2	1	3	5
1c	2½	7	5	6	6	7
2	.....	1	.....	1	3	3
2c	1	2½	2	3	2½	5
3	..... **	.....	.....	.....	.....	.....
3c	½	2	3	3	3	6
4	.....	2	3	2	4	3
4c	3	8	8	9	8	8
5	rancid	rancid	rancid	rancid	rancid	rancid
5c	1	6	5	9	7	7
6	.....	½	1	1	3	3½
6c	1½	4	2½	3	4	5
7	..... ***	½	.....	1	2	4
7c	3	3	4	5	5	7
8	.....	½	3	1	2	4
8c	5	8	10	10	7	7
9	1	½	2	2	3	4½
9c	3	4	5	6	7	7

* The numbers 1, 2, 3, etc., indicate an increasing degree of tallowy flavor.
** All gave slight gum flavor.
*** Slightly salty.

The data in table 1 and figures 1–8 offer evidence that the development of the tallowy flavor in powdered whole milk can be retarded and prevented by the addition of antioxidants. Of the various antioxidants used gum guaiac was the most effective (fig. 3). When this compound was present in powders containing no additions of copper, the powder was still free from tallowy flavor after storage for 231 days at room temperature, while the con-

trol had developed the flavor defect by the end of 45 days. With the addition of 2 ppm of copper, the powder developed the tallowy flavor after 45 days but the degree of oxidized flavor in the control samples was much worse with the same period of storage. The intensity of the off-flavor in the control samples increased rapidly, while paired samples containing gum guaiac showed a much slower rate of the oxidized flavor development.

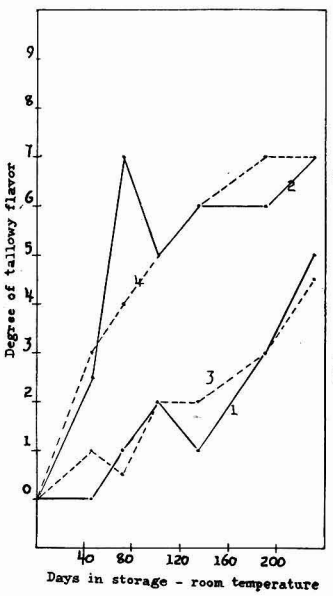

FIG. 1. Effect of the butyl ester of tyrosine on tallowy flavor development.
Legend to curves:
1. Butyl ester of tyrosine
2. Butyl ester of tyrosine —with added copper
3. Control
4. Control — with added copper

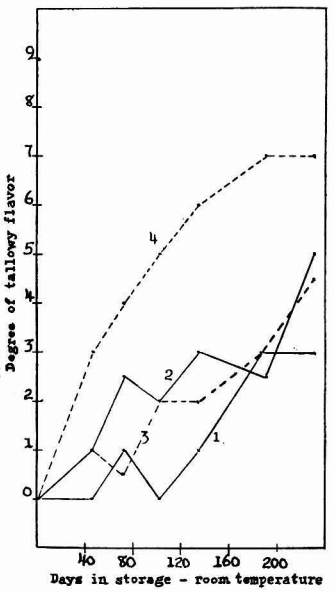

FIG. 2. Effect of hydroquinone on tallowy flavor development.
Legend to curves:
1. Hydroquinone
2. Hydroquinone — with added copper
3. Control
4. Control — with added copper

Hydroquinone, ascorbic acid and sodium citrate (figs. 2, 6 and 7) were also effective in retarding the development of the tallowy flavor in powders with and without copper.

Avenex did not prevent or retard the flavor defect in samples containing copper although the Avenex samples which did not contain copper were free from tallowy flavor for the first 45 days, while the control sample had a noticeable off flavor.

Powder without added copper prepared from milk inoculated with small amounts of *S. lactis* starter, developed tallowy flavor at a slower rate than

did the control, but samples containing copper became tallowy at a more rapid rate than the control sample to which copper had been added.

Powder made from milk to which Enzylac (fig. 5) had been added before drying developed a disagreeable rancid flavor. Samples that were extremely rancid developed no detectable tallowiness; however, when there was only a slight amount of rancidity tallowiness was evident. Samples containing copper were more oxidized in flavor than the control samples. It is inter-

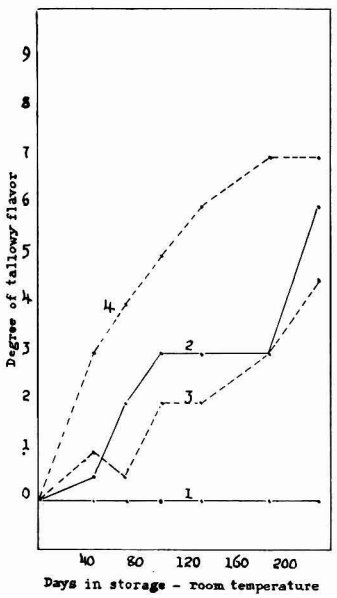

FIG. 3. Effect of gum guaiac on tallowy flavor development.
Legend to curves:
1. Gum guaiac
2. Gum guaiac — with added copper
3. Control
4. Control—with added copper

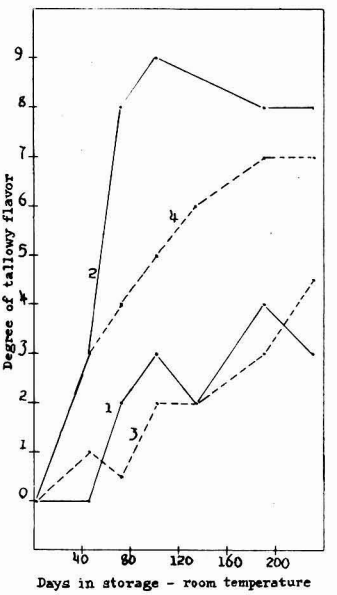

FIG. 4. Effect of avenex on tallowy flavor development.
Legend to curves:
1. Avenex
2. Avenex—with added copper
3. Control
4. Control—with added copper.

esting to note that the more tallowy the flavor the less tendency there was for rancidity to develop and vice versa.

It will be noted that there were some instances of slight decreases in flavor intensity which occurred in some samples from one period of examination to the next. Such discrepancies are to be expected, however, because of the chances for error that may be encountered in obtaining data based upon flavor ratings made at different time intervals. The olfactory sense was used in detecting the tallowing flavors and this makes it difficult to

obtain consistent results on the intensity of the flavor defect from time to time.

Moisture determinations were made on all powder samples but no definite correlation was obtained between the percentage of moisture and the degree of tallowy flavor. The moisture content of the powders probably was not high enough in any of the samples to hasten the flavor deterioration. This is in keeping with the results obtained by other investigators who have found that moisture is not a factor in the deterioration of milk powders until the amount present exceeds 5 per cent.

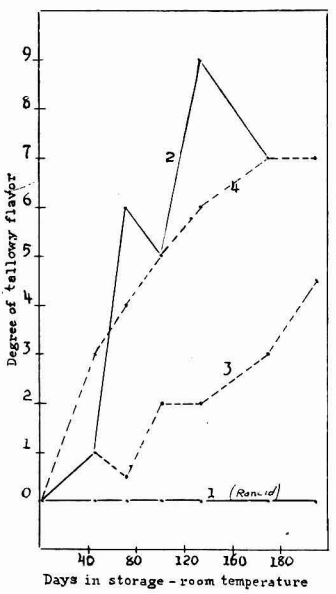

FIG. 5. Effect of Enzylac on tallowy flavor development.
Legend to curves:
1. Enzylac
2. Enzylac—with added copper
3. Control
4. Control—with added copper

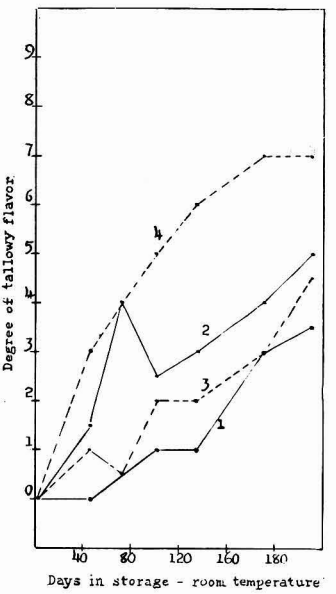

FIG. 6. Effect of ascorbic acid on tallowy flavor development.
Legend to curves:
1. Ascorbic acid
2. Ascorbic acid — with added copper
3. Control
4. Control—with added copper

A slight decrease in moisture content was noted after the first month of storage. This is likely due to the moisture content of the powders not having reached equilibrium at the time the powders were placed in the glass sample bottles. After that initial change the other differences in moisture value were in most cases within the range of experimental error for this type of determination. Under the conditions of this experiment where the

moisture content of the powders varied from a low of 2.32 to a high of 6.64 per cent and the temperature of storage remained constant at approximately 72° F., there was, in general, no significant effect of any of the variables studied on the solubility of milk powders. It should be noted, however, that in the case of samples containing sodium citrate, there is marked evidence that the presence of this salt causes an increase in solubility of the milk powder.

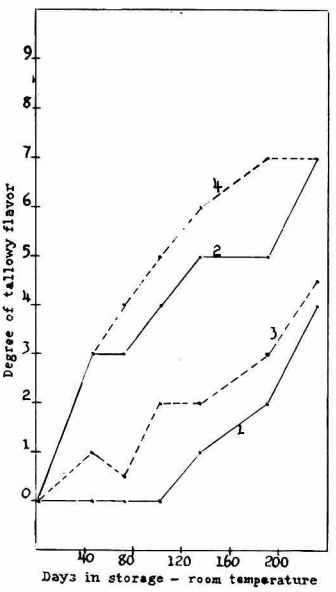

FIG. 7. Effect of sodium citrate on tallowy flavor development.
Legend to curves:
1. Sodium citrate
2. Sodium citrate—with added copper
3. Control
4. Control—with added copper

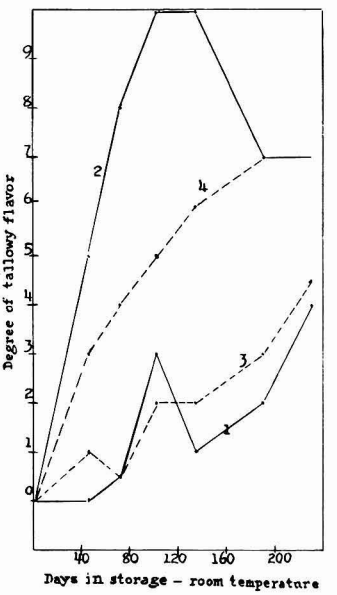

FIG. 8. Effect of bacterial culture on tallowy flavor development.
Legend to curves:
1. *S. lactis* starter
2. *S. lactis* starter—with added copper
3. Control
4. Control—with added copper

Peroxide values have been used with some success in determining the extent of oxidation of fats and oils and it was thought that perhaps it might be possible to follow the oxidation of fat in the milk powders by a chemical as well as an organoleptic method. It will be noted from figures 9, 10, 11, and 12 (plotted from data in tables 1 and 2) that no samples gave a peroxide value until after 40 days of storage. It should also be noted that at the end of 45 days only one sample gave a degree of oxidized flavor of more than 5. Further, after 72 days peroxide values were obtained for 4 of the 6 samples that had a tallowy flavor intensity of 5 or more. In gen-

eral, the tendency was to obtain a peroxide value when the degree of tallowiness in the samples was 5 or greater. At the end of 185 days of storage, two samples which had previously given peroxide values (samples 1c and 6c) no longer did so. Also the peroxide values had increased in some samples and decreased in others. One fact that can be noted is that the

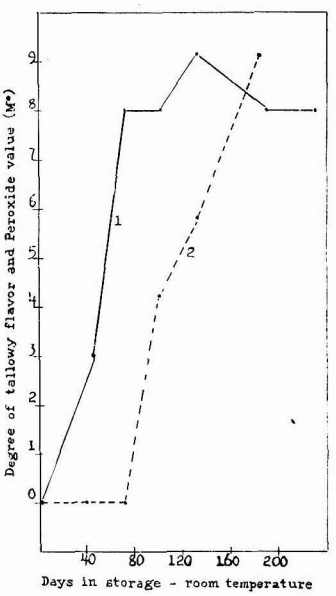

FIG. 9. Correlation between degree of tallowy development and peroxide value. (Avenex with added copper.)
Legend to curves:
1. Degree of tallowy flavor
2. Peroxide value (M) see experimental procedure

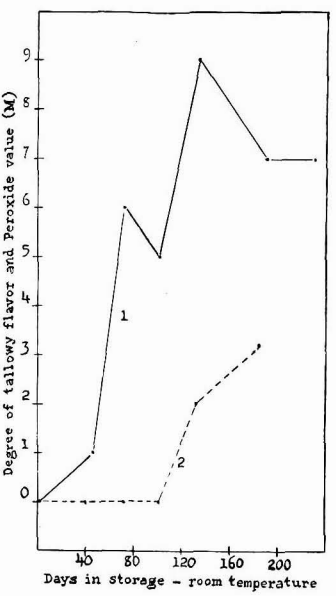

FIG. 10. Correlation between degree of tallowy flavor and peroxide value. (Enzylac with added copper.)
Legend to curves:
1. Degrée of tallowy flavor
2. Peroxide value (M)

tendency previously noted for peroxide values to be obtained only on samples rating 5 or higher in flavor score is not confirmed, as no samples without copper gave a degree of tallowiness of more than 5. It is evident from these data that the olfactory method of detecting tallowiness is more sensitive than the chemical method used in this experiment. The results obtained indicate that peroxide values are not suitable for detection of early oxidation but the accuracy may increase as the oxidation proceeds.

Hydrogen ion determinations made on the reconstituted milk indicated that all samples fell within the range of normal fresh milk (pH 6.4–6.8). There was no definite tendency for changes in pH during storage. Those

TABLE 2

Effect of storage at room temperature upon peroxide values

Sample	Days in storage					
	Fresh	40	72	101	132	185
	M* Values					
A 1	**					
1c			5.027	0.215	0.319	
2						
2c						
3						
3c						0.665
4						
4c				4.232	5.826	9.141
5						0.229
5c					2.029	3.266
6						
6c			0.575			
7						0.292
7c			1.149	1.392		5.605
8						
8c			2.384	8.035	32.196	7.635
9						0.231
9c					0.813	1.955

$* M = \frac{T \times N \times 500}{W}$ W = gm. of fat. T = ml. of sodium thiosulfate. N = Normality of sodium thiosulfate.

** No values found.

samples that were treated with Enzylac were rancid (pH 6.60–6.65) indicating hydrolysis of the fat and the presence of free fatty acids. The addition of sodium citrate increased the pH to the upper limit (pH 6.8) of normal milk. These results indicate that reconstituted milk made from powder stored for several weeks does not differ much if any from normal milk in pH. It is also evident that the buffer capacity of the milk was not materially affected by the drying or any of the variables studied by this experiment.

Effect of Pasteurizing Temperature

In order to determine the effect of pasteurizing temperature on the keeping quality and physical properties of milk powder, raw milk with 0.165 per cent acidity was processed in the regular manner except that pasteurizing temperatures of 150° F., 170° F. and 190° F. for 30 minutes were used. The lots pasteurized at 170° F. and 190° F. for 30 minutes were condensed in laboratory condensing equipment and that pasteurized at 150° F. in the creamery vacuum pan. At the time of drying, copper at the rate of 0.5 ppm was added to one-half of each lot of milk.

No attempt was made to regulate the moisture content of the powder and all samples were packed in brown glass bottles with screw caps and stored at room temperature.

The fat content of the powders in this experiment was as follows:

Pasteurized at	150° F.	30.31%
"	" 170° F.	30.85%
"	" 190° F.	30.53%

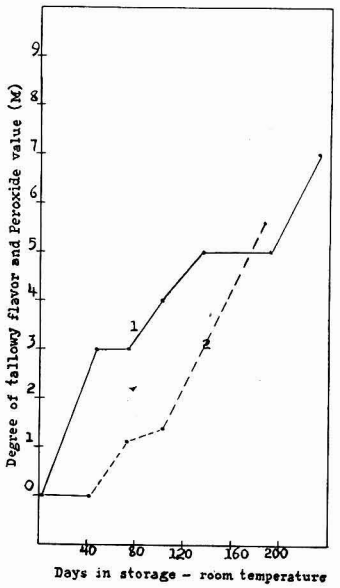

FIG. 11. Correlation between degree of tallowy flavor and peroxide value. (Sodium citrate with added copper.)
Legend to curves:
1. Degree of tallowy flavor
2. Peroxide value (M)

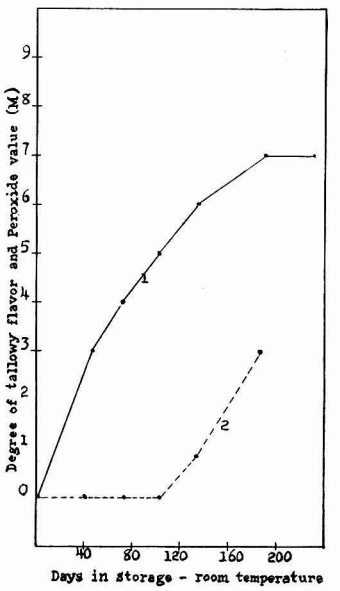

FIG. 12. Correlation between degree of tallowy flavor and peroxide value. (Control with added copper.)
Legend to curves:
1. Degree of tallowy flavor
2. Peroxide value (M)

TABLE 3

Relation of pasteurization temperature to the storage properties of milk powder

Sample	Degree of tallowy flavor Days in storage			ml. of insoluble material Room temperature		
	Fresh	26	67	Fresh	26	27
B 150° F.	.....	1½	5	2.00	2.10	3.70
150° F. with Cu.	.....	4	8	2.10	2.20	3.60
170° F.	.....	2½	1	2.80	3.00	3.50
170° F. with Cu.	.....	3	3½	3.10	3.40	3.80
190° F.	.....	3½	6	2.80	3.40	5.60
190° F. with Cu.	.....	4½	9*	2.80	4.50	8.00

* Defect not typical tallowy but more of a scorched flavor due to browning of powder.

The data in table 3 indicate that the temperature at which the milk is heated before drying is related to the keeping quality of the powder. Best results were obtained when the milk was heated to 170° F. for 30 minutes. It is also evident that the powder made from milk pasteurized at 150° F. for 30 minutes had a better flavor after storage than that made from milk heated at 190° F. for 30 minutes.

Figure 13 graphically presents the data in table 3 and clearly pictures

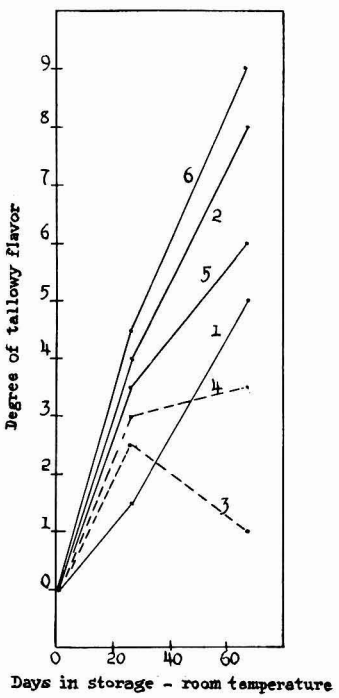

FIG. 13. Relation of pasteurizing temperature to tallowy flavor development.
Curve Number:
1. Pasteurized at 150° F.
2. " " 150° F.
3. " " 170° F.
4. " " 170° F.
5. " " 190° F.
6. " " 190° F.
Numbers 2, 4 and 6 with added copper.

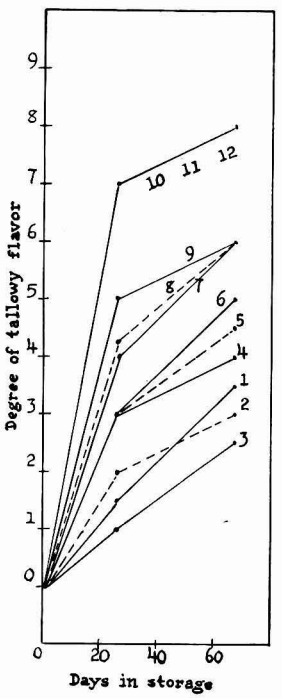

FIG. 14. Relation of moisture content to tallowy flavor development.

Curve No.	Per cent moisture when stored	Storage temperature
1.	2.32	0° C.
2.	3.44	0° C.
3.	5.39	0° C.
4.	2.32	15° C.
5.	3.44	15° C.
6.	5.39	15° C.
7.	2.32	20° C.
8.	3.44	20° C.
9.	5.39	20° C.
10.	2.32	37° C.
11.	3.44	37° C.
12.	5.39	37° C.

the superior keeping quality of the powder made from milk heated at 170° F. for 30 minutes.

The comparison of the solubility indices of powders made from milk heated to the 3 different temperatures shows that the least soluble powders were those made from milk heated to 190° F. The close correlation in flavor between powders made from milk heated to 150° F. and 170° F. and the lack of correlation in the solubility of these two sets of powders indicates that there is no relation between solubility index and flavor change.

Effect of Moisture Content

The milk used in this experiment was processed in the regular manner. At the time of drying 0.5 ppm of copper were added to one-half of each lot of milk. The moisture content of one set of samples was adjusted to approximately 5 per cent by spreading the powder out on parchment paper in a humid room until the desired moisture content was reached. As a control, the powder as it came from the drier with a moisture content of approximately 3.5 per cent was used. By circulating 100° F. air over powder spread on parchment paper a product with a moisture content of 2 per cent was obtained. The fat content was 28.44 per cent in the control sample. All samples were placed in brown glass bottles with screw caps.

In a second experiment a series of 5 samples was prepared in which the moisture contents were varied from 2 to 5 per cent at 0.75 per cent intervals. This was accomplished by adjusting two lots of powder to a moisture content of 2 per cent and 5 per cent respectively and mixing the proper proportions of these high and low moisture powders to obtain the intermediate samples.

Each series of samples was stored at the following temperatures: 0° C., 15° C., 20° C., and 37° C. No copper additions were made to any of the samples and the fat content of the powder before adjusting the moisture was 30.34 per cent.

TABLE 4

Relation of variation of moisture content to the storage properties of milk powder

Sample	Degree of tallowy flavor after indicated number of days in storage at room temperature		
	Fresh	54	116
C l*	.....	1	8
l with Cu.	.....	4½	9**
C m	.....	2	4
m with Cu.	.....	5	4
C h	.....	3	7
h with Cu.	.....	8**	10**

* l low moisture content powder.
m medium moisture content powder.
h high moisture content powder.

** Defect not typical tallowy but more of a scorched flavor due to browning of powder.

It is recognized that the procedure followed in this experiment is open to criticism. In the first place there is some question as to whether or not the adjustments in moisture content were made uniformly throughout each separate lot of powders; it is also a question as to whether or not the treatment to which the powder was subjected in order to adjust the moisture content was related in some way to the changes in the appearance and flavor of the powders that occurred during storage.

TABLE 5

Relation of variation in moisture content and storage temperature to the storage properties of milk powder

Sample	Per cent moisture when placed in storage	Degree of tallowy flavor after indicated days in storage			ml. insoluble material days in storage		
		Fresh	26	67	Fresh	26	67
0° C.	2.32	.....	1½	3½	1.30	1.40	1.50
	3.14	.....	2	3½	1.40	1.40	1.60
	3.44	.....	2	3	1.40	1.30	1.50
	4.64	.....	1	3	1.60	1.50	1.60
	5.39	.....	1	3	1.90	2.00	1.70
15° C.	2.32	.....	3	4	1.30	1.30	1.80
	3.14	.....	3	4	1.40	1.40	1.70
	3.44	.....	3	4½	1.40	1.30	1.60
	4.64	.....	3	5	1.60	1.45	1.30
	5.39	.....	3	5	1.90	1.90	1.50
20° C.	2.32	.....	4	6	1.30	1.20	1.70
	3.14	.....	4¼	6½	1.40	1.50	1.60
	3.44	.....	4¼	6	1.40	1.30	1.70
	4.64	.....	4½	6	1.60	1.30	2.10
	5.39	.....	5	6	1.90	2.50	2.10
37° C.	2.32	.....	7	8*	1.30	1.60	2.00
	3.14	.....	7	8*	1.40	3.00	3.90
	3.44	.....	7	8*	1.40	2.60	2.80
	4.64	.....	7	8*	1.60	2.60	5.90
	5.39	.....	7	8*	1.90	3.60	9.00

* Defect not typical tallowy but more of a scorched flavor due to browning of powder and increasing in intensity with increase in moisture content.

It is safe to conclude, however, from the data (table 5) that the temperature at which the powder is stored is much more of a factor as far as stability or flavor is concerned than is the moisture content. It should be observed that all samples stored at 37° C. in the experiment recorded in table 5 and those samples of the highest moisture content recorded in table 4 turned brown and developed a caramel flavor during the storage. At the higher storage temperature (37° C.) all samples turned brown regardless of moisture content. It is evident that there is a critical point in the neighborhood of 5 per cent moisture which represents the upper limit of moisture for samples to be stored at room temperature without deterioration in

flavor and color. At the higher storage temperatures (20° C. or above) discoloration will take place regardless of the moisture content. This change in the color of powdered milk as related to storage temperature is likely a phenomenon of the same order as occurs in sweetened condensed milk when stored at 20° C. or above.

It should also be observed that those samples which discolored during storage became less soluble indicating a change in the protein constituents of the powder. It is also true that these same samples had a lower pH value than the ones which showed no change in color during storage.

Effect of the Type of Container

The effect of containers on the keeping quality of the powder was investigated by packing the powder in the following types of containers and storing them at room temperature: p—plain cardboard cup and cover; pp—

TABLE 6

Relation of the type of container to degree of tallowy flavor development

Sample	Days in storage*		Sample	Days in storage*		Sample	Days in storage*	
	35	206		35	206		35	206
D 1 p	?	2½	D 4 p	.....	3½	D 7 p	½	2
pp	?	4	pp	.....	5	pp	½	1
ap	.....	2	ap	.....	2½	ap	.....	2
t	?	5	t	.....	6	t	.....	4
et	?	1½	et	.....	4	et	.....	.....
D 1c p	3½	8	D 4c p	3	8	D 7c p	5	8
pp	3	5	pp	2	8	pp	6	7
ap	3	8	ap	2	7	ap	3½	9
t	3	10	t	3½	9	t	5	10
et	3	3½	et	2	5	et	6	7
D 2 p	½	2½	D 5 p	.....Sl.R.**	3	D 8 p	¾	4
pp	½	3	pp	.....Sl.R.	2	pp	¾	5
ap	½	2	ap	.....Sl.R.	2	ap	¾	6
t	½	4	t	.....Sl.R.	5	t	1	7
et	½	1½	et	.....Sl.R.	1½	et	½	3
D 2c p	4	4	D 5c p	.....Vs.R.***	10	D 8c p	6	10
pp	4	2½	pp	.....Vs.R.	10	pp	7	11
ap	4	3½	ap	.....Vs.R.	9	ap	5	10
t	5	7	t	.....Vs.R.	8	t	7	13
et	4	5	et	.....Vs.R.	6	et	7	13
D 3 p	.....	1	D 6 p	.....	4	D 9 p	½	5
pp	.....	½	pp	1	3	pp	.....	4
ap	.....	½	ap	.....	5	ap	.....	4½
t	.....	1	t	1	7	t	1	3
et	.....	½	et	.....	3	et	.....	6
D 3c p	2	8½	D 6c p	5	11	D 9c p	4	9
pp	2	2	pp	7	8	pp	4	7½
ap	2	8	ap	4	5	ap	3	8
t	2	2	t	6	13	t	4½	9
et	2	1	et	5	13	et	4	7

* Stored at room temperature.
** Sl.R. = slightly rancid.
*** Vs.R. = very slightly rancid.

plain cardboard cup and cover dipped in melted paraffin and sealed with paraffin; ap—paper coffee bags lined with Avenized paper*; t—plain tin container with friction type cap; et—sanitary enameled #1 tin (sealed in the regular manner).

The raw milk, with an acidity of 0.15 per cent was processed as indicated under experimental procedure and condensed to a ratio of 2.6–1. Equivalent amounts of the same antioxidants were added at the time of drying and 0.5 ppm of copper was also added to one-half of each lot of milk. No attempt was made to regulate the moisture content of the powder. The average fat content of the powders in this experiment was 27.69 per cent.

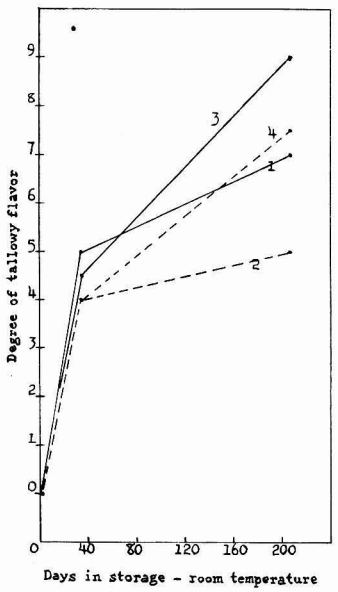

FIG. 15. Correlation between type of container and tallowy flavor development.
Legend to curves:
Hydroquinone with added copper
1. Plain tin
2. Enameled tin
Control with added copper
3. Plain tin
4. Enameled tin

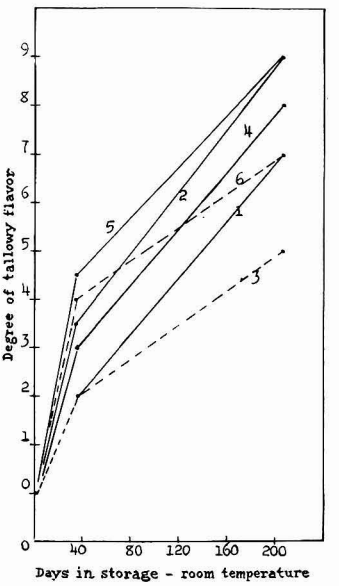

FIG. 16. Correlation between type of container and tallowy flavor development.
Legend to curves:
Avenex with added copper
1. Avenized coffee bag
2. Plain tin
3. Enameled tin
Control with added copper
4. Avenized coffee bag
5. Plain tin
6. Enameled tin

It has been known for a number of years that protection from air and light will improve the keeping quality of powdered milk. The data in table 6 further substantiate the work of other investigators in this respect. When

* Courtesy of Musher Foundation.

the powders were stored in plain cardboard containers, tallowy flavor developed rapidly in all cases.

The treatment of wrappers with oat flour (Avenex) has been shown to improve the keeping quality of butter and, therefore, the effect of this type of package was studied in connection with milk. To a certain extent the Avenized bags protected the powder from oxidation. It is also apparent that this type of package resulted in a fresher and better flavored product in all samples during the first 40 days of storage. This fact is not clearly shown in the data, but was noticeable when the samples were judged.

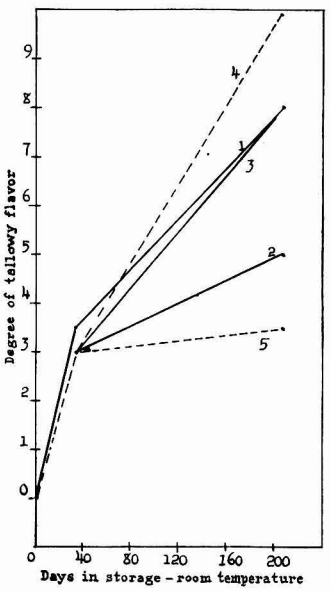

FIG. 17. Correlation between type of container and tallowy flavor development.
Legend to curves:
Butyl ester of tyrosine with added copper.
1. Paper
2. Paraffined paper
3. Avenized coffee bag
4. Plain tin
5. Enameled tin

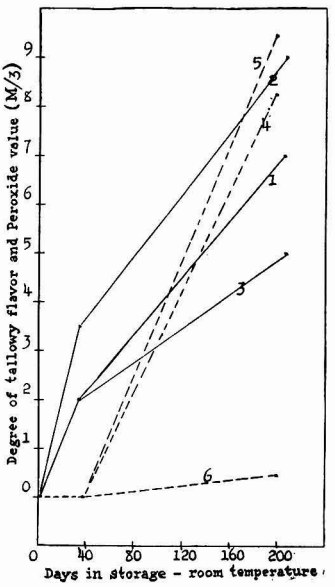

FIG. 18. Correlation between type of container and tallowy flavor development.
Legend to curves:
Control with added copper
1. Paper
2. Paraffined paper
3. Avenized coffee bag
4. Plain tin
5. Enameled tin

Data from table 6 shown graphically in figures 15, 16, 17, and 18, indicate that the type of container used has a definite relationship to the development of tallowy flavor. The plain tin containers, friction sealed, were less satisfactory than the enameled tin container. A heavy coating of paraffin on cardboard and sealing with paraffin gave protection with some samples but the results were not as consistent as in the case of the enameled tin.

The moisture content of the powders varied with the type of container and changed considerably during storage with all containers except in the case of the enameled tin. There was a slight variation in moisture content of the powder stored in the enameled tin container. However, this variation was well within the range of experimental error. In general, the containers sealed against air penetration (paraffined paper and the sanitary container) protected the powders to the best advantage as far as a change in moisture content was concerned.

The effect of the various antioxidants was again shown in this series of samples. Gum guaiac, hydroquinone, ascorbic acid, butyl ester of tyrosine, sodium citrate and Avenex were effective in the order named in preventing the development of a tallowy flavor.

TABLE 7

Relation of the type of container to peroxide values

	M* Values								
Sample	Days in storage**		Sample	Days in storage**		Sample	Days in storage**	
	37	199		37	199		37	199
D 1 p	.....***	.....	D 4 p	.....	.....	D 7 p	.....	.....
pp	.....	.....	pp	.....	.....	pp	.....	.....
ap	.....	.....	ap	.....	.....	ap	.....	.....
t	.....	.....	t	.....	.....	t	.....	.....
et	.....	.....	et	.....	.....	et	.....	.....
D 1c p	.....	16.71	D 4c p	.....	23.48	D 7c p	.....	3.29
pp	.....	.....	pp	.....	3.24	pp	.....	9.38
ap	.....	14.89	ap	.....	24.83	ap	.....	32.57
t	.....	9.33	t	.....	28.37	t	.....	14.80
et	.....	6.68	et	.....	1.36	et	.....	10.76
D 2 p	.....	.....	D 5 p	.....	.....	D 8 p	.....	.....
pp	.....	.....	pp	.....	.....	pp	.....	.....
ap	.....	.....	ap	.....	.....	ap	.....	.....
t	.....	.....	t	.....	.....	t	.....	.....
et	.....	.....	et	.....	.....	et	.....	.....
D 2c p	.....	.....	D 5c p	.....	20.01	D 8c p	.....	26.55
pp	.....	.....	pp	.....	5.04	pp	.....	55.66
ap	.....	.....	ap	.....	26.05	ap	.....	5.53
t	.....	.....	t	.....	1.18	t	.....	16.58
et	.....	.....	et	.....	4.34	et	.....	.....
D 3 p	.....	.....	D 6 p	.....	.....	D 9 p	.....	.....
pp	.....	.....	pp	.....	.....	pp	.....	.....
ap	.....	.....	ap	.....	.....	ap	.....	.....
t	.....	.....	t	.....	.....	t	.....	.....
et	.....	.....	et	.....	.....	et	.....	.....
D 3c p	.....	3.57	D 6c p	.....	20.18	D 9 c p	.....	20.40
pp	.....	0.71	pp	.....	64.29	pp	.....	3.95
ap	.....	3.32	ap	.....	18.58	ap	.....	25.15
t	.....	0.19	t	.....	40.12	t	.....	3.18
et	.....	0.53	et	.....	60.68	et	.....	37.50

* Values see experimental procedure.
** Stored at room temperature.
*** ..... = No values found.

Data from tables 6 and 7 indicate that there is some correlation between the degree of tallowiness, peroxide values and type of container. Enameled tin containers retarded the development of peroxides as well as the tallowy flavor. Avenized bags were more effective in this respect than the plain tin containers but not as effective as the enameled tin cans.

The solubility of the milk powder was not affected by the type of container used.

Effect of Storage Temperature

For the study of the effect of storage temperature a series of three sets of samples were prepared.

1. The raw milk was processed in the regular manner except that it was pasteurized at 170° F. for 30 minutes. At the time of drying, copper at the rate of 0.5 ppm was added to one-half of the lot of milk and the powder samples were packed in brown glass bottles with screw caps and stored at 0° C. and 42° C. The fat content of the powder was 30.85 per cent.

2. The raw milk was processed in the regular manner and copper at

TABLE 8

Relation of storage temperature to the development of tallowy flavor

Sample	Samples stored in Avenized bags				Samples stored in plain tin containers			
	Storage temperature				Storage temperature			
	0° C. Days in storage		42° C. Days in storage		0° C. Days in storage		42° C. Days in storage	
	62	117	49	117	62	117	49	117
	Degree of tallowy flavor				Degree of tallowy flavor			
E 1	heated	.....	.....	2½	heated	1	3	3
1c	2	2	4	5	1	4	burnt	9
2	heated	.....	2	5	heated	1	burnt	8
2c	2	1	1	4½	heated	3½	1	4
3	.....	.....	.....	.....	.....	1	.....	.....
3c	.....	½	.....	.....	.....	3	.....	.....
4	heated	.....	2	1½	.....	3	1½	3½
4c	.....	5	3	5	2	5	3	4½
5	rancid	rancid	rancid	rancid	rancid heated	1	rancid burnt	rancid
5c	rancid	1	rancid	1	rancid	3	rancid burnt	rancid
6	.....	.....	1	1½	.....	1	1	3
6c	heated	1	2	6	1½	3	burnt	9
7	.....	.....	1	1½	heated	2	1	2½
7c	.....	7	6	6	.....	5	3	4½
9	.....	.....	heated	1½	heated	2	3	3½
9c	heated	5	5	7	½	5	5	5

the rate of 0.5 ppm was added at the time of drying. The moisture content of the powder was adjusted to approximately 5 per cent by spreading on parchment paper in a humid room until sufficient moisture had been absorbed. The samples were packed in brown glass bottles with screw caps and stored at 0° C. and 42° C. The fat content of the powder before adjusting the moisture was 28.44 per cent.

3. The same processing procedure was used as under experiment A and

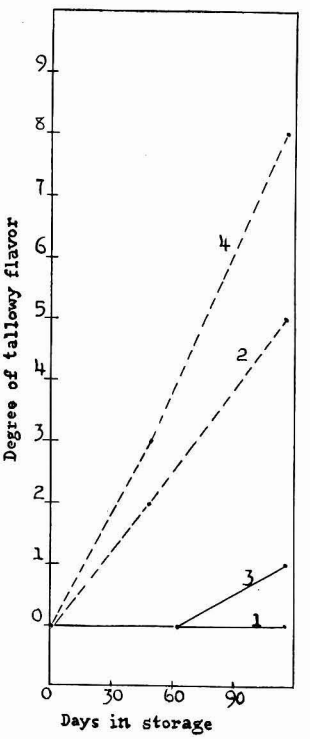

FIG. 19. Relation of storage temperature to degree to tallowy flavor development.

Curve No.	Hydroquinone	Storage Temperature	Type of Container
1.		0° C.	Avenized coffee bag
2.		42° C.	Avenized coffee bag
3.		0° C.	Plain tin
4.		42° C.	Plain tin

the same antioxidants, in equivalent amounts, were added. Copper at the rate of 0.5 ppm was added to one-half of the milk before drying. All samples were packed in the following containers: 1. paper bags lined with Avenized paper; 2. plain tin containers with a friction top. They were stored at 0° C. and 42° C. The fat content of the powder was 30.85 per cent.

The data in table 8 indicate that the storage temperature is important in the rate of tallowy flavor development. All samples stored at 0° C. in Avenized bags had developed little or no tallowy flavor at the end of 117 days of storage. Similar samples stored at 42° C. were definitely tallowy and some were slightly discolored at the end of an equal length of time. Samples stored in plain tin (with friction top) deteriorated more rapidly at 0° C. than did the samples kept in Avenized bags at the same temperature. Storage at 42° C. in plain tin resulted in an increase in the susceptibility toward oxidation and some of the samples had a caramelized flavor and were discolored. A typical example is graphically illustrated in figure 19.

The moisture content of the samples in Avenized bags stored at 0° C. increased as much as 6 per cent because of the high humidity in the refrigerated room.

The moisture content of the powder samples held at 0° C. in tins, with the friction seal, remained nearly constant during storage. Samples in the same type of containers stored at 42° C. increased slightly in moisture content during storage. This change in moisture content may have been a result of the inter-reaction between the lactose and casein at this high temperature. This again may account for the fact that the powders that de-

TABLE 9

*Relation of storage temperature to peroxide values**

Sample	Samples stored in Avenized bags				Samples stored in plain tin containers			
	Storage temperature				Storage temperature			
	0° C. Days stored		42° C. Days stored		0° C. Days stored		42° C. Days stored	
	47	121	47	121	47	121	47	121
E 1	.....**	.....	.....	.....	.....	.....	.....	.....
1c	.....	.....	.....	.....	.....	.....	.....	2.111
2	.....	.....	.....	.....	.....	.....	.....	0.691
2c	.....	.....	.....	.....	.....	.....	.....	.....
3	.....	.....	.....	.....	.....	.....	.....	.....
3c	.....	.....	.....	.....	.....	.....	.....	.....
4	.....	.....	.....	.....	.....	.....	.....	.....
4c	.....	.....	.....	0.915	.....	0.704	.....	.....
5	.....	.....	.....	.....	.....	.....	.....	.....
5c	.....	.....	.....	.....	.....	.....	.....	2.111
6	.....	.....	.....	.....	.....	.....	.....	.....
6c	.....	.....	.....	.....	.....	.....	.....	2.601
7	.....	.....	.....	.....	.....	.....	.....	.....
7c	.....	.....	.....	.....	.....	.....	.....	.....
9	.....	.....	.....	.....	.....	.....	.....	.....
9c	.....	.....	.....	1.898	.....	0.591	.....	.....

* M values—see experimental procedure.
** No values found.

creased in solubility during storage at 42° C. showed a tendency towards an increase in moisture content.

Even though the powder in the Avenized bags increased in moisture, when stored at 0° C. and 42° C., there was very little change in solubility. The samples packed in tin, however, showed a greater fluctuation in solubility when stored at 42° C. than did the samples in the paper container. A marked decrease in solubility took place in the powder when stored in tin at 42° C., although this type of container was more or less air tight as indicated by the constant moisture values.

As previously noted there was a decrease of approximately 4–1 in solubility index of the samples to which sodium citrate was added before drying, showing a marked increase in solubility when this salt is present.

TABLE 10

Relation of storage temperature and moisture content to the storage properties of milk powder

Sample		Per cent moisture Days in storage			Flavor Days in storage			ml. insoluble Days in storage		
Temp.	Number	Fresh	57	97	Fresh	57	97	Fresh	57	97
0° C.	C h*	5.46	3.46	3.31	.....	4	6	2.40	1.80	1.50
	C hc	5.20	5.03	5.08	.....	6**	8**	3.50	8.00	10.00
42° C.	C h	5.46	2.74	3.00	.....	7	9**	2.40	7.20	9.00
	C hc	5.20	5.00	4.46	.....	8**	11**	3.50	12.50	12.00

* h High moisture powder.
** Defect not typical tallowy but more of a scorched flavor due to browning of powder.

Peroxide values (table 9) were found only after 121 days of storage at 42° C. The conclusions, previously drawn from table 6, of the increase in susceptibility of powders to oxidation when stored in plain tin and held at high temperatures are further substantiated by the results of this experiment. Only two samples stored in Avenized paper bags at 42° C. gave slight values while values were found for 4 samples of powder stored in tin at 42° C.

The pH values of the reconstituted milk gave little indication of any definite trend except in the case of those samples with a decreased solubility. As previously shown (Experiment A) a drop in pH occurs when there is a noticeable decrease in solubility and change in the color of the powder.

The data in table 10 further confirm the results indicated in tables 5 and 8 in that there is an increase in rapidity of the development of the tallowy flavor at high storage temperature. This effect is more marked where copper is present.

CONCLUSIONS

1. Sufficient evidence has been obtained to indicate that it is possible to retard the development of oxidized flavor in whole milk powders by adding antioxidants to the milk before it is dried.

2. All antioxidants studied were found to have some effect in retarding the development of oxidized flavor in milk powder. These products varied, however, in their effectiveness and may be grouped in this respect as follows:

Group 1. (Most effective antioxidants)
- a. Gum guaiac
- b. Hydroquinone

Group 2 (Intermediate in effectiveness)
- a. Ascorbic acid
- b. Sodium citrate

Group 3 (least effective)
- a. Butyl ester of tyrosine
- b. Avenex
- c. Enzylac
- d. Bacterial culture

3. Powder made from milk heated to 170° F. for 30 minutes is less likely to develop an oxidized flavor than that made from milk heated to a higher (190° F.) or lower (150° F.) temperature.

4. High moisture (5 per cent or above) content in the powder and high (20° C. or above) storage temperatures increase the rate of oxidized flavor development.

5. The conditions found favorable for brown discoloration of the powder during storage were as follows:
- a. Preheating the milk at a high (190° F.) temperature.
- b. A moisture content of 5 per cent or higher.
- c. Presence of added copper salts.
- d. Storing at temperatures of 20° C. or higher.

6. The type of container has a bearing upon changes in color, moisture, solubility and flavor during storage. The container features found to be favorable for maintaining a normal condition of the powder were:
- a. Construction which reduced the amount of air infiltration.
- b. Coating the surface of tin containers with lacquer.
- c. Use of paper bags treated with oat flour (Avenex).

7. Discoloration, reduction in solubility, and a lowering of the pH occur concurrently suggesting a common cause. A reaction between the protein and other constituents in the milk is thought to be involved in much the same manner as in the case of the discoloration and thickening of sweetened condensed milk.

8. Addition of sodium citrate to milk before drying greatly increased the solubility of the milk powder.

9. The peroxide value cannot be used to detect early oxidation of the fat. It may be used, however, to show oxidation of a high degree.

10. The development of oxidized flavor in milk powder can be detected at an earlier stage by the sense of taste than by the use of the peroxide test.

11. The peroxide test could not be used to predict the keeping quality of a fresh sample of powdered whole milk.

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MICHIGAN INVITES YOU

To the Officers and Members of the
American Dairy Science Association:

The summer meetings of the American Dairy Science Association, which have become so popular, were originated on the campus of the Michigan State College.

Since this first meeting in 1927, with about seventy-five in attendance, these summer meetings have become an outstanding event with record attendance.

We have been looking forward for several years to your return to our campus.

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As a former active member, I am pleased to invite you to visit us in Michigan, the Playground of the Nation and a state famous for its dairy development.

Signed Ernest L. Anthony,
Dean of Agriculture,
Michigan State College.

THIRTY-SEVENTH ANNUAL MEETING, MICHIGAN STATE COLLEGE, EAST LANSING, MICHIGAN, JUNE 22–25, 1942 (TENTATIVE PROGRAM)

Sunday, June 21

2:00 P.M.– 9:00 P.M.—Registration

Monday, June 22

12:00 M. —Preconvention trip, KVP, Parchment (north edge of Kalamazoo, Michigan)
8:00 A.M.– 9:00 P.M.—Registration
7:00 P.M.—Committee Meetings or Social Period

Tuesday, June 23

9:30 A.M.–11:00 A.M.—Opening Session (General program)
11:00 A.M.–12:00 M. —Committee meetings
1:30 P.M.– 4:00 P.M.—Section program meetings

4:00 P.M.– 6:00 P.M.—Tour of dairy barns and pastures
or New Score Card—Judging dairy products
8:00 P.M.—Social period

Wednesday, June 24

9:00 A.M.–11:00 A.M.—Section program meetings
11:00 A.M.–12:00 M. —Committee meetings
1:30 P.M.– 3:30 P.M.—Section program meetings
3:30 P.M.– 4:30 P.M.—Section business meetings
8:00 P.M.—Social period

Thursday, June 25

9:00 A.M.–11:00 A.M.—Section program meetings
11:00 A.M.–12:00 M. —Committee meetings
1:00 P.M.– 3:00 P.M.—Section meetings
3:00 P.M.– 3:30 P.M.—Section business meetings
3:45 P.M.– 5:00 P.M.—Business (General program)
6:30 P.M.—Banquet

Friday, June 26

9:00 A.M. —Post-convention trip, Dearborn, Michigan. Visit Greenfield Village and Ford Museum.

VOLUME XXV MARCH, 1942 NUMBER 3

JOURNAL OF DAIRY SCIENCE

Published by the
AMERICAN DAIRY SCIENCE ASSOCIATION
R. B. STOLTZ, Sec.-Treas.
Ohio State University, Columbus, Ohio

ABSTRACTS OF LITERATURE

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JOURNALS

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SPECIAL PUBLICATIONS

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

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

ADVANCE ABSTRACTS OF REPORTS ACCEPTED FOR PUBLICATION IN THE JOURNAL OF DAIRY SCIENCE

110. The Effect of Inhaled Substances on Milk Flavors. W. E. PETERSEN AND J. G. BRERETON, Div. Dairy Husbandry, University of Minnesota.

The effect of the inhalation of odors and vapors of 13 substances upon the flavor of milk was studied. The substances studied were placed or atomized into a specially constructed tent in which only the head and neck was entered. The effect upon milk flavors was ascertained by milk judges. The animals were subjected to the test substances for a period of two hours immediately before milking.

Inhalation of turpentine, paradichlorbenzene, camphor and vanillin caused flavoring of the milk characteristic of these compounds while inhalation of benzaldehyde, onion and garlic imparted a flavor to the milk that was not characteristic of these compounds. Inhalation of odors from corn silage, alfalfa silage and decomposing manure, caused "off flavors" in the milk, while synthetic orchid and scrapings from Roquefort cheese caused no detectable "off flavors."

111. Purification of Rennin from Commercial Rennin Extract: Properties of Purified Product. C. L. HANKINSON AND L. S. PALMER, Division of Agricultural Biochemistry, Univ. Minnesota, St. Paul, Minnesota.

For abstract see JOURNAL OF DAIRY SCIENCE, *23*, No. 6: 520. 1940.

112. Studies of Lipase Action. IV. The Inactivation of Milk Lipase by Heat. VLADIMIR N. KRUKOVSKY AND B. L. HERRINGTON, Department of Dairy Industry, Cornell University.

Butter samples were churned from fresh cream pasteurized at 110°, 125°, 140°, 155°, 170°, and 180° F., with holding times ranging from 0 to 150 minutes. The rate of lipolysis during storage was measured by titration of free acids in the fat.

At 110° F., lipolysis was first activated and then reduced as the holding time was increased. The rate was reduced about $\frac{2}{3}$ by holding 150 minutes.

At 125° F., the rate of lipolysis was reduced about $\frac{1}{2}$ after 20 minutes (estimated) but it was still measurable after 150 minutes.

At 140° F., the rate of lipolysis was reduced more than half at zero holding time. The rate was measurable with a holding period of 15 minutes but not after 35 minutes.

At 155° F., the rate of lipolysis was scarcely measurable after zero minutes of holding.

113. Studies of Lipase Action. V. The Effect of Storage Temperature Upon Lipolysis in Butter. B. L. HERRINGTON AND VLADIMIR N. KRUKOVSKY, Cornell University, Ithaca, New York.

Samples of unsalted sweet cream butter were stored at a series of temperatures ranging from 32° F. to −15° F. for more than one year. The extent of lipolysis was measured at intervals by titration of the free acids in the fat. The data indicate that, in butter, lipolysis by the natural lipases of milk is inhibited at 5° F. or lower, though they are active at 30–32° F.

The data do not reveal any difference in the abilities of the formaldehyde tolerant and the formaldehyde sensitive enzymes to act at low temperatures.

114. Studies of Lipase Action. VI. The Effect of Lipolysis Upon the Flavor Score of Milk. VLADIMIR N. KRUKOVSKY AND B. L. HERRINGTON, Cornell University, Ithaca, New York.

A study was made of the relationship between the judges' scores and the "acid degrees" of raw milk within a few hours after milking.

The data indicate a threshold value for the recognition of rancidity at acid-degrees near 0.8. They also indicate that very slight degrees of lipolysis, such as is common in commercial market milk, may influence a judge's score without his being aware of the reason.

In the case of this particular pair of judges, and milk supply, statistical analysis shows that an increase of 0.33 acid degrees corresponded to a decrease of one point in the flavor score of the milk.

115. Studies of Lipase Action. VII. The Influence of the Rate of Cooling Upon the Subsequent Rate of Lipolysis in Milk Stored at Low Temperatures. B. L. HERRINGTON AND VLADIMIR N. KRUKOVSKY, Cornell University, Ithaca, New York.

The rate of lipolysis in milk stored at low temperatures depends upon the rate at which the milk was cooled before the storage period.

To secure a minimum rate of lipolysis, the cooling time should be reduced to a few seconds.

There is a critical temperature range in which the rate of cooling is most important. The upper limit of this range is approximately 20°–25° C. The lower limit is approximately zero in the case of natural milk, and approximately 10° C. in the case of temperature-activated milk.

116. The Relation of the Use of Certain Antioxidants and Methods of Processing to the Keeping Quality of Powdered Whole Milk. H. A. HOLLENDER AND P. H. TRACY, Department of Dairy Husbandry, University of Illinois, Urbana, Illinois.

All the antioxidants studied were found to retard the development of oxidized flavor in powdered whole milk but some were much more effective than others. The powders that developed the least amount of tallowiness under all conditions of treatment were those containing gum guaiac and hydroquinone. Powder made from milk preheated to 170° F. was more resistant to oxidation than that made from milk heated to either higher (190° F.) or lower (150° F.) temperatures. High moisture and high storage temperatures were conducive to oxidation.

Container features that favored retention of the normal flavor, color and solubility in milk powder were absence of air infiltration and the use of Avenex treated paper bags.

The sense of taste was more accurate than the peroxide test in detecting the early development of the oxidized flavor. The latter test was of no value in predicting the keeping quality of a fresh sample of powdered whole milk.

117. **Metabolism Stalls.** A. D. PRATT AND C. W. HOLDAWAY, Virginia Agricultural Experiment Station, Blacksburg, Va.

A description is given of four metabolism stalls which are built with sewer gratings in the rear of each and with funnels which direct the excreta into thirty-gallon garbage cans. Water cups, with a metered flow, and adjustable mangers are provided.

The room is heated for the convenience of the operator during digestion trials, by a hot water supply boiler which delivers the hot water to a Trane unit heater. A wall thermostat controls the fan in the Trane heater. An aquastat (reverse acting) in the return line between the Trane unit and the boiler actuates a water circulator.

Ventilation is accomplished by a Jamesway fan ventilator which starts when the temperature reaches 56° F. and stops at 52° F.

118. **The Bacteriology of Brick Cheese. II. Comparison of Washed-curd and Conventional Methods of Manufacture.** EDWIN M. FOSTER, JOHN C. GAREY, AND WILLIAM C. FRAZIER, Univ. Wisconsin, Madison.

In an effort to eliminate the common defect of excessive acidity with its accompanying effect on the body and flavor in high moisture Brick cheese a process was introduced for washing the curd with water before dipping. This procedure consisted of adding 25 to 28 pounds of water per 100 pounds of milk to the vat; then 50 to 55 pounds of whey were removed and replaced by an equal volume of water warmed to 90° F. The washing process removed about one-third of the lactose in the curd and fermentation of the remainder reduced the pH to the desirable range of 5.00–5.15 in cheese with a moisture content of 40–42 per cent. When the mixed starter of *Strepto-*

coccus lactis and *Streptococcus thermophilus* was used, all the lactose disappeared and the desired pH was reached in about one day.

The washing process had no noticeable effect upon the rate of development of the starter bacteria as detectable by cultural counts, but there was a slightly slower rate of acid formation in the washed-curd cheese.

The occurrence of undesirable fermentations was more pronounced in the washed-curd than in the conventional cheese, due probably to the relatively lower acidity in the former. However, the milk of good quality undesirable fermentations did not appear when the mixed starter was used; and the washed-curd cheese was superior to the other in flavor and body as well as in moisture content. The washed-curd cheese made from good quality milk had a mild and clean flavor, soft and smooth body and a medium close texture.

Late gas formation by anaerobic spore forming bacteria occurred in all cheese in which the pH did not drop below 5.3 during the first three days of ripening. This condition was most pronounced in cheese made with *Streptococcus thermophilus* starter by the washed-curd method from pasteurized milk.

119. The Bacteriology of Brick Cheese. III. The Organisms Involved in Ripening. EDWIN M. FOSTER, JOHN C. GAREY, AND WILLIAM C. FRAZIER, Univ. Wisconsin, Madison.

Brick cheese made from raw and pasteurized milk by the conventional and washed-curd methods with *Streptococcus lactis* and *Streptococcus thermophilus* starters alone and in combination was examined for the bacteria present during ripening. Cultural counts were made on samples taken at weekly intervals and representatives of the predominant organisms isolated at each sampling period.

Identification of 1040 cultures from eighteen lots of Brick cheese showed *Streptococcus lactis* predominant throughout ripening when it was used as the starter. It was also detected in cheese made with *Streptococcus thermophilus* alone, and with one or two exceptions eventually became predominant. *Streptococcus thermophilus* died out rapidly in cheese in which it was the starter and was seldom detectable in appreciable numbers after two or three weeks. Lactobacilli developed in all cheese made from raw milk, but usually were absent in pasteurized milk cheese. *Lactobacillus casei* was always the predominant rod form and usually was detectable after the second week of ripening. *Lactobacillus brevis* and *Lactobacillus lactis* were found in smaller numbers in several samples.

Streptococci other than the starter organisms frequently developed during ripening namely, *Streptococcus fecalis, Streptococcus bovis* and *Streptococcus liquefaciens.* The first two were particularly noticeable in cheese made from pasteurized milk. There was no regularity to the occurrence of

these organisms, hence their presence apparently depended upon the individual milk supply. When they did develop they usually were detectable after the first or second week of ripening.

120. The Carotenoid Content of Milk Fat Fractions. VLADIMIR N. KRUKOVSKY, Department of Dairy Industry, Cornell University, Ithaca, New York.

A study was made of the relationship between the carotenoid content and the physico-chemical properties of different milk fat fractions.

The data indicate an inverse relationship between the carotenoid content and the melting points of the fractions. They also indicate a definite relationship between the carotenoid content and the iodine numbers of the fractions.

The data suggest that the efficiency of absorption of carotene by an animal from its feed might be influenced by the degree of unsaturation of the fat present in the feed.

The flavor score of different fractions at the end of two years' storage at 4°–5° C. revealed that the intensity of the oxidized flavor varied inversely with the carotenoid content of the fractions. It appears that the substances responsible for the reduction in the susceptibility of the fat to oxidized flavor are concentrated in the liquid fraction.

The extreme low temperature fractions might well serve as the starting point in an attempt to identify the highly unsaturated acids and the antioxidant of butter fat.

121. The Effect of High-Temperature Short-Time Forewarming of Milk upon the Heat Stability of Its Evaporated Product. B. H. WEBB AND R. W. BELL, Div. Dairy Res. Lab., Bur. Dairy Indus. U. S. D. A.

High-temperature short-time forewarming fresh whole milk generally caused the heat stability of its 26 per cent solids evaporated product to be increased 2 times and occasionally as much as 6 times the stability of control samples. The control samples were forewarmed to 95° C. for 10 minutes. The test samples were forewarmed in a special tubular heater to temperatures between 101° C. (213.8° F.) and 165° C. (329° F.) with a heating time of 4 seconds, a holding time of 25 seconds, and a cooling time of 4 seconds. The relationship between the high forewarming temperature and the heat stability of evaporated milk differs with each milk. When a coming-up time of 4 seconds and a holding time of 25 seconds are used the optimum high forewarming temperature for most milk will probably fall between 120° C. (248° F.) and 140° C. (284° F.). Use of the optimum high forewarming temperature brought about, in the milks tested, a greater increase in heat stability in the evaporated milk than could be attained by

the addition of the optimum quantity of stabilizing salt to a normally forewarmed milk.

122. **Milk Lipase and Milk Flavor.** I. HLYNKA AND E. G. HOOD, Div. Chem. and the Div. Bact. and Dairy Res. Science Service, Dept. Agr., Ottawa, Canada.

The relation between lipase activity as indicated by surface tension measurement and flavor as judged by odor was studied. The results on a total of 144 milk samples including not more than 4 samples from one cow and representing 51 individual cows gave a correlation coefficient of .23. The role of milk lipase in average milk under ordinary methods of handling is discussed in relation to the flavor of milk and reference is made to raw milk cheddar cheese.

123. **Increased Milk and Milk Fat Production Following the Feeding of Artificially Formed Thyroprotein (Thyrolactin).** C. W. TURNER AND E. P. REINEKE, Univ. Missouri, Columbia, Mo.

Milk protein (thyrolactin) that had been iodinated to approximately the level at which optimal thyroidal activity is obtained was fed to lactating goats and cows and its effect on milk production was noted. When fed to goats at the rate of 5 to 10 grams daily for a 5 day period, thyrolactin stimulated increases in milk production ranging from 9.8 per cent and averaging 10.51 per cent. The heart rate was accelerated an average of 8.2 beats per minute. Fifty to 100 grams of thyrolactin fed daily to lactating cows for a 3 day period caused an average increase in milk yield of 8.59 per cent. Individual increases ranged from 6.09 to 22.6 per cent. In six trials in which milk fat analyses were made there was an average increase of 6.77 in fat percentage and 13.9 per cent in fat yield. Since the production of thyroidally active proteins is dependent upon proper control of the iodination process, it is recommended that iodoproteins to be used for the stimulation of lactation be produced by methods that have been proved to give satisfactory results, and further, that all such preparations be assayed biologically before being put to extensive use.

124. **The Availability of The Iron of Cocoa and of Iron-Fortified Cocoa Mixtures.** FAYE KINDER, W. S. MUELLER AND HELEN S. MITCHELL, Massachusetts State College, Amherst.

The availability of the iron of cocoa and iron-fortified cocoa was determined by measuring the degree of hemoglobin regeneration in anemic rats when these substances were fed at the same level of iron intake as inorganic salt of iron. The effect of pure tannic acid was also determined. It was found that the iron of cocoa regenerated approximately two-thirds as much

hemoglobin as an equivalent amount of ferric chloride. Iron added to a cocoa mixture was found to be completely available, indicating that the factor which limited the availability of the iron of cocoa had no influence on added iron. Approximately two (1.7) per cent of pure tannic acid did not reduce the availability of the iron added to a milk ration. It is concluded that the fortification of cocoa or chocolate milk with iron may be warranted on the basis of the availability of the added iron and on the antioxidants which retard or prevent rancidity development in the presence of iron. However, the indiscriminate use of chocolate and cocoa in milk is not recommended because of the yet unexplained effect of cocoa on growth and intestinal function.

BACTERIOLOGY

125. **Plate Contamination in Milk Control.** K. P. LORENZ, Hanovia Chemical and Mfg. Co., Newark, N. J. Milk Dealer, *30,* No. 12: 34–35, 79. September, 1941.

A discussion is given of how plate contamination can be prevented by means of ultraviolet air irradiation. C.J.B.

126. **Variability in Streptococci of Group B.** J. M. SHERMAN, ELIZABETH CHASE GREISEN, AND C. F. NIVEN, JR., Cornell Univ., Ithaca, N. Y. Jour. Infect. Dis., *69:* 271–277. 1941.

Variations in cultures of group B streptococci have been found by observations over a period of several years on carefully studied stock cultures and by plating and re-isolating hundreds of daughter cultures for study. The characteristics studied were, ability to hemolyze blood and the ability to attack salicin and lactose. Although most of the strains proved to be remarkably stable, true variations were found in which daughter strains lost the characteristics studied and also variations in which daughter strains of negative parent strains acquired the characteristics with respect to salicin and lactose but not hemolysis of blood. The authors conclude that these characteristics are not sufficient in themselves for differentiation between species. J.F.C.

127. **The Hemolytic Streptococci. Studies on the Carrier State in the San Francisco Area, with Notes on the Methods of Isolation and Serological Classification of these Organisms.** LOWELL A. RANTZ, Stanford Univ. School of Med., San Francisco. Jour. Infect. Dis., *69:* 248–253. Nov.–Dec., 1941.

Streptococci were isolated from 51.7 per cent of 345 excised tonsils and 30.2 per cent of 298 throat swabs taken a week before tonsillectomy. Group A streptococci were found in 32.7 per cent of the tonsils and 16.4 per cent

of the swabs; group B in 3.5 per cent and 1.7 per cent respectively; group C in 2.9 and 4.1 per cent; group F in 1.4 and 1.3 per cent; and group G in 3.8 and 2.0 per cent. Groups D, E, and H were not found in throat swabs and in only 0.3, 0.9, and 0.3 per cent, respectively, of the tonsils. J.F.C.

128. The Selective Bacteriostatic Effect of Slow Oxidizing Agents. W. L. MALLMANN, W. E. BOTWRIGHT, AND ELBERT S. CHURCHILL, Michigan Agr. Expt. Sta., East Lansing. Jour. Infect. Dis., *69:* 215–219. Nov.–Dec., 1941.

The slow oxidizing agents, potassium dichromate and sodium azide, were found to exert a greater bacteriostatic effect upon gram-negative bacteria than on gram-positive bacteria. By use of an appropriate concentration of these agents in culture media, the gram-negative organisms can be suppressed, thus facilitating the isolation of gram-positive organisms. The gram-positive cocci were found to tolerate the slow oxidizing agents in greater concentrations than were the gram-positive spore-bearing bacteria. Sodium azide was more stable than potassium dichromate, in that its effect was not destroyed by sterilization and its solutions deteriorated more slowly during storage. J.F.C.

129. Bacteriological Air Analysis by the Cloud-Chamber Method. S. D. ELLIOTT, London Hospital, London. Lancet, *241,* No. 6166: 514–515. Nov. 1, 1941.

A method is described for isolation of the organisms from a sample of air in a fluid medium rather than a solid medium, as in the case of exposed plates and the air centrifuge. The essential features of the method are: First, the trapping of suspended particles by drawing the air sample through a water-vapor mist obtained by directing into a humidifying chamber a fine jet of steam, rapidly cooled by expansion to below 50° C.; second, the condensation of water on any particles left in suspension by cooling the saturated air; and third, by transferring known fractions of the washings from the chamber and the condenser into plates to be poured with a suitable medium. In experiments in which broth cultures of an easily identifiable streptococcus were sprayed into the room air to be tested, plugs of sterile cotton-wool, placed at the end of the system, for testing the sterility of the washed air remained sterile during all of the trials, indicating a high efficiency in trapping the organisms in the system. J.F.C.

BUTTER

130. Investigation on Diacetyl in Butter. M. DE BUCCAR. Ann. Hyg. Publ., Ind. Sociale, *18* (N.S.), No. 7: 271–276. 1940.

Methods for the determination of diacetyl in butter are reviewed. R.E.L.B.

CHEESE

131. Fermentation in Processed Cheese. H. J. PALMER, Dairy Indus., *6*, No. 9: 241. 1941.

In a study of the factors affecting fermentation in processed cheese it was found that minimum processing temperature of 165° F. is described as the "Critical Processing Temperature," below which the organisms which produce fermentations flourish in large numbers and above which few survive. The addition of 0.1–0.5 per cent potassium nitrate to processed cheese has a definite deterrent effect upon these organisms but the effect is much less than that of temperature. The use of the potassium nitrate along with a processing temperature of between 145–160° F. appears to be definitely helpful in retarding fermentation. D.V.J.

CHEMISTRY

132. The Reduction Potential of Formaldehyde with Special Reference to the Microanalysis of Formaldehyde. ROKURO AKANO AND MASAZO WATANABE, Inst. of Hygiene, Medical Academy of Kioto. Mitt. med. Akad. Kioto, *30*, No. 2: 629–643 (in German)–(in Japanese, 664). 1940.

Traces of HCHO can easily be detected in milk or in the milk distillate by means of the polarographic method using a dropping mercury cathode. R.E.L.B.

BY-PRODUCTS

133. Plastics as Industrial Materials. G. C. GRESS, Monsanto Chemical Co., Springfield, Mass. Refrig. Engin., *43*, No. 1: 7. 1942.

A comprehensive review of the important types of plastic materials including thermosetting and thermoplastic kinds. Factors upon which plastics are evaluated to determine their suitability for any use which may be under consideration are: Mechanical properties, physical properties, durability and stability, moldability, and cost. Plastics have been used in the commercial refrigeration industry because they possess one or more of these characteristics: 1. Superior dielectric strength; 2. Superior mechanical strength; 3. Lower costs; 4. Chemical resistance; 5. Corrosion resistance; 6. Color or transparency; 7. Low heat transfer; 8. Decorative qualities.

Interior parts of domestic refrigerators are being made from polystyrene, a thermoplastic which does not become embrittled by low temperatures but, in fact, it increases in impact and tensile strength at 0° F. over that of 70° F. It also possesses high dimensional stability, and a low coefficient of expansion. Other properties commending it for refrigerator construction are: immunity to action of acids and alcohol, high heat insulation value, and its being odorless and tasteless. L.M.D.

134. Canned Whey Pudding—A New Product. ANONYMOUS. Food Indus., *13*, No. 11: 36–38. 1941.

Whey, the by-product from manufacture of cheese and casein, contains approximately half of the solids of milk, including nearly all the milk sugar, salts, albumin and water soluble vitamins. This paper describes the process of manufacture of another food product that may be added to a growing list of prepared foods containing whey solids. J.C.M.

DISEASE

135. Report and Comments Upon an Epidemic of Septic Sore Throat in McCook, Nebraska. JAMES MEDFORD WILLIS, McCook, Nebr. Nebr. State Med. Jour., *26*, No. 7: 248–251. 1941.

The epidemic of septic sore throat in McCook, with about 2000 cases and 11 deaths which occurred in the spring of 1934, was attributed chiefly to the milk from one dairy. In the case of several epidemics in this country the infected milk has been pasteurized by the flash method and the evidence in all has indicated that the milk was contaminated before pasteurization. Other epidemics of septic sore throat are also discussed. Apparently all investigators reporting epidemics of sore throat agree that the human type of *Streptococcus hemolyticus* is almost invariably the causative organism; the human carrier infects the cow's udder or a part of the udder producing mastitis and the milk from the infected cow infects the consumer. It is probable that many isolated or sporadic cases and small epidemics are never reported or suspected as being of milk-borne origin. Persons with sore throats or infections on the hands should never handle milk intended for human consumption. Efficient pasteurization is the best known preventive at the present time. R.E.L.B.

136. A Practical Index of Mastitis. J. G. DAVIS. Dairy Indus., *6*, No. 9: 239. 1941.

A method is presented for detecting mastitis milk. It employs the use of catalase, rennet coagulation and solids-not-fat tests, the results of which are analyzed and a numerical index calculated. The calculation is based upon the following scale: 1 point is given for every centimeter of gas over 3 centimeters in the catalase test, 1 point for every $\frac{1}{4}$ hour over $\frac{3}{4}$ hour required for coagulation with rennet and 1 point for every 0.2 per cent S.N.F. below 8.8 per cent for Shorthorns (9.1 per cent for Guernseys and Jerseys, and 8.5 per cent for Holsteins). The sum of the points is interpreted as follows: 0–2 = negligible or nil; 3–4 = slight; 5–7 = definite; 8–10 = bad; over 10 = very bad.

The method has two main applications, namely, as a mastitis survey of

producers milk and as a means of correlating the extent of mastitis with the quality of the finished product after manufacture. D.V.J.

137. A City Health Officer Looks at Public Health. JOHN L. RICE, Commissioner of Health, New York City. Amer. Jour. Pub. Health, *31:* 1121–1127. 1941.

In a presidential address to the American Public Health Association, Dr. Rice states that health departments must assume leadership and responsibility for a broader field of public health.

In regard to milk control, Dr. Rice states, "Our programs of milk control need looking into. Probably too much effort is being placed on inspection of dairy farms and too little on the collection stations and on the pasteurizing plants. In many communities we have reached a point where the quality of the milk supply is such that the health department no longer needs to spend its time in setting and enforcing standards for different grades. Rather, the health department should spend its time in making sure that all milk offered for sale is safe." M.W.Y.

138. Milk-Borne Disease in Massachusetts 1933–1940. ROY F. FEEMSTER, Mass. Dept. Pub. Health, Boston, Mass. Amer. Jour. Pub. Health, *31:* 1169–1173. 1941.

Milk-borne disease continues to decrease in Massachusetts with only four outbreaks within the last five years. The milk-borne diseases occurring at the present time are largely limited to septic sore throat and undulant fever. Over 90 per cent of the milk consumed in the state is pasteurized. Progress in sanitary control is evidenced by the fact that 78 communities representing nearly 80 per cent of the population of the state, now have regulations requiring that all milk be either pasteurized or certified. M.W.Y.

139. Undulant Fever. L. P. HIGHTOWER, Box 1719, Fort Worth, Texas. Texas State Jour. Med., *36,* No. 8 : 542–546. 1940.

The public health problems now seem to be the eradication of Bang's disease from all dairy herds, the prevention of re-infection from all possible sources, and the further insistance on the sale and use of only pasteurized milk and other dairy products. R.E.L.B.

140. Etiology and Symptomatology of Brucellosis. DEWITT NEIGHBORS, Med. Arts Building, Fort Worth, Texas. Texas State Jour. Med., *37,* No. 5 : 353–355. 1941.

More than 10 per cent of the tested cows of the U. S. have shown positive agglutination tests for Brucella infections. The swine and goat varieties of Brucella may be disseminated through cow's milk. Human infection by

direct contact with animals is of frequent occurrence. Probably less than 5 per cent of individuals using diluted infected milk will develop clinical brucellosis. Consideration should be given to the contrasting symptoms and clinical course of acute and chronic brucellosis. R.E.L.B.

141. Brucellosis, a Public Health Problem. LUTHER L. TERRY, Dept. Pub. Health and Prev. Med. and Practice of Med., Med. Branch, Univ. Texas, Galveston. Texas State Jour. Med., *37*, No. 5: 359–363. 1941.

"Clean" or non-infected herds must be retested at frequent intervals in order to maintain their freedom from disease, and all contacts or additions to the herd must be known to be free of Bang's disease. The latest evidence supplied by the Livestock Sanitary Commission of Texas shows that 4.8 per cent of those cattle tested between 1934 and 1941 were positive reactors. However, there is an evident decrease in percentage of reactors where proper control measures have been instituted. Where a more careful evaluation of the incidence of swine infection has been made, a control program similar to that now being carried out with cattle may be found necessary. Pasteurization of all milk and milk products must be extended. When milk is used in rural areas from infected or potentially infected cows, there is a reason for advocating boiling of milk. The pasteurization of such milk products as butter and cheese should receive more serious consideration than it has in the past. The protection of slaughterhouse workers, veterinarians, dairy husbandrymen, etc., must be forwarded by education to the dangers of handling potentially infected animals, especially if there are abrasions on the hands or arms. The immediate disinfection of wounds inflicted while at work and the desirability of wearing rubber gloves when abrasions are present must be emphasized. Further development of vaccines now under study may offer greater hope than any measure now known to protect this group of individuals. R.E.L.B.

FEEDS AND FEEDING

142. The Effect of Feeding Some Fat Soluble Dyes to Milking Cows upon the Color of Milk Fat. C. F. HUFFMAN AND C. W. DUNCAN, Michigan State College, Agr. Expt. Sta., East Lansing, Mich. Quarterly Bul., *24*, No. 1: 54–55. 1941.

It was found in this study that milk fat is readily stained by feeding certain soluble dyes. When Sudan III or IV were fed the color was noticeable in the next milking 12 hours later. When Brilliant Green was fed, the resulting butter was white with a green tinge. Upon melting, the butter oil was stained green. Perfect Purple also caused the butterfat to be green. Nigrosine Black produced a pink butterfat. It is apparent that certain

dyes are altered in the digestive tract or in the system of the cow. The possibility of using these fat-soluble dyes in studying the relation of food fat to milk fat is indicated. P.H.T.

143. The Economic Utilization of Wheat. A. J. AMOS. Food Mfr., *16,* No. 9. 1941.

Under normal peace time conditions England imports about 80 per cent of the wheat consumed in the country. This article discusses the advantages and disadvantages of producing white, "Wheatmeal," or wholemeal flour. The problem involves reduced materials for animal feeding.

J.C.M.

FOOD VALUE OF DAIRY PRODUCTS

144. More Consumer Education—the Real Answer to More Milk in the Diet. E. M. HARMON, National Dairy Council, Chicago, Ill. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 88–96. 1941.

Attention is called to a study by the National Dairy Council under the direction of Dr. C. W. Pierce to determine the effect of price upon milk consumption. Through various subsidies relief families in Boston were furnished milk through milk depots at five cents per quart. A similar basis was used in New York, Chicago and other cities. In each case the producer received a lower price, the dealer and retailer a lower margin and there was a subsidy by the Surplus Marketing Administration. The effectiveness in getting more milk consumed is answered by the fact that in Washington, D. C., only 25 per cent of those eligible to receive five cent milk actually went to the depots for it while in St. Louis only 12 per cent did so. It is argued that more consumer education is needed as much as cheaper milk. This contention is supported by findings of Gillett and Clark in a 1914 New York City survey of low income groups that a group not in contact with nutrition education spent 10 per cent of the food budget for milk and cheese while another group exposed to nutrition education spent 19 per cent. A similar comparison in 1928 gave 16 per cent and 25 per cent respectively for such groups. In one school with no nutrition program only 4 to 5 per cent of the students chose lunches which included milk and were rated adequate while in the other school with a nutrition program 30 per cent of the students chose adequate lunches. The avenues for education provided by the National Dairy Council and other agencies are outlined and it is suggested that their activities could with advantage be expanded.

E.F.G.

145. Milk Is in the Army Now. JAMES P. JOHNSTON, Civilian Consultant to Quartermaster General, U. S. Army, Washington, D. C. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 9–13. 1941.

Everything possible is being done by the U. S. Army to increase the consumption of milk among our soldiers. The daily garrison ration per man contains eight ounces of fresh milk, one ounce of evaporated milk, two ounces of butter and a quarter ounce of cheese. In the army ration there is no oleomargarine. First prescribed in 1776 fresh milk then disappeared from the army ration entirely for 150 years. Now through daily experience many of our soldiers are learning what constitutes a balanced diet of which fresh milk is an important part. There is every reason to believe that new or at least improved food habits will be carried back to civilian life including that of drinking milk.

The first week at a milk bar at Ponchartrain Beach, New Orleans, milk outsold beer 2 to 1. This was followed by recommendations to the National Dairy Council that dealers be encouraged to establish milk bars at all thirty Army Recreation Centers. It is recommended that the best thought and most thorough cooperation be given to the Defense Industry Advisory Committees which will attempt to make effective the efforts of the dairy industry in the defense production program. E.F.G.

146. Milk in Defense. A. G. MARCUS, Internatl. Assoc. Milk Dealers. Internatl. Assoc. Milk Dealers, Assoc. Bul. *34:* 3–8. 1941.

The problem is to increase consumption of dairy products in order to promote the nations health and at the same time to protect this effort from the well-intentioned though misdirected individuals who would substitute low cost foods as the price of milk rises. To meet the competition with some 300 other foods and beverages it is necessary to strive for lower costs of distribution to help get milk to consumers at a lower price. Particular attention is called to the work of the Public Relations committee through the Milk Industry Foundation in furnishing information, facts and statistics to various government defense agencies. It is suggested that members of the International Association of Milk Dealers as a matter of standard practice communicate with the Foundation in problems involving relations with any Federal agencies or departments.

The National Dairy Council is active in the nation wide nutrition program for defense. E.F.G.

147. "Super-Iodized" Milk. JOHN J. FOLEY, Washington Dairy, N. Tarrytown, N. Y. Milk Dealer, *30,* No. 12: 39. September, 1941.

The Washington Dairy at N. Tarrytown, N. Y., found that what was at first thought to be an expensive undertaking was just the opposite. Iodized milk has increased sales and the community response has made them truly glad that they took the step.

By feeding organic iodine they have increased the iodine content of milk

from 420 parts of iodine to 1 billion parts of milk to 1,260 parts of iodine to 1 billion parts of milk. C.J.B.

148. **Pasteurization and the Nutritive Value of Milk.** C. A. ELVEHJEM, Dept. Biochem., Univ. Wisconsin, Madison, Wis. Milk Dealer, *30,* No. 12: 44–52. September, 1941.

For abstract see Journal of Dairy Science Vol. XXIV page A330 Nov., 1941. C.J.B.

149. **Facts about Milk.** ANONYMOUS. Milk Dealer, *30,* No. 12: 37–38, 84–85. September, 1941.

A collection of previously published or released statements concerning nutritional value of milk. The purpose of the article is to make readily available material that can be used to sell more milk. C.J.B.

150. **Milk and Human Nutrition.** J. C. NISBET, Ohio Dairy Products Assoc., Columbus, Ohio. Milk Dealer, *31,* No. 1: 154–158. October, 1941.

Milk and human nutrition are discussed under the following headings: Make-up of human body; maintaining the human body; milk and energy; milk for protein; milk for minerals; and milk for vitamins. C.J.B.

151. **Refuel with Milk.** F. H. PLETCHER, Lab., Borden's Farm Products Co., Brooklyn, N. Y. Milk Dealer, *31,* No. 1: 52–60. October, 1941.

The requirements of the body in terms of an optimum food consumption are summarized under four prerequisites as follows: 1. If the activities of life are to be normally performed an adequate amount of appropriate protein material must be furnished by the food. 2. If an optimum development of the bones and teeth is to be acquired in youth and the internal activities of the body are to be discharged a definite amount of ash or mineral constituents must be made regularly available. 3. A food supply must have present a sufficient quantity of the essential vitamins which have been found requisite for the normal functioning of tissues. 4. The greatest single demand of the body upon a food supply is that it furnish energy for the performance of the continuous, never-ceasing work which must be accomplished while life is present. The main carriers of energy for the performance of body activities are the fuel foods, the fats and carbohydrates and to a lesser extent protein material.

The author then relates how milk fulfills these prerequisites. C.J.B.

152. **The Vitamin C Content of Dried Milk.** F. JUNG, Inst. Pharmacol., Univ. Berlin. Klin. Wochschr., *19,* No. 7: 153–155. 1940.

Fresh pasteurized bottled milk (3 samples), bulk milk (4 samples) and high-grade bottled milk (1 sample), which had a low bacterial count and was intended especially for infant feeding, contained 0.24–0.46, 0.32–0.98 and 0.43 mg. per cent ascorbic acid, respectively. These milks were purchased in the open market in Berlin. The vitamin C contents of various dried milk preparations, used in infant feeding, were determined: solutions of dried whole milk (14 g. milk powder in 100 g. water) contained 0.67–0.68 mg. per cent, solutions of dried buttermilk (10 g. milk powder in 100 g. water) 0.79 mg. per cent, and solutions of acid milk (14–16.7 g. milk powder in 100 g. water) 0.59–0.82 mg. per cent ascorbic acid. Transparent bottles, long transportation and prolonged refrigeration reduces the vitamin C content of fresh milk before it reaches the consumer. The vitamin C content of solutions of milk powder decreases on standing, although the vitamin C in the dried powder is quite stable in air. Irradiation with a mercury lamp, such as is used to increase the vitamin D content, reduces the content of ascorbic acid. The vitamin C content of dried milk powder is equivalent to that in Berlin whole milk. The vitamin C contents of both dried and fresh milk are too low to satisfy infant requirements and the use of ascorbic acid supplements is necessary. R.E.L.B.

153. Iodine Factor in Nutrition. ORMSBY MCHARG, Iodine Products Co., New York, N. Y. Milk Dealer, *30,* No. 11: 82–86. August, 1941.

The author points out the need for iodine in the daily diet and how it can best be acquired through iodized milk. C.J.B.

HERD MANAGEMENT

154. Raising Herd Replacements. E. K. BERG, Belle-Vernon Farms, Novelty, Ohio. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 65–67. 1941.

Careful selection of both males and females on the basis of heredity is recommended and detailed advice is given on the care and feeding of the young. A case is reported where 150 different females purchased at auction privately averaged 2.9 lactations with only 15 per cent remaining in the herd at an average depreciation cost of $28.75 per lactation while 100 home raised females completed 2.74 lactations with 55 per cent remaining and at a depreciation cost of $16.50 per lactation. E.F.G.

ICE CREAM

155. Cost of Pies. PETER TRIMBORN, Adv. Mgr., Ice Cream Field, New York. Ice Cream Field, *38,* No. 6: 6. 1941.

The typical pie making operations as carried out by Eliot Creamery Incorporated, Milton, Massachusetts, are shown by photographs.

It is stated that these pies wholesale for 28 cents each and dealers retail them for 39 cents each. The flavor of the centers is changed monthly, the most popular flavors being strawberry, butterscotch, cocoanut-pineapple, cherry, blueberry, and chocolate fudge.

Production costs are tabulated. These figures show a total cost of $0.1673 excluding overhead. It is claimed ice cream pies stimulate winter sales and also enable the company to keep valuable help through the winter.

W.C.C.

156. Developments in the Homogenization of Ice Cream Mixes. J. C. HENING, New York Agr. Expt. Sta., Geneva, N. Y. Ice Cream Field, *38*, No. 6: 14. 1941.

The importance of the homogenizer in the ice cream industry is pointed out and recent developments in homogenizers stressed. The results of several investigators are reviewed to emphasize the importance of many factors in determining the correct homogenization pressures to use as well as the conditions under which double stage and triple stage homogenization will likely be beneficial.

Mention is also made that rotary type machines do not give results equal to those obtained with the high pressure machines operating in the range 2000–3000 pounds pressure per square inch but they did compare favorably with those obtained in the range 1000–1500 pounds pressure per square inch. Results obtained by the author with a centrifugal colloidal mill gave coarse-textured ice cream.

W.C.C.

157. How to Make Pies. C. D. DAHLE, Pennsylvania State College, State College, Pa. Ice Cream Field, *38*, No. 6: 7. 1941.

Ice cream pies now combine fruit and ice cream in a form so attractive, so palatable and at a price that the demand in certain markets is very great, it is claimed.

According to the author plants equipped for large scale production of pies generally follow this procedure. A paper plate is passed under a continuous freezer or hopper and the correct amount of soft ice cream dropped and formed as a crust on the plate. Next a filler drops a measured amount of fruit on the bottom "crust" after which ice cream from a continuous freezer or hopper is added for the top "crust." The pie is then decorated with an edging of whipped cream and a star or rosette may be placed in the center. It is then placed in an attractive package with a cellophane window.

Unless the plant is properly equipped the author questions the advisability of making these pies. In certain cases it is pointed out that the fruit centers are frozen in metal or paper containers of the correct diameter and are then cut to the desired thickness and placed in the soft ice cream "crust."

The proper relation of sugar content of filling to temperature of serving

must be maintained, and the stabilizer content (usually pectin) must be carefully regulated as a means of maintaining the desired hardness of the filling at the time of serving. Approximately 45 per cent sugar gave the desired results.

Satisfactory results were obtained with gelatin as a stabilizer for chocolate filling in pies it was stated. W.C.C.

158. Ice Cream Pies. KEN FORREST MECRCH, Editor, Ice Cream Field, New York. Ice Cream Field, *38*, No. 6: 32. 1941.

During the fall and winter months most ice cream is bought for home consumption, it is stated. That is the time to dress up your ice cream package, create new ideas and new combinations. Offer an ice cream that is delicious to eat, and in a form easy to serve besides having eye appeal is the recommendation of the author. It is stated further that many ice cream companies have found it profitable to make ice cream pies that retail generally at 33 cents to 39 cents each.

Pie-filling formulas and often advertising streamers may be secured from established supply houses. The author lists a number of such supply houses. W.C.C.

159. Midwestern Dairy Trade Barriers. C. A. IVERSON, Iowa State College. Internatl. Assoc. Ice Cream Mfrs., Proc. 41st Ann. Conv., *1:* 85. 1941.

In general, trade barriers are said to fall into three different classes as follows: 1. Restrictions on trucks which are used in transporting ice cream or materials used for ice cream. 2. Licensing and registration restrictions on manufacture or sale of ice cream. 3. Trade barriers which restrict the areas from which dairy products going into ice cream may come.

The problems of trade barriers between states may be in part solved through the activities of the Council of State Governments. However, inspection regulations have the effect of trade barriers and are at fault because they lack uniformity as to sanitary requirements and as to the training and qualifications of inspectors. The U. S. Public Health Service Milk Ordinance and Code is of considerable value as a basis for standardization of inspection requirements. The International Association of Milk Sanitarians should also function in bringing about uniform and satisfactory standards for the inspection of dairy products. M.J.M.

160. Barricades to Business. W. H. LIST, JR. Internatl. Assoc. Ice Cream Mfrs., Proc. 41st Ann. Conv., *1:* 76. 1941.

Trade barriers in the North Atlantic States are affecting the ice cream industry by retarding the free flow of dairy products in intrastate and inter-

state commerce, by creating artificial price structures for dairy products, by increasing inspection costs, and by causing dissatisfaction and confusion among producers whose milk and cream may be used in several markets. Trade barriers are raising the costs of dairy products for ice cream manufacturing. A comparison of the cost of cream in New York City in comparison to other leading markets of the North Atlantic States is attributed to the trade barrier effect of the New York City Board of Health regulation requiring cream for ice cream to come from locally inspected producers.

Constructive action is possible if approved creameries under one health jurisdiction should receive reciprocal approval from other consuming markets. Uniformity of regulations for inspection of all milk should be established, with producer inspection carried on by authorities in the producing rather than consuming areas. Any shipper of cream or butter should be allowed to sell his products in any market providing credentials of inspection and notice of intention to ship have been filed in advance. And finally, by enlightened public opinion much should be accomplished. M.J.M.

161. **The Year's Work.** ROBERT C. HIBBEN, Washington, D. C. Internatl. Assoc. Ice Cream Mfrs., Proc. 41st Ann. Conv., *1:* 35. 1941.

This comprehensive report of the activities of the International Association of Ice Cream Manufacturers, the Statistical and Accounting Bureau of the Association, and the Ice Cream Merchandising Institute, Inc., was published as a special bulletin of the I.A.I.C.M. entitled, "Outline of Activities for the Year 1941." An abstract of this bulletin recently appeared in the Journal of Dairy Science. M.J.M.

162. **Address.** THE RIGHT HONORABLE MALCOLM MACDONALD, M.P., High Commissioner in Canada for the United Kingdom. Internatl. Assoc. Ice Cream Mfrs., Proc. 41st Ann. Conv., *1:* 28. 1941.

The question of proper diet has become a crucial consideration for Great Britain in the present war. The British people are partly dependent upon food imports from other countries overseas, although every effort has been made to increase food production in England. Since the ships that are free to carry this food are limited, it is essential that the foodstuffs be concentrated and of high nutritive value. They should also come from as near at hand as possible, so that ships can make a maximum of trips. In this address the speaker stressed the importance of the program of the Dairy Industries of America in furnishing the necessary dairy products for the British people at this critical time. M.J.M.

163. **Dairy Foods for Democracy.** L. E. HURTZ, Pres., Internatl. Assoc. Ice Cream Mfrs. Internatl. Assoc. Ice Cream Mfrs., Proc. 41st Ann. Conv., *1:* 22. 1941.

The program of the dairy industry in producing dairy products for the United States and her allies is the subject of this discussion. The dairy products which have been shipped to Great Britain, and the future needs, are given. Since evaporated milk, cheese, and dry milk are the products suited to export shipment, the idea might be accepted that only a part of the dairy industry is affected. However, the structure of the dairy industries is so complex that any change in one branch affects the others. The ice cream industry can be especially helpful in the emergency by furnishing an outlet for part of the sweet cream remaining from the manufacture of dried skim milk. Lend-lease aid alone will increase the production of sweet cream, through dry milk manufacture, over 100,000,000 gallons. If no market for this excess cream existed, the farmer could not be paid a sufficient price for milk for drying to justify its production. Since milk will be produced in larger quantities than ever before, the processors and manufacturers must handle this supply efficiently and economically. M.J.M.

164. **Substitutes in Ice Cream.** L. J. HYNES. Food Mfr., *16,* No. 8: 84. 1941.

Since the war in England, the ice cream industry of Great Britain has been hard hit because ice cream is a milk solids product, and legislation has put a stop to their use in ice cream. This article goes into detail telling how the manufacturer can replace the solids by use of unsalted margarine and vegetable fats. Also the use of fillers such as starch from wheat flour and soya bean flour is discussed. J.C.M.

MILK

165. **The Influence of Rancidity in Milk upon the Accuracy of the Fat Determination by the Mojonnier Method.** I. A. GOULD, Michigan State College, Agr. Expt. Sta., East Lansing, Mich. Quarterly Bul., *24,* No. 1: 19–22. 1941.

By aggravating lipolysis of the fat in milk through homogenization of the raw milk it was shown that the development of rancidity in milk would not only increase the fat acidity but also decrease slightly the percentage of fat as determined by the Mojonnier method. Increases in the fat acidity of 10-fold caused a reduction in the Mojonnier fat test of the milk of 0.0971 per cent. Larger errors in the Mojonnier results would be expected to occur in rancid products of high fat content. P.H.T.

166. **Influence of the Method of Sampling on the Accuracy of the Acidity Test of Sour Cream.** I. A. GOULD, Michigan State College, Agr. Expt. Sta., East Lansing, Mich. Quarterly Bul., *24,* No. 1: 42–49. 1941.

Analysis of 264 samples of sour cream for acidity were made on samples taken by three different methods. The methods used, together with the average results, are as follows: a. Weighed 9 gram sample—0.49 per cent; b. Use of 9 ml. pipette—0.423 per cent; c. Use of 9 ml. pipette rinsed with water—0.483 per cent.

The results indicate that for all practical purposes the use of a 9 ml. pipette will give sufficiently accurate results if the rinsings are included in the titration. When using this method the pipette should be rinsed with 7–9 ml. of clean, acid-free water. P.H.T.

167. **Analysis of Various Portions of Frozen Homogenized Milk.** G. M. TROUT, Michigan State College, Agr. Expt. Sta., East Lansing, Mich. Quarterly Bul., *24*, No. 1: 31–36. 1941.

When creaming was inhibited by heating or by homogenization, the unfrozen portion was higher in fat and milk solids not fat than the frozen portion. In the case of unhomogenized milk the frozen portion was higher in fat but lower in solids not fat than the unfrozen portion. A pronounced settling of fat was noted in frozen homogenized milk. The wateryness at the surface was more pronounced when the milk was thawed slowly. Upon thawing homogenized milk exhibited no flakiness which commonly occurs in unhomogenized milk when frozen and thawed. When homogenized milk was frozen and thawed, a marked settling of the fat and solids not fat was noted, being greater when the thawing was done slowly. P.H.T.

168. **Short-Time High Temperature Pasteurization.** T. W. WORKMAN, Yale Univ., New Haven, Conn. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., No. 22: 585–588. Aug., 1941.

The various fundamental factors in a satisfactory pasteurization system are grouped under five headings. To determine how well the high temperature short time system met the requirements of satisfactory pasteurization twenty commercial plants of varied capacity operating with standard units of Cherry-Burrell, Creamery Package, Electro-pure and York were studied. Laboratory pasteurization at 160° F. for 15 seconds was effective in all cases using 17 strains of *Micobacterium tuberculosis,* 74 strains of *Brucella abortis, suis* and *melitensis,* 218 strains of Streptococci of human origin, and 186 strains of mastitis types of bacteria.

In the case of the plants studied temperatures and holding time were satisfactory, every particle of milk was propertly treated and the resulting product was fully equal in creaming property, keeping quality and flavor to milk pasteurized by the standard holding method. Thermoduric types of bacteria may be destroyed in a lesser percentage, than with the standard holding method but these bacteria do not have public health significance and

such difficulty can usually be eliminated by a search for unsanitary conditions on some producers farms. It may be said that a short-time high temperature pasteurization: 1. Effectively destroys pathogenic bacteria; 2. Presents an entirely "closed" processing system; 3. Eliminates thermophylic development during processing; 4. Permits automatic control and the elimination of human element; 5. Yields final bacterial counts comparable with the holder process; 6. Presents some economic and operating advantages over standard holding equipment. E.F.G.

169. Short-Time, High-Temperature Pasteurization Using Tubular Heat Exchanger. F. C. CLAUSON, Flynn Dairy Co., Des Moines, Iowa. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., No. 22: 581–584. Aug., 1941.

Experience in adapting a tubular heat exchanger with a direct expansion tubular cooler to the pasteurization of market milk is reported. With this method 1100 ft. of sanitary pipe and much other equipment was dispensed with and the new system occupied only about one third of the floor space of the old. High counts obtained at first were found to be due to thermodurics from improperly cleaned milking machines which were not killed by the new method of pasteurization. Elimination of this source of thermoduric bacteria resulted in milk of satisfactory bacterial count. To secure more uniform bacterial results two 600-gallon holding tanks were used so that milk from many producers could be mixed. Consumer reaction to the flavor of the milk produced by this method of pasteurization was very favorable. E.F.G.

170. Merchandising Value of Homogenized Milk. G. G. DIFFENBACK, Abbotts Dairies, Inc., Philadelphia, Pa. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, 97–104. 1941.

The survey of the I.A.M.D. membership revealed 126 members in 111 cities now selling homogenized milk with seven others planning to enter the field. The highest average sales record was 60 per cent of the load by a concern selling at a one cent premium. Fifty-eight per cent of those reporting say that the major part of the homogenized milk supply is fortified with vitamin D and the usual premium for this milk is one cent.

The Philadelphia experience in introducing homogenized milk was very successful following a year of clinical study by the medical society on the nutritive properties of this milk in infant feeding. The favorable results of this study won the approval of the local physicians for the product. Homogenized milk is aided by the extensive promotion of evaporated milk on the basis of the desirable effects of homogenization. Fountain milk shakes are much improved when made with homogenized milk and increased consumption of milk shakes has in many cases been marked. E.F.G.

171. Repercussions of Defense Activities on the Milk Dealers Supply Problem. JOHN L. WILSON, U. S. Agr. Marketing Service, Washington, D. C. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 55–64. 1941.

Due to the fact that approximately one per cent of our population is now in army camps and also because of the varying effects of export needs from various branches of the industry, there are now many shifts going on within the industry. For 1941 certain fluid milk production areas faced smaller supplies of roughage and higher grain costs. Other sections of the country were rather liberally supplied with both. In 1940 an equivalent of a half billion pounds of milk placed the United States on an export basis for the first time since 1922. A milk equivalent of 2½ billion pounds will be exported in 1941 with present plans for doubling that in 1942. Traditionally fluid milk plants have been the largest outlet for whole milk but indications point to manufacturing plants taking the lead in 1942. The price spread between fluid and manufacturing milk has narrowed. This is illustrated by the fact that by the latter part of 1941 Wisconsin farmers received 170 per cent of the 1930–1939 average for cheese milk, 160 per cent for condensery milk but market milk had advanced only to 116 per cent. It is expected that the development of new manufacturing milk areas will ease the pressure upon the fluid milk supply areas. Normally a dairy feed ration costs 2–2½ times as much in certain eastern fluid milk sections as in major manufacturing milk areas but this year the eastern producers are at an even greater disadvantage. Labor costs are also giving more trouble to eastern producers. Year to year changes in consumption of fluid milk are about half as great percentagewise as national income. Population shifts because of defense activity are also affecting the fluid milk demand. It is expected the milk dealer will continue to have serious supply problems for the duration. E.F.G.

172. Some Competitive Aspects of Fresh and Evaporated Milk. L. C. CUNNINGHAM, Cornell Univ., Ithaca, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 68–79. 1941.

Over the last two decades the per capita consumption of fresh milk has been about constant, while that of evaporated milk has more than doubled. In low income areas particularly the consumption of evaporated milk has gained whenever the price spread between fresh and evaporated milk has widened. The 20-year average spread between New York Class I milk and Midwest condensery milk has averaged near $1.00 per hundred to the producer. A study of comparative costs of production of Class I milk and condensery milk in two New York State areas indicate an added expense for Class I of about $0.50 per hundred. The writer concludes that the historic spread and additional costs of producing fluid milk both are useful guides

in pricing fluid milk. The purchasing power of the consumer and the level of other foods must also be taken into consideration because too high a price for fluid milk will result in a shift to other alternatives. Over a period of years producers can expect only enough premium for fluid milk over evaporated milk to cover the cost of servicing the market. These added costs include mainly those due to meeting sanitary requirements, producing uniform year round supply and higher expenses of production in less favorable areas. E.F.G.

173. How Some Ontario Dealers Solved the Special Delivery Problem. HAROLD P. HART, Oshawa Dairy, Ltd., Oshawa, Ontario. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 39–44. 1941.

In Oshawa over a period of a month 72 per cent of 4000 milk customers did not use the special delivery service at all and 6 per cent of the customers accounted for an average of 74 of the 130 daily special deliveries. A one cent special delivery charge in 1934 reduced special deliveries by 30 per cent at the end of the first year and 34 per cent after the second year at an estimated annual saving to the Oshawa Dairies of $5000 per year. Special deliveries began to increase again in 1940 but the Milk Control Board prohibited this service altogether on August 1, 1941. In Guelph a one cent charge per package was added beginning in 1936. Sales were not reduced and public opinion was favorable. London added a one cent charge February 1, 1941, cutting special delivery costs 75 per cent to 80 per cent. A "No Special Delivery" order is in effect now. Important facts are that a small per cent of the customers are responsible for most of the special deliveries and that a one cent charge is enough in depressed times but too low as conditions improve. E.F.G.

174. Some Suggestions for Cleaning Equipment in the Plant. GEORGE W. COUGHLAN, Natl. Electric Mfg. Co., New York City. Milk Dealer, *30,* No. 12: 86–87. September, 1941.

A brief discussion is presented on how to prevent corrosion in milk-plant equipment. Methods of preventing and removing milk stone are also given. C.J.B.

175. Stepping up Milk Consumption in Industrial Plants. W. LAWRENCE WEAVER, E. I. DuPont de Nemours Co., Richmond, Va. Milk Dealer, *30,* No. 12: 72–78. September, 1941.

A discussion is given of how milk consumption was increased in an industrial plant. This increased consumption has brought about a downward trend in illnesses and absences due to illness. The author concludes that all over the United States there are industries that need such a program.

The Dairy Council can show them the need and give them the materials with which to work. C.J.B.

176. Bacteriological Problems in Short Time High Temperature Pasteurization. HAROLD WEINESS, York Ice Machinery Corp., York, Pa. Milk Dealer, *31*, No. 1: 106–112. October, 1941.

Data are presented which show that the plate count and the methylene blue test do not indicate the quality of raw milk for pasteurization as they do not show thermoduric contamination. Further data are then presented to show that the resazurin test is a relatively accurate index of thermoduric contamination. C.J.B.

177. Some Principal Constituents of Normal Breast Milk. M. WATANABE, K. KOBAYASI AND Y. KATO, Inst. Hygiene and the Children's Clinic, Medical Academy of Kioto. Mitt. med. Akad. Kioto, *30*, No. 4: 1077–1082 (in Japanese) (in German, 1345). 1940.

The milk of normal women in Kioto contained 2.43 to 2.89 (average 2.64) g. total N, 0.46–6.33 (average 1.55) mg. Zn and 8.9 to 40.5 (average 22.0) mg. vitamin C per l. The specific gravity of the milk varied between 1.0287 and 1.0343 (average 1.0319). R.E.L.B.

178. Solids-Not-Fat Nomograph. D. S. DAVIS, Wayne Univ., Detroit. Chem.-Anal., *30*, No. 4: 80. 1941.

A nomograph is given for the estimation of the percentage of solids-not-fat in milk when the specific gravity of the milk and its percentage of milk fat are known. The nomograph is based on the equation of Hawley (Analyst, *58*: 272. 1933): $S.N.F. = 287.2(D-1)/D - 0.328\ F$, where *S.N.F.* denotes the percentage of solids-not-fat, *D* the specific gravity at 85°/60° F., and *F* the percentage of milk fat. R.E.L.B.

179. The Freezing Point of Carabao's Milk and Its Use in the Detection of Added Water. M. GUTIERREZ, Nutrition Lab., Inst. of Hygiene, Univ. of the Philippines. Acta Med. Philippina, *2*, No. 4: 497–510. 1941.

The average freezing-point depressions of 16 samples each of carabao milk and cow milk were $-0.539° \pm 0.00097°$ and $-0.542° \pm 0.00218°$ respectively; the difference between these figures is not statistically significant. The amount of water added to the milk can be calculated from the equations: $y = -0.5318 + 0.0057x$ for carabao milk and $y = -0.5375 + 0.0056x$ for cow milk, where x = per cent added water and y = the freezing-point depression. The straight lines described by these equations are given. A tolerance of 3 per cent added water is recommended. Higher values, found

cryoscopically, render it very probable that water has been added to the milk. The fats and solids-not-fat were shown to have no influence on the freezing-point depressions of carabao and cow milks and were also found to be less reliable as indices for the presence of added water. Acidity within the limits noted in this investigation (0.154–0.250 per cent for carabao milk and 0.138–0.210 per cent for cow milk) had little, if any, effect on the freezing-point depression. R.E.L.B.

180. A Simple Method for Detecting Adulteration of Milk with Coconut "Milk." M. GUTIERREZ AND P. SUNICO-SUACO, Food Lab., Inst. of Hygiene, Univ. of the Philippines. Acta Med. Philippina, *2*, No. 3: 351–353. 1941.

The addition of coconut "milk," the milk emulsion obtained by expressing the grated meat of fresh coconuts, constitutes a unique and not uncommon method of adulteration of milk in the Philippines. The following method for detecting this form of adulteration is based upon the Selivanoff test for fructose, a constituent of coconut "milk" but not of animal milk. To a *fresh* solution of 0.1 g. colorless resorcinol (crystals of U.S.P. or reagent quality) in 10 cc. of 25 per cent hydrochloric acid are added 10 cc. of the suspected milk; this is mixed well and heated on the boiling water bath for 5 minutes. The development of a pink to red color indicates the presence of coconut "milk." Varying concentrations of coconut "milk," prepared by pressing through cheesecloth a mixture of 300 g. freshly grated coconut meat soaked in 500 cc. water for about 1 hour, were added to fresh carabao's or cow's milk. Milk which contained 6 per cent coconut "milk" gave a faint pink color with this test; this color became more distinct with concentrations of 10 per cent coconut "milk" or higher. With this test coconut "milk" alone gave a deep red color and precipitate, while carabao's or cow's milk gave a light brown color. Sucrose added to milk also gave a positive test but this form of adulteration can usually be detected by the sweet taste. R.E.L.B.

181. Coliform Organisms and Pasteurization. H. BARKWORTH. Dairy Indus., *6*, No. 5: 132. 1941.

The author reviews recent work with regard to the survival of coliform organisms during pasteurization. In summarizing the literature he concluded that even if certain strains of coli are capable of surviving pasteurization (145° F. for 30 minutes) it is clear from the evidence that for practical purposes survival can be ignored. Survival is obviously more a bacteriological phenomenon than a dairy problem and presence of coliform organisms in pasteurized milk is due to contamination after the heating procedure. D.V.J.

182. Sampling Producers Milk at Creameries. S. B. THOMAS, R. H. WEEKS AND I. ROBERTS. Dairy Indus., *6*, No. 9: 235. 1941.

Sampling from the weigh-tank after all cans from a producer have been poured in, was found to be a satisfactory method. Checking each can separately is theoretically the best and is advocated for official sampling by Public Health Authorities. However, under commercial conditions this system is far too laborious and complicated.

No significant difference was found in the fat content, solids-not-fat content and resazurin reduction time of samples taken before and after mixing the milk in the weigh-tank. There was no detectable contamination from residual milk left in the tank after draining. D.V.J.

183. The Bacteriological Control of Pasteurized Milk. A. ROWLANDS AND A. L. PROVAN. Dairy Indus., *6*, No. 5: 134. 1941.

The authors recommend the phosphatase test for determining the proper pasteurization of milk. When unsatisfactory tests are obtained in bottled milk, checks should be made throughout the processing system to determine the source of the difficulty. As bacteriological tests on raw milk, the methylene blue or resazurin tests are suggested. The conventional plate count should be used on pasteurized bottled milk.

The modified Burri smear, which gives adequate information for commercial purposes, can be used in checking laboratory pasteurized samples.

Coliform tests are useful but in cases of slight contamination these organisms may pass undetected if tests are run immediately after pasteurization. This difficulty can be overcome by incubating the samples at 22° C. for 18–24 hours before testing.

The keeping quality test involves holding the pasteurized milk samples at 60° F. and tasting for development of taint and/or coagulation upon boiling. These observations are made at about one-half day intervals. A keeping quality of at least 3 days under those conditions is desirable. The development of a taint or coagulation in less than 2 days indicates a questionable bacteriological condition in the product. D.V.J.

184. Food-Poisoning Epidemics. ANONYMOUS. Food Mfr., *16*, No. 10. 1941.

A number of food-poisoning epidemics of the para-typhoid type have been reported in various parts of England. Synthetic cream has been suspected as being the cause.

Synthetic cream is a valuable war-time substitute for cream or artificial cream made from butter. It is unfortunately liable to act as a good medium for the growth of bacteria, therefore, the greatest care is necessary to prevent infection during preparation. Bacteria may be introduced in one or

all of the following ways: (a) By use of infected materials. (b) By improperly cleaned plant or containers. (c) By hands and clothing of workers. The article discusses how these ways of infection may be removed. J.C.M.

185. The Dairying of the Future. JOHN G. DAVIS. Food Mfr., *16*, No. 11. 1941.

This article recommends certain sweeping alterations in the dairy industry, but it is emphasized that some of them may have to wait until the end of the war. The dairy industry is the most important aspect of the food supply and of agriculture. With a few exceptions the dairy industry is backward and suffers from a lack of up-to-date knowledge and co-ordination of its many aspects.

This article goes into the discussion of: Resting the Land; Inefficient Cows; Quality and Quantity of Milk; Inefficiency in Collection and Transport; and Problems of Small Retailer. The author makes several suggestions such as an Advisory Service; Payment on Quality Basis; and Dairy Education Centers. J.C.M.

186. Preventing Oxidized Flavor in Milk. D. V. JOSEPHSON AND C. D. DAHLE, Dairy Div., Pennsylvania State College. Milk Dealer, *30*, No. 11: 29, 60–62. August, 1941.

A discussion is given of the use of cereal extract as a preventive of oxidized flavor in milk. The following conclusions are drawn: When 0.02 per cent of a concentrated extract of maize flour was added to milk which was subsequently contaminated with copper, a definite antioxygenic effect was noted. This retardation or prevention of the oxidized flavor was evident throughout the normal storage period for milk.

During seasons of the year when milk is somewhat susceptible to the development of the oxidized flavor, very small contaminations of copper from equipment are sufficient to produce the defect. C.J.B.

187. Does a Co-operative Sales Program Pay? HAROLD F. ALBERT, Triple Cities Milk Council, Binghamton, N. Y. Milk Dealer, *30*, No. 11: 33, 64–66. August, 1941.

A discussion is given of the advantages of a cooperative sales program. From the results of actual experience in the triple cities the author believes that such advertising pays. C.J.B.

188. Cultured Skim Milk or Buttermilk. F. V. KOSIKOWSKY AND H. J. BRUECKNER, Dept. Dairy Industry, Cornell Univ., Ithaca, N. Y. Milk Dealer, *30*, No. 11: 36–50, 71–74. August, 1941.

This is a report of a study of the factors influencing the quality of cultured skim milk and buttermilk. The following conclusions are drawn:

1. Viscosity of cultured skim milk was directly related to the acidity at the time of breaking the curd. As the acidity increased the viscosity of the cultured skim milk became greater.

2. Overripening of cultured skim milk, when incubated at 72° F., did not cause whey separation. On the contrary, as the acidity increased, whey disappeared in cultured skim milk that had been subjected to high pasteurization temperature.

3. Underripening, at the time the curd was broken, was directly related to whey separation until an acidity of 0.725 to 0.750 per cent had been reached.

4. Viscosity of the cultured skim milk was directly related to amount of M.S.N.F. in the skim milk. However, at an acidity of 0.70 per cent or lower no clear relationship existed.

5. Standardizing milk to different percentages of M.S.N.F. solids produced no significant results regarding whey separation in these studies.

6. A pasteurization temperature of 185° F. for 30 minutes produced the highest viscosity.

A pasteurization temperature of 150° F. for 30 minutes produced the lowest viscosity studied, while pasteurization temperatures of 205° F. and 170° F. produced a viscosity intermediate between 185° and 150° F.

7. A pasteurization temperature of 185° F. for 30 minutes produced the minimum amount of whey, while a pasteurization temperature of 150° F. for 30 minutes produced a maximum amount.

8. Holding periods of 60 minutes were not effective in changing the viscosity or improving the whey separation qualities of cultured skim milk when compared to holding periods of 30 minutes.

9. Pancreatic enzyme, when used in concentration of 1/15,000, was effective in reducing the viscosity of the cultured skim milk without increasing the possibility of whey separation.

10. Pancreatic enzyme, when added directly to whole milk prior to separation, was found more effective in reducing the viscosity than when pancreatic enzyme had been added directly to the skim milk. However, less whey was produced when pancreatic enzyme had been added to the skim milk.

11. The flavor score of the cultured skim milk was not lowered when pancreatic enzyme was used.

12. The amount of whey separated in the low range of acidity was directly related to length of storage period.

13. A storage temperature of 38° F. was more effective in preventing the separation of whey for a period of one to three days than a higher storage temperature. After this period of low storage temperature had no

apparent effect on the prevention of whey separation of the cultured skim milk. C.J.B.

189. Milk Vending. WILLIAM HESLIN, JR., Heslin Dairy Co., New Britain, Conn. Milk Dealer, *31,* No. 1: 50, 130–131. October, 1941.

A brief discussion is presented on how the Heslin Dairy Company has profited from the use of milk-vending machines. C.J.B.

PHYSIOLOGY

190. The Treatment of Deficient Secretion of Milk by Irradiation with Ultrashort Waves. N. HIRAMOTO. (The 42nd Convention of the Obst. and Gynec. Soc. in Japan, held in Osaka, March 26, 1941.) Jap. Jour. Obst. Gynec., *24,* No. 2: 37. 1941.

The breast and mid-brain were irradiated with ultrashort waves (6 m.). For irradiation of the breast a round pole, 12 cm. in diameter, was used. The distance of irradiation was 40 cm. Irradiation was applied from the back and front once daily, beginning with 5, 7, 9 and 10 minutes and then 10-minute irradiation was applied 4–10 times. For irradiating the mid-brain a round pole, 7 cm. in diameter, was used. The distance of irradiation was 35 cm. Irradiation was applied from the right and left sides of the head once daily for 5, 5 and 7 minutes, respectively, on 3 successive days. This treatment, when given to 15 puerperal women with deficient secretion of milk, decidedly accelerated the lactation. No ill effects appeared locally or in the entire body. This method became more effective when combined with other methods for promoting lactation. R.E.L.B.

191. Effect of Visible Light on the Secretion of Milk. KOTARO MENZYU, Gynec. and Obst. Inst. Kitano Hospital, Osaka. Jap. Jour. Obst. Gynec., *23,* No. 3: 130–140. 1940.

Direct irradiation of the mammary glands of puerperal guinea pigs with red light promoted the secretion of milk, while irradiation with blue light resulted in retardation of the milk secretion; irradiation with white light had no effect. If the heads of puerperal guinea pigs were irradiated with red light 30 minutes daily for 8 days, the secretion of milk was accelerated, but similar irradiation with blue or white light produced no visible effect. Irradiation of the puerperal guinea pigs with red or blue light 1 hour after the subcutaneous injection of 1 cc. of 0.025 per cent methylene blue or 0.7 cc. of 1 per cent eosin per 100 g. body weight, respectively, gave no indication of any intensifying action. The effects of visible light on the secretion of milk are induced through the vegetative nervous system and the endocrine glands. R.E.L.B.

192. An Experimental Study on the Mechanism of the Secretion of Milk. I. An Experimental Study on the Physiological Growth of the Mammary Gland. K. MENZYU, Gynec. and Obst. Inst., Kitano Hospital, Osaka. Jap. Jour. Obst. Gynec., *22,* No. 4: 257–264. 1939.

The number of secretory ducts in the mammary glands was small in infant rabbits but increased as maturity was reached. The ducts increased rapidly during pregnancy. The vessel walls usually consisted of a double layer of epithelium, but in the later stages of pregnancy and in the puerperium secretory ducts of medium or small size with a single layer of epithelium began to appear; fat was evident within the cells. The amount of interstitial tissue was in inverse proportion to the growth of the gland tissue. The "endoapparatus," "endochambers" and glandular lobes were usually absent in the mammary glands of the infant rabbits. A few "endoapparatus" but no "endochambers" were found in adult virgin rabbits. In the early stages of pregnancy the secretory ducts, "endoapparatus" and glandular lobes developed but not the "endochambers." In the later stages of pregnancy and the puerperium the "endochambers" showed quite rapid growth. R.E.L.B.

193. An Experimental Study on the Mechanism of the Secretion of Milk. II. The Relation Between the Anterior Pituitary Lobe and the Mammary Gland. K. MENZYU, Gynec. and Obst. Inst., Kitano Hospital, Osaka. Jap. Jour. Obst. Gynec., *22,* No. 6: 376–386. 1939.

Infant female rabbits and ovariectomized rabbits were given daily intravenous injections of 20, 50, 100, 200 and 400 R.U. (rat units) of gonadotropin or praehormon (total 280–840 R.U.). Daily injection of 20–200 R.U. of either hormone preparation resulted in a gradual increase in the growth of the mammary gland parallel to the dose injected; in the group which received 400 R.U. daily, however, the growth was about the same as in those which received 200 R.U. daily. The secretory development also increased gradually with the dosage up to 200 R.U.; it was extremely vigorous when 400 R.U. was administered daily. Gonadotropin and praehormon acted upon the mammary gland chiefly, though not wholly, through the ovary; the action of both preparations was identical. The growth of the mammary gland did not parallel the secretion when acted upon by the anterior pituitary hormones. R.E.L.B.

194. An Experimental Study on the Mechanism of the Secretion of Milk. III. The Effect of the Separate and Combined Action of Follicular Hormone, Luteohormone and Anterior Pituitary Hormone On the Mammary Gland. KOTARO MENZYU, Gynec. and Obst.

Inst., Kitano Hospital, Osaka. Jap. Jour. Obst. Gynec., *23*, No. 1: 25–34. 1940.

Daily subcutaneous injections of 100 I.U. of ovahormone benzoate (follicular hormone) for 21 days markedly accelerated the growth of the mammary glands in immature castrated rabbits; the growth was accelerated still further if 1 "K.E." oophormin (luteohormone) was also injected during the last 6 days. Daily injection of 1000 I.U. of ovahormone benzoate or of water-soluble ovahormone for 6 or 7 days into puerperal guinea pigs beginning on the first day of the puerperium inhibited lactation; ovahormone benzoate had a greater inhibitory action than water-soluble ovahormone. This inhibitory action apparently originates in the mid-brain. The subcutaneous injection of 1000 I.U. of ovahormone benzoate or of water-soluble ovahormone combined with the intravenous injection of 200 R.U. of gonadotropin daily for 21 days into immature, female, noncastrated rabbits produced a greater acceleration of the growth of the mammary gland than the administration of ovahormone benzoate or water-soluble ovahormone. If the rabbits which had received this treatment for 15 days followed by the administration of water-soluble ovahormone, gonadotropin and oophormin as above for 6 days were castrated 24 hours after the last injection, a marked acceleration of the secretory function appeared 72 hours later. Oophormin is particularly important for the growth of the "endoapparatus" of the mammary gland; it has practically no effect on lactation. R.E.L.B.

195. An Experimental Study on the Mechanism of the Secretion of Milk. IV. The Relation between the Adrenal and the Mammary Glands. KOTARO MENZYU, Gynec. and Obst. Inst., Kitano Hospital Osaka. Jap. Jour. Obst. Gynec., *23*, No. 1: 35–41. 1940.

Gradual atrophy of the mammary gland occurred in puerperal guinea pigs which had been separated from their young 2 to 4 hours after delivery; secretion was still active, however, even on the 6th day of the puerperium. Daily subcutaneous injections of 0.5 cc .of 0.1 per cent adrenaline hydrochloride inhibited lactation. Daily subcutaneous injections of 0.5 or 1.0 cc. interenin (cortical hormone) during the first 5 days of the puerperium inhibited lactation slightly. R.E.L.B.

MISCELLANEOUS

196. New Aids for Better Cleaning. F. M. SCOLES AND MURIEL KEMP, Sheffield Farms Res. Lab., New York City. Internatl. Assoc. Milk Dealers, Assoc. Bul., 33rd yr., No. 22: 589–604. Aug., 1941.

It is pointed out that a formula for chemical cleaners may be satisfactory for some plants but not for others because of differences in the nature and extent of water hardness. In softening 3 waters of low, medium, and high

hardness it was found that for these samples sodium tetraphosphate was much more efficient than sodium hexametaphosphate or tetra sodium pyrophosphate. An explanation of the action of wetting agents or synthetic organic detergents is given and it is pointed out that synthetic organic detergents like soap have a polar or water soluble group on the end of a straight chain hydrocarbon while the wetting agents have the polar group nearer the middle of the chain.

Synthetic organic detergents which reduce the surface tension of their solutions so that suds are readily formed may be used to advantage in difficult cleaning operations. In can and bottle washers or where such solutions are pumped, excessive foaming might interfere. A prerinse plus slight soaking with the wetting solution, even sprinkling on with a brush, may be sufficient for many purposes. When laboratory tested, seven promising synthetic organic detergents gave cleaning results from very good to poor showing wide differences.

On the farm the producers cleaning problem can be greatly simplified by the use of the right synthetic organic detergent. For milk cans in the plant one of the polyphosphates may prevent calcium deposits on milk cans. Not to exceed 0.05 per cent of the right wetting agent may make a good can washing solution. Can washing with an acid solution has certain advantages over an alkali solution. For heaters treatment with acid solutions at 37.6° C. (100° F.) for half an hour followed by trisodium phosphate added to the same solution and circulated for 15 to 20 minutes may be used.

E.F.G.

197. **How to Develop Safe Drivers.** E. G. QUESNEL, The Borden Co., New York, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34:* 83–87. 1941.

Safe driving is a combination of good physical condition, proper mental attitude, experience, training, knowledge, skill and action. Specific suggestions are given on selection of employees and their later training. The causes of accidents lie in the failure either of some one person or thing. Since the art of safe driving is little used by most people it must be developed and its practice encouraged. The 1942 winners of the vehicle accident prevention contest of the I.A.M.D. were announced at the end of this paper presented before the Sales and Advertising Section at Toronto, Ontario.

E.F.G.

198. **Helping Men Sell.** EARL W. BEEBE, H. P. Hood and Sons, Inc., Boston, Mass. Internatl. Assoc. Milk Dealer, Assoc. Bul. *34:* 45–51. 1941.

Salesmen are best prepared by a thorough basic knowledge of their products. Then give them something different to talk about like: 1. Cello-

phane-wrapped butter, 2. Flower pots and ruby glasses, 3. Vacuum-packed cheese, 4. Butter dishes, 5. Cook books. These special packages effect permanent improvement in fluid sales. As a relaxation from delivery and collections it is suggested that one hour per day be used for competitive solicitation by route men. Unit money payment with a route building policy should be supplemented by periodic sales programs. E.F.G.

199. **Safe Practices for Dairy Salesmen and Drivers Accident Prevention Committee.** ANONYMOUS. Internatl. Assoc. Milk Dealers, Assoc. Bul., *33:* 3–12. 1941.

The subject is treated under two headings; first, safe driving practices and second, safe delivery practices. Under the former 34 situations likely to be hazardous to the dairy vehicle driver are discussed and suggested rules or procedures given. Under the second heading certain normally safe methods are given for handling bottles, cases, vehicles, cans and for certain delivery practices. The publication is intended as a manual for safety meetings of drivers and route men. E.F.G.

200. **Highlights of the New Tax Law.** J. S. SEIDMAN, C.P.A., Seidman and Seidman, New York City. Milk Dealer, *31,* No. 1: 82. October, 1941.

The new tax law is discussed from the standpoint of tax on investment profit, excess profits tax, and new capital. C.J.B.

201. **Advances with Full-Time Health Leadership. Progress Reported in Middletown.** FRANKLIN M. FOOTE, Hartford, Conn. Conn. State Med. Jour., *5.* No. 2: 116–121. 1941.

A brief discussion is included of food and milk supervision in Middletown, Connecticut. In 1939 the number of inspections of farms producing milk to be sold raw was more than doubled and the kind of inspection was improved. In 1937 approximately 40 per cent of the raw milk sold had a median bacterial count under 50,000 per cc.; in 1939 there was 84 per cent of such quality. The pasteurized milk sold increased from 51 per cent in 1937 to 61 per cent in 1939. A regulation requiring that caps on all grades of milk cover the pouring lip of the bottle went into effect on January 1, 1939. R.E.L.B.

202. **Refrigeration Requirements Affect Design of Water Cooling Equipment. Part I. Spray Ponds and Natural Draft Towers.** L. T. MART, The Marley Co., Kansas City, Kans. Refrig. Engin., *42,* No. 6: 365. 1941. **Part II. Mechanical Draft Towers.** Refrig. Engin., *43,* No. 1: 17. 1942.

A review of the trend in design of spray ponds, natural draft towers, and mechanical draft towers used in cooling water for refrigeration condensing systems and air conditioning systems. The mechanical draft tower has become increasingly important for water cooling, resulting in refinement in design of towers and increased capacity and efficiency in smaller units occupying less space. Diagrams and illustrations are included. L.M.D.

203. FlakIce Machines in Units. C. P. HOLLEY, York Ice Machinery Corp., Philadelphia, Pa. Refrig. Engin., *43*, No. 1: 23. 1942.

Two sizes of FlakIce machines are described, one DER-10, having capacity ranging up to 2000 lb. for 24 hours, and the larger DER-25, with capacity ranging from two to 5 tons. Freon-12 is the refrigerant employed in direct expansion in the freezing cylinder. The DER-10 machine is a package unit completely assembled at the factory, the only work necessary in the field being to make necessary electrical and water connections. The DER-25 machine, consisting of a freezing unit and separate condensing unit, must be assembled at point of field installation. The principal points of difference between these new models and the original FlakIce machine lies in their freezing cylinders being rigid in construction, not flexible. Ice is removed by an ice cutter made up of eight spiral blades whose action is of wedging effect rather than scraping in removing the ice layer which is 7/100 in. thick. Refrigeration is direct expansion in spiral grooves directly under the outer stainless steel shell of the freezing tube, the liquid refrigerant being fed through a shaft stuffing box, then through a drilled hole in the shaft to the spiral grooving and suction gas then is removed by means of similar connections at the other end of the cylinder. The ice leaving the freezing cylinders of these machines differs from that of the older machines in that its refrigerating effect is 144 b.t.u./lb. not having been subjected to any sub-cooling. L.M.D.

204. The Role of the College Graduate in the Dairy Industry. H. J. JUDKINS, President, A.D.S.A. Internatl. Assoc. Ice Cream Mfrs., Proc. 41st Ann. Conv., *1:* 68. 1941.

The various opportunities for the college man in the dairy industry are presented. They are (a) Research and quality control, (b) Production supervision, (c) Plant construction and maintenance, and (d) Positions having to do with business management.

Thus far in the selection and training of college men vocational training has been overstressed. In order to avoid this it is suggested that college departments of Economics, Business Administration and Dairy Manufactures work out a combined program more suited to the needs of the industry.

In the selection of college men summer employment can be used as a trial

period. Where union labor contracts make it difficult to employ college graduates, the office, laboratory or sales department are points for starting these men. Once employed, they should be given an all-around training and should be watched. An employee experience record is suggested as a way of keeping in touch with the men. A suggested form for an employee experience record is given. M.J.M.

205. Watch Your Water Supply—It Affects Food Quality. K. G. WECKEL. Food Indus., *14*, No. 1. 1942.

Water can affect the quality of food products in a multitude of ways. The qualities that determine the worth of the water are: 1. Acceptable flavor and color; 2. Clarity, freedom from turbidity, and sediment; 3. "Inert" chemical properties; 4. Uniformity in composition; 5. Bacteriological acceptability; 6. Availability in volume; 7. Acceptable temperature.

This article cites examples where even water used for cleansing purposes is likely to leave deposits that change flavor, odor or color. Some of the things to guard against in water properties, and what to do to overcome water difficulties, are set forth in this article. J.C.M.

206. Research Laboratory to Develop New Foods. F. L. SEYMOUR-JONES. Food Indus., *14*, No. 1. 1942.

The Borden Company has recently installed a laboratory, complete with pilot plant equipment, on the 17th floor of its office building in New York. The purpose of the laboratory is to develop new food products, with choice of projects based on needs of sales department and capacities of production department. J.C.M.

207. Control of pH in Canning Acid Foods. C. T. TOWNSEND, AND M. J. POWERS. Food Indus., *14*, No. 1. 1942.

Sterilization of canned foods is a function of time and temperature. This applies to acid foods as well as to those requiring pressure cooks. It has been found that the pH concentration must be kept below 4.5 to prevent spoilage. Some products must have the pH carefully controlled. The author then discusses how the pH may be controlled. J.C.M.

208. Bottled Gas. ANONYMOUS. Milk Dealer, *31*, No. 1: 42–43, 102. October, 1941.

A description is given of how a unique power installation, utilizing Butane gas, supplies refrigeration and heat at the Bluff View Dairy Company of Dallas, Texas. It is claimed that this gas method is saving from 10 to 35 per cent over former methods in a number of processes. C.J.B.

209. Licking Fleet Problems. ANONYMOUS. Milk Dealer, *31*, No. 1: 44–45, 118. October, 1941.

A discussion is given of how the Marin-Dell Dairy, wholesale dealer in San Francisco, has reduced the cost of operating its trucks by using correct size of tires, more careful battery service, and change in truck rear ends. Other savings are discussed under the following: Reducing deadweight, "check back" provided, road calls, oil dilution, and recording engine speed. Copies of the company's service record forms are shown. C.J.B.

210. British Food Industry Develops New Ideas. ANONYMOUS. Food Indus., *13*, No. 11: 39–40. 1941.

Under the pressure of total war, England's food factories have worked out new products, processes, ingredients and equipment. For example, they are making more use of home meats such as rabbit, gray squirrel, venison and wild duck. J.C.M.

211. Birdseye Demonstrates New 20-Plate Froster. ANONYMOUS. Food Indus., *13*, No. 11: 46–47. 1941.

This new 20-plate quick freezer represents an enlargement in capacity and improvement in control and efficiency of operation over the semi-commercial 10-plate unit described in Food Industry, September, 1940.

A freezing operation of this sort is adopted for large-volume operations in which the food is frozen in bulk prior to packaging. J.C.M.

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January 10th, 1942

Attention of Mr. H. J. Kerr

Gentlemen:

I wish at this time to take the opportunity to report upon the exceptional service which we have received from your No. 26 Super Roto-Matic Bottle Filler and Eight Wide CP Junior Bottle Washer.

The filler was installed about eight months ago and in the succeeding time we have handled through this ten valve machine an average of thirty-five thousand (35,000) bottles in a sixteen hour day. All this has been done with a minimum amount of upkeep. Compactness and simplicity of design with fewer moving parts are, in my estimation, mainly responsible for this excellent type of service.

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The service these two machines give and the number of units handled per day should be a guide in helping other dairymen in selecting this type of machinery.

Sincerely yours,
LOCKSHORE FARMS, INC.
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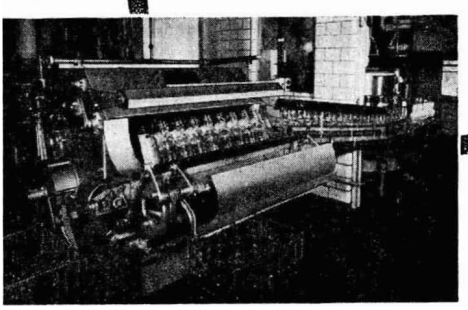
Plant Supt.



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