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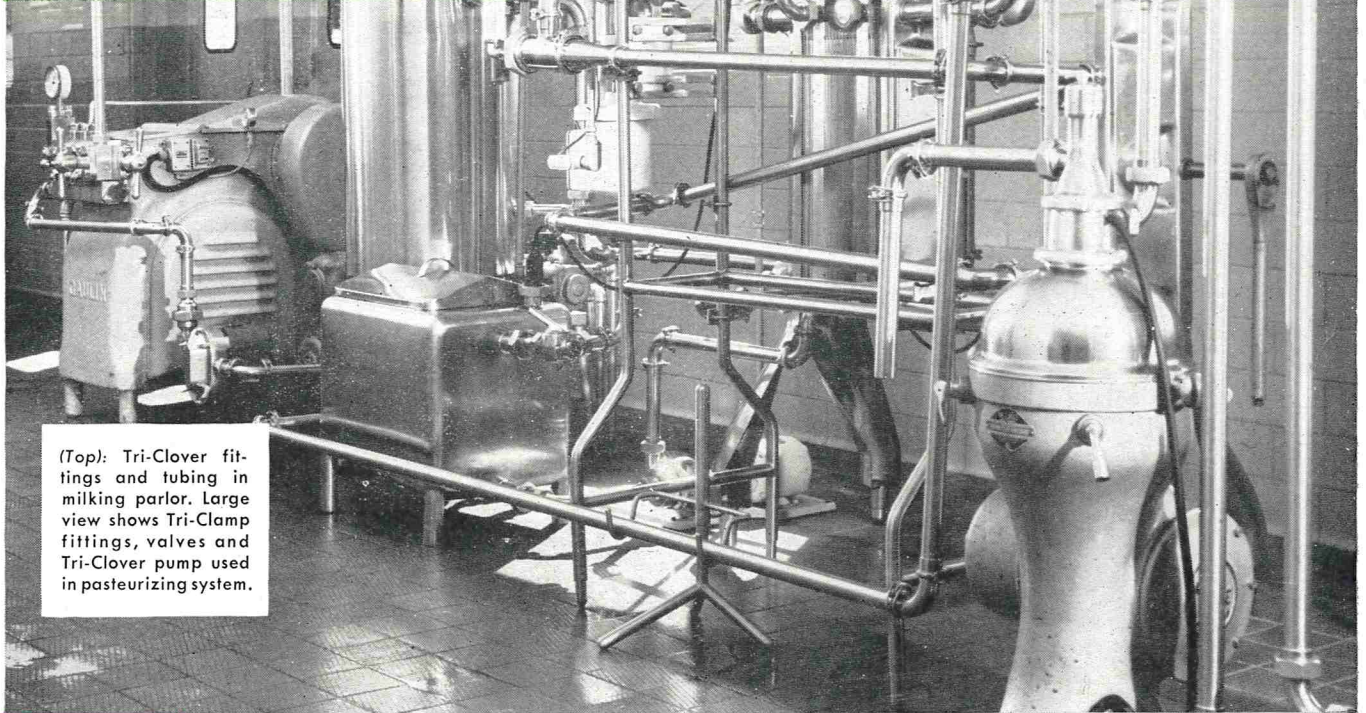
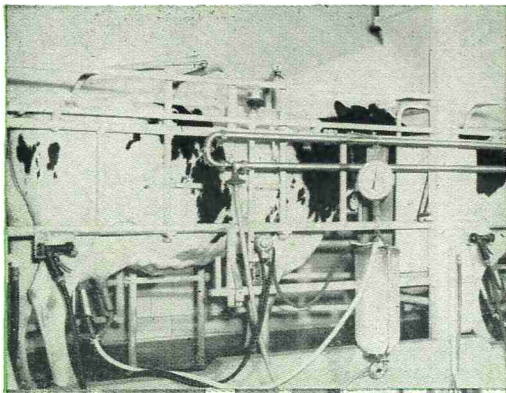
Journal of

MILK and FOOD TECHNOLOGY

Official Publication

International Association of Milk and Food Sanitarians, Inc.

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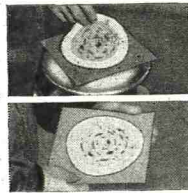
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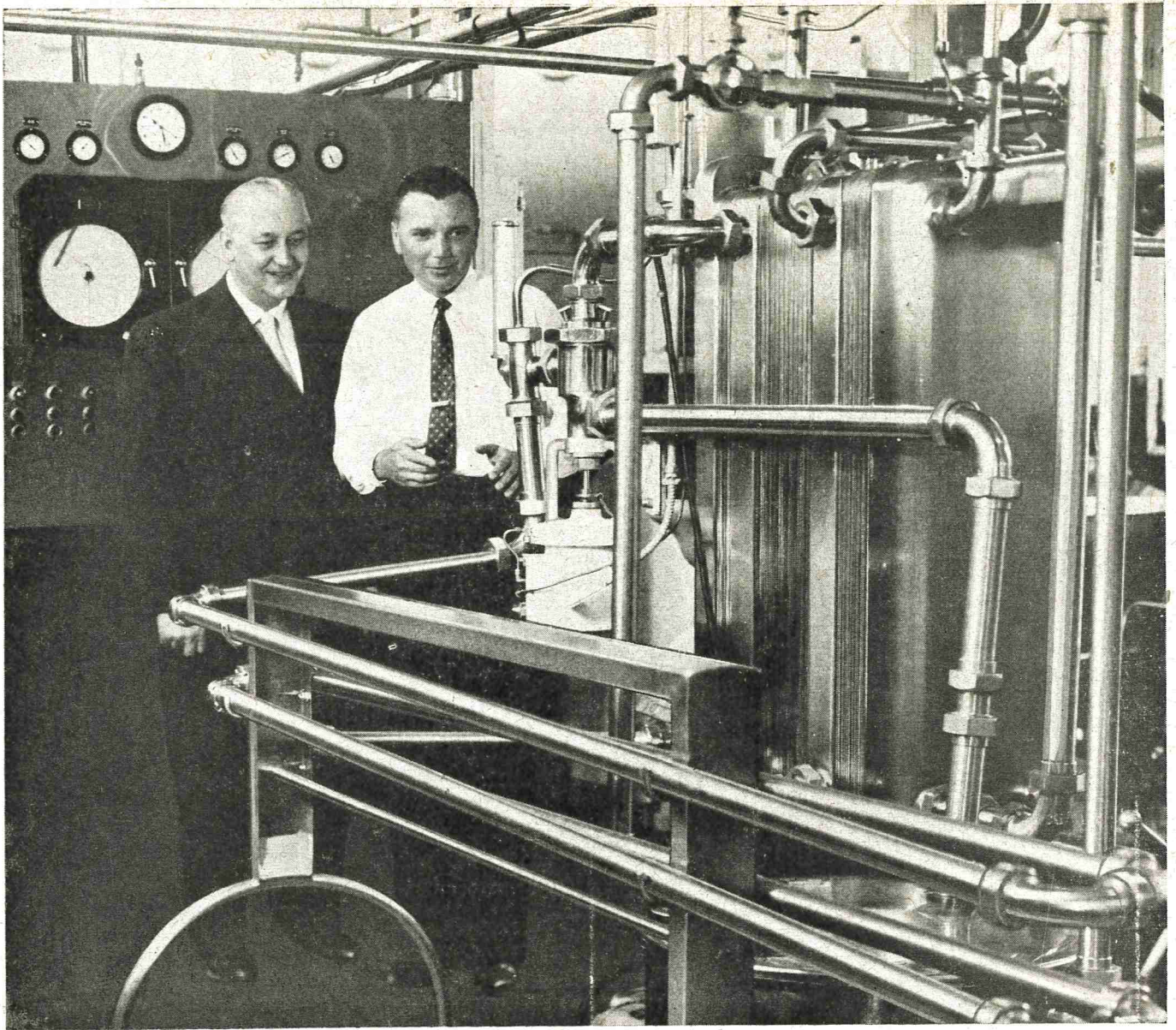
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Journal of

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INCLUDING MILK AND FOOD SANITATION

Official Publication

International Association of Milk and Food Sanitarians, Inc.

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Vol. 19 September No. 9

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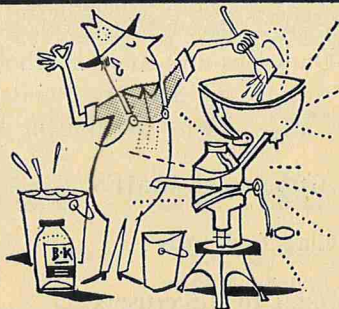
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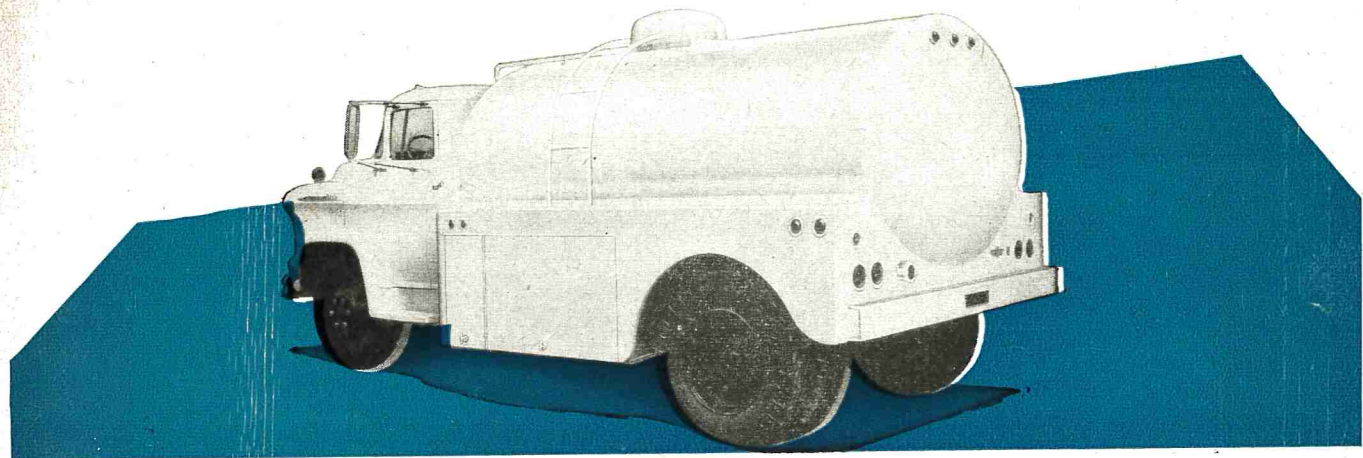



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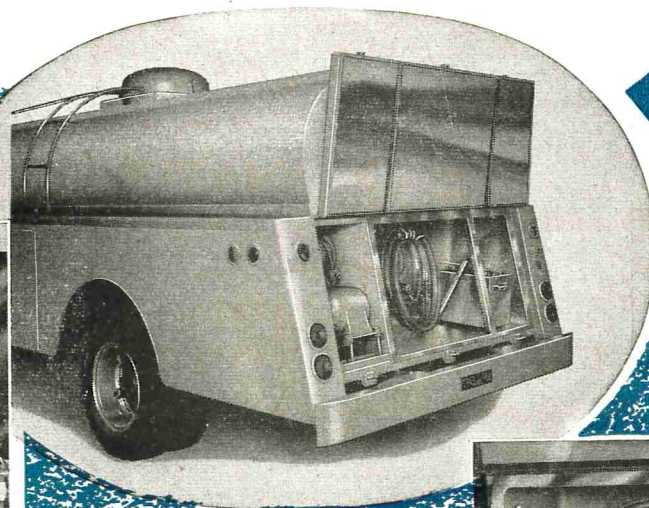


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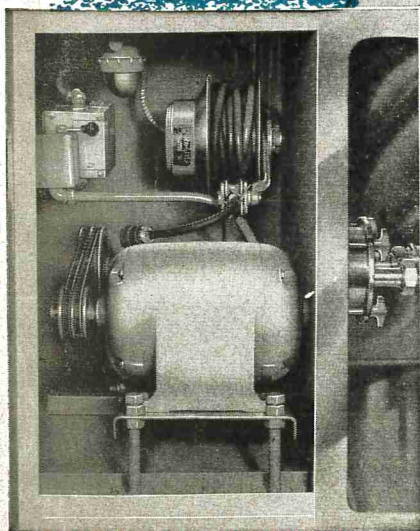


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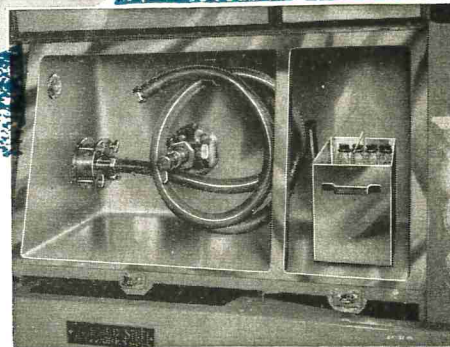
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Below: Large pump and sample compartments . . . Flash lights with automatic switch . . . Easily removable sample box with sampler tube conveniently mounted on side . . . Pump and sample compartment insulated with 2" expanded rubber insulation, including heavily insulated doors.



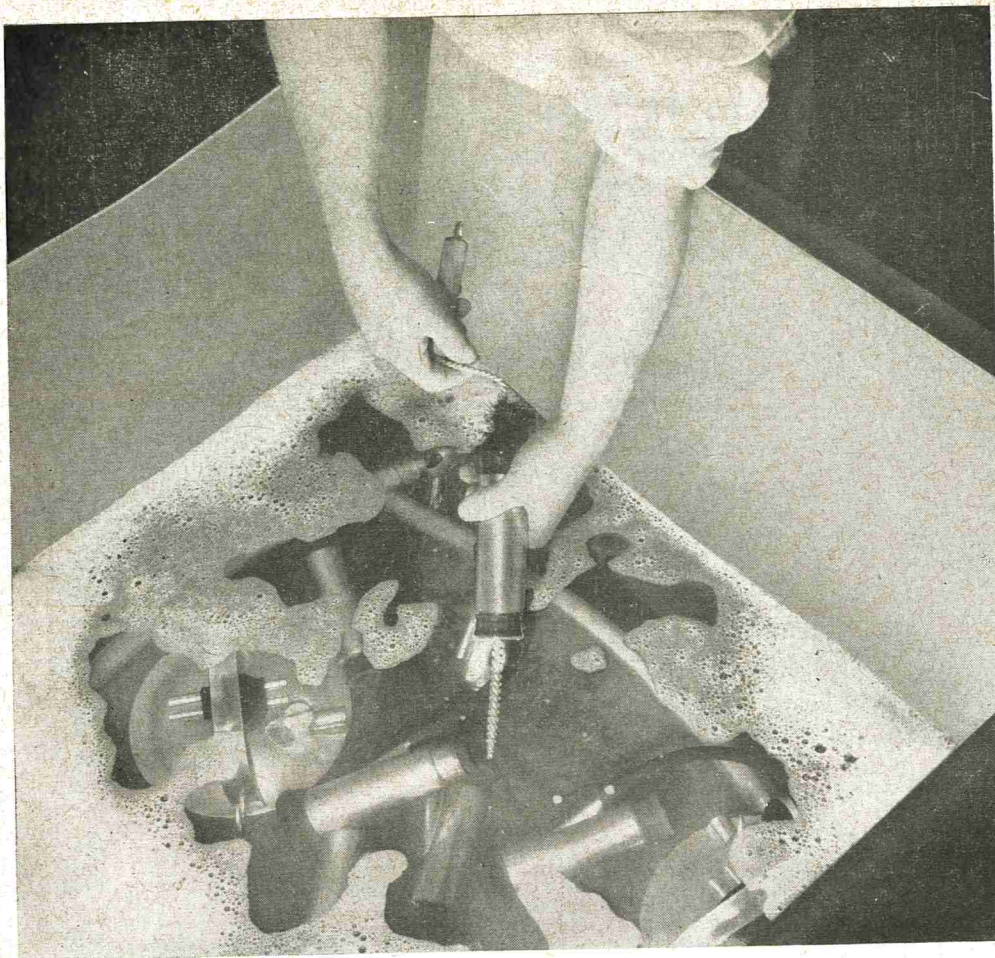
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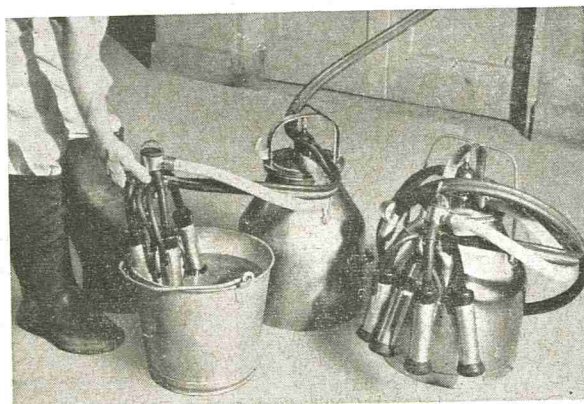
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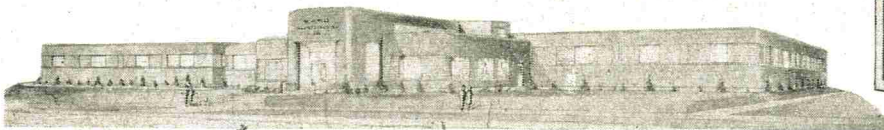
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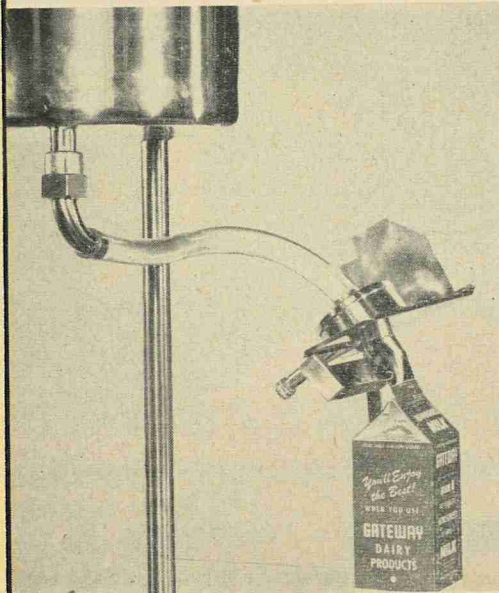


**mojonnier dawson's new
contributions to better sanitation
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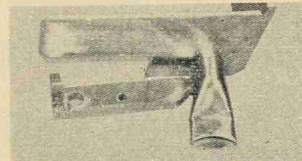
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A STATISTICAL ANALYSIS OF REDUCTION TIMES IN RELATION TO PLATE COUNTS

EUGENE K. HARRIS, ROBERT C. THOMAS, AND LUTHER A. BLACK

Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio

Received for publication February 4, 1956

In judging the bacteriological quality of milk supplies, most laboratories use either of two general methods for estimating bacterial density: (1) counting of colonies on an agar plate or clumps in a stained microscopic film, or (2) indirect estimation from dye reduction times.

Grade limits have been recommended by the Public Health Service Milk Ordinance and Code for each type of test. The counting procedures are covered by a single set of limits, established in terms of colonies or clumps counted under conditions specified by Standard Methods for each test. In the dye reduction tests, grades are based on the hours required to reduce the dye completely to a given color standard.

PUBLIC HEALTH SERVICE MILK ORDINANCE STANDARDS

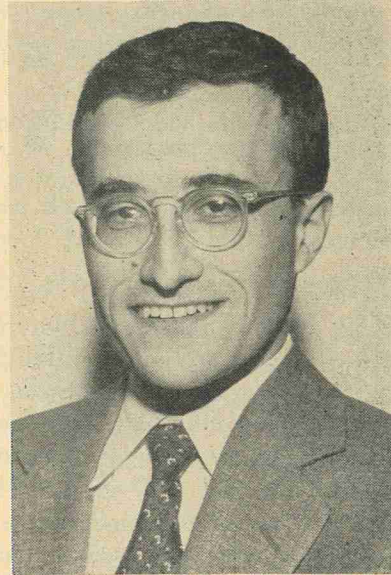
The 1953 edition of the Milk Ordinance and Code recommended by the Public Health Service (1) for adoption by states and communities contains the following grade standards for the alternative tests, based on an average of four samples taken during a period not to exceed six months.

The purpose of the present study was to examine the agreement in grades assigned to replicate samples of milk by plate count and reduction time tests carried out under the conditions specified in the Ninth Edition of Standard Methods for the Examination of Dairy Products (2). Various reduction time limits, including those recommended in the 1953 Milk Ordinance and Code (see Table 1) were examined to reveal discrepancies which might arise if the same milk were graded by total plate count and reduction time.

Statistical analysis was based on agar plate count rather than the direct microscopic count, or both, for several reasons: (a) recommended grade limits are the same for both counting procedures, (b) the direct count has been shown to be subject to considerable variation among individual readers — a source of error probably much less important in the plate count, and (c) it was desired to test agreement between reduction time and plate count when the latter was obtained after incubation at 32° and at 35° C.

EXPERIMENTAL WORK AND ANALYSIS

Data were obtained from 407 milk samples collected during fall, winter, spring, and summer seasons. A preliminary analysis of this material has been pre-



Dr. E. K. Harris has been in charge of statistical services at the Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio, since 1952. A graduate of Trinity College, Hartford, Connecticut, he obtained his Ph.D. from Yale University, and served for two years as instructor in biostatistics at the University of California in Berkeley before joining the Public Health Service.

viously reported (3). Methylene blue tubes were read after thirty minutes and at hourly intervals thereafter. Resazurin tubes were examined every hour. All tubes were inverted after each reading until a completed test was obtained. The distribution of individual milk samples by reduction times and Grade as indicated by plate counts after 32°C. incubation, is summarized in Table 2 for methylene blue and Table 7 for resazurin.

Results were analyzed by calculating per cent disagreements in grade classification under various reduction time limits. Consider, for example, a lower limit of three hours for the resazurin reduction time (to Munsell P 7/4) of Grade A raw milk. A sample which did not reduce resazurin within three hours but yielded a plate count greater than 200,000 per ml. would represent a disagreement in grade classification. For convenience, let us say that a milk placed in one grade by the plate count and in a higher grade by the reduction time has been "upgraded"; conversely, if placed in a lower grade by the reduction time, the milk has been "downgraded". Our purpose

TABLE 1 — BACTERIAL AND REDUCTION TEST STANDARDS FOR RAW MILK TO BE PASTEURIZED (AS DELIVERED FROM THE FARM)^a

Grades	Log. average plate or direct microscopic clump count/ml not to exceed:	Arithmetic average reduction time in hours to be not less than:	
		Methylene Blue	Resazurin (to Munsell P 7/4)
A	200,000	5½	2¾
B	1 million	3¾	2
C	No limit		No limit

^aSource: 1953 Milk Ordinance and Code (1), footnotes 30 and 34, pp. 12 and 17, respectively.

is to select reduction time limits which lead to the smallest total error of upgrading and downgrading.

METHYLENE BLUE REDUCTION

The following example illustrates the procedure, utilizing data in the first section of Table 2, namely spring milk samples classified by methylene blue reduction time and plate count after incubation at 32°C.

Five sets of limiting times were considered: (1) 6½ — 4½ — 0, implying that milk would be classified Grade A if its methylene blue reduction time were not less than 6½ hours, Grade B if between 4½ and 6½ hours, and Grade C if less than 4½ hours, (2) 5½ — 4½ — 0, (3) 5½ — 3½ — 0, (4) 4½ — 3½ — 0, and (5) 4½ — 2½ — 0, all with connotations analagous to those for the first set.

Under the first set, 6½ — 4½ — 0, Table 2 (Spring) shows that 20 of the 35 samples or 57.1 per cent, placed in Grade A by the plate count would be downgraded by the reduction time test. Similarly, 12 of the 29 samples, or 41.4 per cent, placed in Grade B by the plate count would be downgraded by the reduction test, while 4, or 12.8 per cent, would be upgraded. Finally, 8 of the 57 samples, or 14.0 per cent, placed in Grade C by the plate count would be upgraded by the reduction test. The overall average per cent change of grade would be 32 per cent, resulting from an average of 49 per cent downgrading change and 14 per cent upgrading change.

These results and similar calculations for the other sets are included in Table 3. A set of high reduction time limits would lead to considerable downgrading but little upgrading. The converse situation follows from a set of low reduction time limits.

Calculations such as these were carried out for each season and incubation temperature. The two temperatures yielded very similar results. The overall average per cent grade change under each set of methylene blue reduction time limits is given in Table 4 by season and temperature.

Even apart from the somewhat atypical results ob-

served during winter, which were not confirmed on more precise analysis, Table 4 does not offer much basis for choosing any one among the middle three sets of standards. The reason for this, of course, is the great variation shown in reduction times and plate counts by milk samples of apparently equivalent quality.

This unreliability of individual samples has been recognized in the Milk Ordinance and Code (1) (p. 49) which recommends grading based on the average of four successive observations. As noted in Table 1, a geometric mean plate count and an arithmetic mean reduction times are used.

Of the 67 farms from which data was obtained during fall, winter, and spring, a large majority contributed at least four samples. Farms sampled during summer were rarely represented in the other seasons; consequently, this season was eliminated from further analysis. Table 4 shows that per cent disagreements observed in summer milk samples were similar to those of fall and spring samples. An analysis of winter averages, based on two samples yielded by each 40 farms, did not confirm the atypical winter findings observed during the other seasons, namely, a minimum per cent disagreement in the neighborhood of 5½ — 4½ — 0 and 5½ — 3½ — 0 grade limits for methylene blue reduction time.

Therefore, samples from each farm during fall, winter, and spring were averaged to produce a single mean plate count and reduction time. Altogether, 51 farms were represented, each contributing 4 to 6 samples, accounting for 87 percent of all samples collected during these seasons. The resulting frequency distribution at 32°C. incubation temperature is shown in Table 5. The intervals 2½ — 3¾ and 3¾ — 4½ hours were employed to permit an exact test of the current Milk Ordinance and Code (1) Grade Limit recommendations.

Table 6 gives the average per cent disagreement under various methylene blue reduction time grade limits using means of 4 to 6 samples over several seasons. These findings support the presently recommended time limits, 5½ — 3¾ — 0, as the most suitable set for controlling discrepancies which may arise when grading by both plate count and methylene blue reduction time.

RESAZURIN REDUCTION

The evaluation of resazurin followed the same pattern as that described in detail for methylene blue. Table 7 classifies individual milk samples according to resazurin reduction times and plate counts after 32°C. incubation, while Table 8 shows the distribution of means. Use of the interval 2¾ — 2 hours permits an

TABLE 2 — DISTRIBUTION OF INDIVIDUAL MILK SAMPLES ACCORDING TO METHYLENE BLUE REDUCTION TIME AND PLATE COUNT AT 32°C., BY SEASON

Plate Count (per ml)	Reduction time (hours)							Total
	<1½	1½-2½	2½-3½	3½-4½	4½-5½	5½-6½	>6½	
Spring:								
<200,000 (Grade A)				5	5	10	15	35
200,000 - 1 million (Grade B)		1	2	9	10	3	4	29
>1 million (Grade C)	3	16	19	11	5	1	2	57
Total	3	17	21	25	20	14	21	121
Summer:								
<200,000			3	7	5	10	16	41
200,000 - 1 million		2	6	4	6	6	5	29
>1 million	12	20	12	7	2			53
Total	12	22	21	18	13	16	21	123
Fall:								
<200,000					6	4	5	15
200,000 - 1 million			1	5	6	1	1	14
>1 million	6	6	13	6	5	1	2	39
Total	6	6	14	11	17	6	8	68
Winter:								
<200,000			1	11	14	25	51	
> 200,000 - 1 million			2	7	2	3	2	16
>1 million	5	8	7	5	1	1	1	28
Total	5	8	9	13	14	18	28	95

exact test of the Grade limits, 2¼ - 2 - 0, recommended by the current Milk Ordinance and Code.

Finally, Table 9 shows the average per cent disagreement under various resazurin reduction time grade limits. Again, the presently recommended limits appear to be most satisfactory.

DISCUSSION

It is interesting that the analysis of means revealed differences between the two incubation temperatures which were not apparent when individual samples were studied. Plates incubated at 32°C. were less likely to disagree with dye reduction time than plates incubated at 35°C., under the optimal reduction time limits. Nevertheless, even under these time limits, and despite the use of means, the probability of disagreement between resazurin or methylene blue reduction

TABLE 3 — EXAMPLE OF AVERAGE PER CENT CHANGES IN GRADE, BY TYPE OF CHANGE, WHEN VARIOUS SETS OF REDUCTION TIME LIMITS ARE COMPARED WITH PLATE COUNTS (DATA OF TABLE 2: SPRING, METHYLENE BLUE, PLATES INCUBATED AT 32°C.)

Reduction time limits	Overall average	Average per cent changes in grade	
		Downgraded	Upgraded
6½ - 4½ - 0	32	49	14
5½ - 4½ - 0	27	35	19
5½ - 3½ - 0	24	19	29
4½ - 3½ - 0	29	12	46
4½ - 2½ - 0	36	9	63

TABLE 4 — AVERAGE PER CENT CHANGES IN GRADE WHEN VARIOUS SETS OF METHYLENE BLUE REDUCTION TIME LIMITS ARE COMPARED WITH PLATE COUNTS, BY SEASON AND TEMPERATURE

Reduction time limits	Spring		Summer		Fall a		Winter
	32°C	35°C	32°C	35°C	32°C	32°C	35°C
6½ - 4½ - 0	32	30	31	28	34	33	31
5½ - 4½ - 0	27	25	30	28	29	30	28
5½ - 3½ - 0	24	22	30	28	24	24	23
4½ - 3½ - 0	29	28	32	32	25	22	22
4½ - 2½ - 0	36	32	32	35	32	25	25

aIncubation at 35°C. omitted during fall

TABLE 5 — DISTRIBUTION OF ARITHMETIC MEAN METHYLENE BLUE REDUCTION TIMES AND GEOMETRIC MEAN PLATE COUNTS AT 32°C. INCUBATION FOR SAMPLES COLLECTED FROM 51 INDIVIDUAL FARMS DURING FALL, WINTER, AND SPRING

Plate count/ml.	Reduction time (hours)							Total
	0-1½	1'-2½	2½-3½	3½-4½	4½-5½	5½-6½	>6½	
<200,000					2	6	5	13
200,000 - 1 million			1	5	10	5		21
>1 million	1	4	9	3				17
Total	1	4	10	8	12	11	5	51

TABLE 6 — AVERAGE PER CENT CHANGES IN GRADE WHEN VARIOUS SETS OF MEAN METHYLENE BLUE REDUCTION TIME LIMITS ARE COMPARED WITH MEAN PLATE COUNTS, BY TEMPERATURE

Incubation Temperature	Reduction time (hours)				
	6½-4½-0	5½-4½-0	5½-3¾-0	4½-3¾-0	4½-2½-0
32°C.	23	17	15	23	36
35°C.	32	27	22	25	30

TABLE 7 — DISTRIBUTION OF INDIVIDUAL MILK SAMPLES ACCORDING TO RESAZURIN REDUCTION TIME AND PLATE COUNT AT 32°C., BY SEASON

Spring: Plate Count per ml.	Reduction time (hours)					Total	
	<1	1-2	2-3	3-4	>4		
<200,000		3	11	15	6	35	
200,000 - 1 million			13	10	5	1	29
>1 million		19	30	5	3		57
Total		19	46	26	23	7	121

Summer: per ml.	Reduction time (hours)					Total
	<1	1-2	2-3	3-4	>4	
<200,000	3	8	16	9	5	41
200,000 - 1 million	1	11	14	3		29
>1 million	32	16	4	1		53
Total	36	35	34	13	5	123

Fall per ml.	Reduction time (hours)					Total	
	<1	1-2	2-3	3-4	>4		
<200,000		1	4	5	5	15	
200,000 - 1 million			1	8	4	1	14
>1 million	14	16	5	3	1	39	
Total	14	18	17	12	7	68	

Winter: per ml.	Reduction time (hours)					Total
	<1	1-2	2-3	3-4	>4	
<200,000		5	13	14	19	51
200,000 - 1 million		2	7	5	2	16
>1 million	15	11	2			28
Total	17	23	20	16	19	95

TABLE 8 — DISTRIBUTION OF ARITHMETIC MEAN RESAZURIN REDUCTION TIMES AND GEOMETRIC MEAN PLATE COUNTS AT 32°C. INCUBATION FOR MILK SAMPLES COLLECTED FROM 51 FARMS DURING FALL, WINTER, AND SPRING

Plate Count/ml.	Reduction time (hours)					Total
	0-1	1-2	2-2½	2½-4	>4	
<200,000		1	1	11		13
200,000 - 1 million			3	15	3	21
>1 million	4	11	2			17
Total	4	15	18	14		51

TABLE 9 — AVERAGE PER CENT CHANGES IN GRADE WHEN VARIOUS SETS OF MEAN RESAZURIN REDUCTION TIME LIMITS ARE COMPARED WITH MEAN PLATE COUNTS, BY TEMPERATURE

Incubation Temperature	Reduction time (hours)		
	4-2½-0	2½-2-0	2-1-0
32°C.	46	14	42
35°C.	44	21	35

time and standard plate count remained substantial.

Other workers in this field, notably Barkworth *et al.* (4), in England, and, most recently, Johns (5), in Canada, have noted increased reduction times in cooler months, attributing this to an inhibiting effect of low temperature on the activity of individual organisms. The former authors point out, however, that an increase in average methylene blue reduction time was seen only in milk of relatively low bacterial count. A density greater than 200,000 organisms per ml., was sufficient to counteract effects of low temperature and show reduction times similar to those during summer.

The findings were confirmed in the present work, although more clearly in the case of resazurin than methylene blue. Average resazurin reduction time of individual Grade A milk samples was about 40 per cent longer during winter than summer; methylene blue reduction time was only twelve per cent longer. In milks of higher bacterial count, average reduction times in winter and summer were almost identical. Hence, no excessive upgrading error would be expected during winter, nor was one observed.

These results do not agree with those reported (in graphical form) by Johns. He observed average reduction times in high count milk between 50 and 100 per cent higher during cooler months (March-April) than warmer months (May-June).

SUMMARY

1. An analysis has been made of plate counts and

dye reduction times (methylene blue and resazurin) observed in 407 split milk samples as delivered from farms during all four seasons of the year.

2. A simple procedure is introduced for estimating disagreements in grading when accepted plate count and various dye reduction time grade limits are applied to these observations.

3. Observations in individual milk samples were found too variable to permit clear selection of the set of reduction time grade limits which minimizes disagreements. Therefore, an analysis was undertaken of logarithmic mean plate counts and arithmetic mean reduction times based on groups of 4 to 6 milk samples as delivered during fall, winter, and spring from each of 51 farms.

4. Results indicate that reduction time standards recommended in the 1953 Milk Ordinance and Code for methylene blue and resazurin are most suitable for minimizing disagreements between dye reduction time and plate count in grading milk supplies.

5. Average resazurin reduction time of individual Grade A milk samples was 40 per cent longer in winter than in summer; methylene blue reduction time was 12 per cent longer. However, in milks of higher bacterial count, average reduction times in winter and summer were almost identical.

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STATUS OF POULTRY SANITATION¹

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Three general statements describe the status of poultry sanitation today: (a) Substantial gains have been made in poultry sanitation by many progressive processors and distributors; (b) there is a definite need for even wider application of known sanitary measures throughout much of the poultry industry; and (c) there are a number of current developments which show promise of bringing about vast improvements within the next few years.

SUBSTANTIAL GAINS

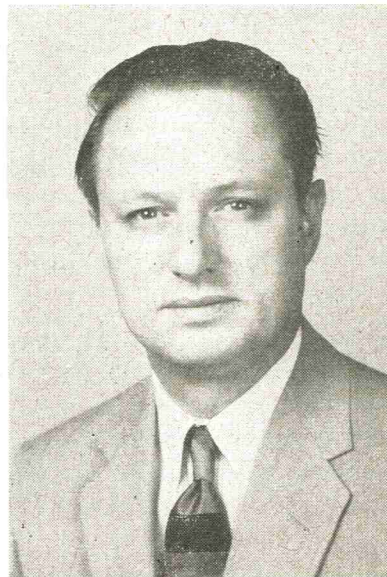
Evidence of improved sanitary practice in the poultry-processing industry is apparent to all. The variety of appetizing ready-to-cook and precooked poultry products available in stores throughout the United States afford a sharp contrast to the live or New York-dressed bird commonly offered to the housewife in the past. Improved sanitary practice has made the processing and distribution of these products possible.

Much credit is due the poultry-processing industry for these advancements. Undoubtedly, self-interest has been one prime motive of those responsible. The availability of ready-to-cook and precooked poultry and poultry products has been the basis for a 100 percent increase in poultry production since 1940. Nevertheless, the best interests of the consuming public have also been served to the extent that progress has been made by the industry in utilizing better sanitation and refrigeration practices.

In 1928, certain members of the poultry industry requested the U.S. Department of Agriculture to provide a poultry inspection and sanitation service to help assure the wholesomeness and sanitary quality of processed poultry. Such a service has been provided, on a permissive basis, since that time. More than 250 plants now operate under U.S.D.A. inspection, producing between 20 and 25 percent of the total poultry processed in the United States. The operators of these establishments are to be commended, particularly because they are not required to have the inspection service, but voluntarily apply for it and pay most of the cost involved.

Important in influencing processors to use the U.S.D.A. inspection and sanitation services are the

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requirements of the Department of Defense for inspected poultry to feed military personnel. Contributory, also, is the assistance thus provided the processor in meeting the requirements of regulatory agencies, such as the U.S. Food and Drug Administration or State and local regulatory agencies.

Along similar lines, some State and local jurisdictions offer permissive poultry inspection and sanitation services. Furthermore, general food sanitation programs in many States and municipalities have been effective in bringing about varied improvements in poultry sanitation within the jurisdictions concerned. In a few instances, specific poultry regulations within

a metropolitan consuming area have resulted in improved sanitary practice in processing plants supplying the market, even though located in distant jurisdictions (e.g., the poultry-sanitation requirements of Cincinnati, Ohio, and the requirement for official inspection of ready-to-cook poultry shipped into New York City).

STATUS GENERALLY UNSATISFACTORY

Notwithstanding progress made, many existing conditions and practices leave much to be desired. State and local poultry-sanitation requirements vary greatly. Some poultry processors have never been advised on the essentials of good sanitary practice, or have disregarded such advice in this absence of effective, official enforcement. Full realization of the need for uniform, adequate, official enforcement programs is just becoming apparent on the part of many regulatory officials, legislators, consumers, and representatives of the poultry industry.

Furthermore, enforcement of applicable regulations may be largely ineffective because of (a) inexperience or disinterest on the part of enforcement personnel, (b) insufficient number of personnel for enforcement, (c) lack of public, official, or industry support for the program, or (d) because the regulations do not provide the authority needed for effective enforcement.

Unsatisfactory Conditions

Some of the conditions and operations found, which are unsatisfactory from a sanitation viewpoint, are:

1. Lack of adequate separation of live poultry areas, poultry dressing operations, and eviscerating and subsequent processing operations. This is frequently associated with inadequate space for operations conducted, and lack of proper construction and maintenance of floors, walls, doors, windows, and processing equipment.
2. Lack of proper ventilation, with employees and products exposed to heavily contaminated air.
3. Lack of adequate bleeding of poultry.
4. Lack of proper bleeding and scalding facilities in small establishments.
5. Lack of proper eviscerating facilities in small establishments.
6. Lack of adequate lavatories and of facilities along the processing line for rinsing hands and utensils.
7. Lack of adequate facilities for thorough cleaning and sanitizing of small utensils and portable equipment.
8. Inadequate methods for cleaning and sanitizing equipment and plant; cleaning not performed at proper intervals.
9. Processing operations conducted at speeds which are incompatible with proper maintenance of sanitary

conditions, and which render it impossible or impracticable for employees to perform their duties consistently in a sanitary manner.

10. Inadequate cleaning and washing of dressed poultry.

11. Chilling in ice slush, or other holding of New York-dressed carcasses before evisceration.

12. Contamination of giblets and edible carcass during evisceration with material from crops or intestines.

13. Inadequate pinning, trimming, evisceration, or washing of so-called ready-to-cook poultry; improper procedures or sequence for the various steps of evisceration.

14. Inadequate facilities, methods, or temperatures for the chilling and other refrigeration of products.

15. Lack of proper sanitary precautions in the processing of precooked poultry products.

16. Water supplies insufficient, not of known safety, lacking in adequate pressure; cross-connections and submerged inlets.

17. Inadequate protection against rodents and insects.

18. Waste-disposal facilities, methods, or schedules not adequate for consistent protection of product from contamination and for general maintenance of sanitary conditions.

19. Poor personal hygiene and habits of employees.

20. General sanitation of plant and premises unsatisfactory.

21. Products not adequately protected or refrigerated subsequent to shipment from the processing establishment.

In many instances, habit, local custom, or economic considerations may be responsible for the existence of these unsatisfactory conditions. Contributing in large measure, however, is a lack of knowledge or interest on the part of management in regard to the need for, and value of, proper sanitation. This results either in a similar lack of knowledge or interest on the part of employees, or in a feeling of frustration and helplessness among those employees who are informed and conscientious in this regard. In addition, representatives of official agencies may fail to carry out their responsibilities, thus confounding management and employees alike.

A Few Examples

Following are just a few examples which show that the inadequacies existing today in some poultry-processing plants are not confined to very small plants, or to those not under official surveillance. All of these examples were observed in relatively large establishments producing substantial to extremely large volumes of poultry. In some instances, all or part of the resulting product carried an official legend or stamp indicating official inspection for wholesomeness or pro-

duction under official sanitary supervision.

1. On a visit with a local regulatory official to a large, well-constructed and well-equipped plant, it was observed that the vents of the carcasses were being pulled outward and excised, thus opening the cloaca or terminal part of the intestines and contaminating the body cavities of the carcasses with fecal matter. The "inside-bird-washer" was not being used to wash out the eviscerated carcasses because "so many girls were sick and didn't come to work that day". It was quite apparent that there was no shortage of personnel to hang birds on the line for slaughter and to remove the eviscerated carcasses from the line for chilling and shipment from the plant. No enforcement action was initiated, presumably because of the absence of an adequate municipal ordinance dealing specifically with poultry.

2. On an informational survey with State and local officials, a number of poultry-processing plants were visited. Several of these were operating under continuous inspection-for-wholesomeness services. Significant sanitation deficiencies were noted in each plant, *e.g.*, (a) air in processing rooms heavily laden with dust from live-poultry areas; (b) surfaces of "flaps" in conveyor-line openings having thick accumulations of organic matter caused by repeated contact over many months with carcasses on the processing line, accompanied, apparently, by an absolute lack of thorough cleaning at any time; (c) head-pulling contrivances which removed the heads of carcasses but left the stick-wounds and adjacent contaminated tissues on the carcasses, and which, in some instances, appeared as if they had never been effectively cleaned of the coagulated blood and other soil; (d) frequent and unnecessary contamination of edible tissues during evisceration, with one official inspector actually pulling the suspended viscera loose from each carcass, breaking intestines and contaminating his hands, the giblets, and the carcasses with fecal matter; and (e) a general lack of adequate number of lavatories, and of utensil and equipment-cleaning facilities.

3. In an exceptionally large, new plant, one processing line was operating under continuous official inspection, with relatively sanitary eviscerating procedures. Another line operating without official inspection was running at a speed approximately four times that of the inspected line, with vents being pulled out and excised, and numerous other procedures and conditions resulting in repeated contamination of product. A very large fan blowing inward at the live-poultry receiving door forced a draft of dust-laden air down a hall at the far end of the holding room, into the eviscerating room. After a day in the plant, clothing and nose were impregnated with dust. Of course,

the eviscerated product was likewise exposed.

4. On an informational survey with State personnel, several plants were visited, and varying undesirable conditions observed. One large eviscerating plant, operating under an official inspection-for-wholesomeness program, conducted no slaughtering and dressing operations, but processed New York-dressed poultry supposed to originate in plants operating under continuous official sanitation supervision. Some carcasses had been opened, found partly frozen, and placed back in tanks of water for further defrosting, thus contaminating the incised tissues and body cavities of the carcasses with the dirty water containing fecal matter and other wastes. In one plant not operating under continuous official sanitation supervision, the owner volunteered the information that he sometimes sold lots of New York-dressed poultry to the plant mentioned above, where it was then eviscerated under inspection.

In a large plant producing New York-dressed poultry, it was observed that the carcasses were not being washed at any time. The official sanitation supervisor, and his superior who happened to be in the plant that day, explained that the wash machines had been cut off because the private water supply used by this plant was not providing enough water. The poultry was being placed in cartons bearing labels indicating production under official sanitation supervision.

5. Scruggs (2) reported a visit to a plant in a heavy production area which was processing "inspected" poultry for a major metropolitan market. He described the conditions in this plant as being extremely bad, to the point that "both the employees and the food product that they were handling were being bathed constantly in an aerosol of intestinal contents". The official inspector in the plant was not doing a satisfactory job of inspection, resulting in this comment by Dr. Scruggs: "Such a practice, and this is not an isolated circumstance, is nothing short of prostituting the veterinary profession in order to gain a marketing advantage by furnishing 'inspected' poultry".

CURRENT DEVELOPMENTS PROMISE IMPROVEMENTS

Several things indicate an increased realization of the need for definitive action by official agencies in the field of poultry sanitation.

The interest and cooperation of the poultry industry, of Federal, State, and local agencies, and of professional associations, has resulted in the development by the Public Health Service, U.S. Department of Health, Education, and Welfare, of a suggested poultry ordinance for consideration by State and local jurisdictions (1). The general provisions and sanitation requirements were published in April 1955. The pro-

visions dealing with ante-mortem and post-mortem inspection of poultry are now ready for official clearances, and will be incorporated with the sanitation requirements for publication as a complete inspection and sanitation ordinance.

Several organizations, including the U.S. Livestock Sanitary Association, the Association of State Public Health Veterinarians, and the Amalgamated Meat Cutters and Butcher Workmen of North America, have gone on record recommending the adoption of the Public Health Service poultry-inspection ordinance when it becomes available. Much interest has been expressed in the various States. The Institute of American Poultry Industries has adopted a resolution favoring the "development and adoption of sound, mandatory inspection for wholesomeness programs for all poultry and poultry products, provided such programs are paid for from federal and state funds." The Conference of State and Territorial Health Officers has adopted a resolution calling for the evisceration, and the inspection before and after slaughter, of all poultry shipped interstate.

Finally, several bills introduced into the current session of Congress (2nd Session, 84th Congress), call for amendment of the Federal Food, Drug, and Cosmetic Act, so as to prohibit the movement in interstate or foreign commerce of unsound, unhealthful, diseased, unwholesome, or adulterated poultry or poultry products. As introduced, these bills would provide for mandatory official inspection-for-wholesomeness of all poultry and poultry products processed for interstate commerce. Other bills which have been introduced would provide for mandatory inspection by the U.S. Department of Agriculture of poultry and poultry products processed for interstate com-

merce and, furthermore, of poultry and poultry products processed, sold, received, or delivered in cities or areas designated through a prescribed procedure by the Secretary of Agriculture as being "cities or areas where poultry or poultry products are handled or consumed in such volume as to affect, burden, or obstruct the movement of inspected poultry products" in interstate commerce, granting the Secretary of Agriculture exclusive jurisdiction in the fields within the scope of the bills. Other proposed legislation would provide for the mandatory inspection of poultry by the Meat Inspection Branch, U.S.D.A., on a basis comparable to the present Federal inspection of red meats.

SUMMARY

Although significant progress has been made, there is an obvious need for more consistent and widespread application of known principles of sanitation to the poultry industry. Associated with this need, indeed inseparable from it if the consumer is to be assured of wholesome and acceptable poultry and poultry products, is the necessity for adequate official inspection for wholesomeness of poultry. Recognition of these needs has resulted in a number of current developments which are directed toward the establishment of mandatory official poultry-inspection programs at the Federal, State, and local levels.

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THE INFLUENCE OF ENVIRONMENT AND PROCESSING ON SPOILAGE ORGANISMS IN COTTAGE CHEESE¹

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Microbiological analyses were performed on samples taken at various stages of processing of 17 vats of cottage cheese manufactured in 12 commercial plants. In 10 vats of fresh cheese whose shelf-life ranged from 5 to 10 days, the logarithmic averages of the counts of coliform, lipolytic and proteolytic bacteria were 50, 1,298 and 1,967 percent greater than the corresponding averages of 7 vats whose shelf-life ranged from 13 to 16 days. Spoilage organisms were found in water, coagulator, starter, air, contaminated equipment and improperly pasteurized milk and cream. Several water supplies contained high populations of lipolytic and proteolytic organisms, but were free of coliform bacteria which are commonly used as an index of acceptability for water supplies.

In recent years numerous workers have reported on the types of organisms responsible for spoilage in cottage cheese. Deane and Nelson (6) examined 79 samples from 25 commercial plants for yeast, mold, coliform, proteolytic and lipolytic organisms. Poor keeping quality at 21° C. was associated with mold counts in excess of 100 per g. and poor keeping quality at 6° C. was associated with proteolytic and lipolytic bacteria counts in excess of 100 per g. Elliker (7) and Parker *et al.* (12) reported that three species of bacteria, *Pseudomonas fragi*, *Pseudomonas viscosa* and *Alcaligenes metalcaligenes* are responsible for much of the slimy, gelatinous defect of cottage cheese. These workers isolated the above organisms from equipment, creaming mixtures, plant dust and water supplies. Collins (3) reported that prolonged incubation permitted cultures of *Ps. fragi*, *Ps. viscosa* and *Alc. metalcaligenes* to cause surface spoilage of cottage cheese at initial pH values as low as 4.6 and at temperatures as low as 3.5° C. Harmon and Smith (8) reported on the relationships between pH and the type of organisms dominating cottage cheese spoilage. Davis and Babel (5) found that cottage cheese curd washed with suspensions containing from 2,000,000 to 120,000,000 bacteria per ml. retained from 0.0093 to 0.40 percent of the organisms. The temperature of incubation had a greater effect on the rate of slime formation than did the number of bacteria in the wash water. Lyons and Mallmann (10) enumerated the coliforms in 150 samples of cottage cheese from 8 plants. Line samples from 6 plants contained coliforms at all sampling points. Sixty percent



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of the fresh packaged cheese from all plants contained coliforms.

The data herein reported were secured to determine the source and numerical frequency of each of the various groups of organisms detrimental to the keeping quality of cottage cheese. The relationship was determined between keeping quality and temperatures at critical points in the processing and storage of cottage cheese.

EXPERIMENTAL PROCEDURE

Twelve commercial cottage cheese plants were visited. The complete manufacturing procedure of 17 vats of cheese was observed and recorded. Samples were taken of all ingredients and of the cheese at each of several designated stages of the manufacturing process. Swabs of the vats and handling equipment were made according to Standard Methods (1). The samples were promptly refrigerated and returned to

¹Mich. Ag. Exp. Sta. Journal Article No. 1904

the laboratory for microbiological and chemical analyses.

The cheese samples were prepared for analyses by mixing 11 g. of cheese and 99 ml. of buffered sterile water for two minutes in a Waring blender jar. The Waring blender jars were sterilized by soaking for one hour with a 500 p.p.m. chlorine solution and rinsing with sterile distilled water. Control plates from the rinsings of jars prepared in this manner seldom showed any growth and never more than two colonies. All samples of cheese and raw materials were examined for coliform, lipolytic, proteolytic, yeast and mold organism populations. Total counts were performed on swabs, rinses from containers and on all ingredients except starter. Coliform, yeast, mold and total counts were performed according to Standard Methods (1). Lipolytic organisms were determined by the method of Long and Hammer (9). Proteolytic bacteria were enumerated on a medium containing 0.2 percent peptone, 1.5 percent agar, and 2 percent sterile skim milk added at the time the plates were poured. Air borne contamination was determined in the packaging and manufacturing areas by exposure of poured plates of tryptone glucose yeast agar and acidulated potato dextrose agar, according to Standard Methods.

One ml. or 1 g. portions of all of the samples collected were inoculated into cottage cheese which had been sterilized by autoclaving. The inoculated cheese was held four days at 21° C. to observe the type of deterioration.

Creamed cottage cheese samples were scored organoleptically, stored at 42° and 50° F. and observed for shelf-life. The pH was determined on the dry curd, creaming mixture, and on the fresh and spoiled cheese.

RESULTS

Spoilage organisms in cottage cheese at various stages of manufacturing. All of the vats of cheese observed in this study were made by the "short set" with the incubation times and temperatures varying from 4 to 6 hours and 86° to 90° F., respectively. Since this temperature is favorable for most contaminants, it is not surprising to find significant populations in the cut curd. The range of the various counts (shown in Table 1) is particularly significant and indicates that at this stage of manufacture, contaminants may be completely absent or may have attained sufficient numbers to represent a quality hazard. Most of the vats of cheese were cooked to about 120° F. which resulted in considerable reduction in coliforms, but was not effective in destroying lipolytic, proteolytic, yeast or mold organisms. The washing operation caused a substantial increase in the average counts of lipolytic and proteolytic bac-

teria, which is attributed to the high populations of these organisms in some of the water supplies. The range of counts of each of the different types of spoilage organisms in the packaged creamed cottage cheese illustrates the wide variation in the microbiological condition of the freshly made product and establishes the fact that it is possible to produce cheese containing very few contaminating organisms. Data in Table 1 also show the range and logarithmic average of the counts of various organisms in the cheese held at 50° F. until spoiled and the counts of duplicate samples held at 42° F. for the same length of time. The advantage of the lower storage temperature in reducing development of organisms is obvious.

Data in Table 1 indicate the results of microbiological analyses of "line samples" from 12 commercial plants. The minimum and maximum counts and the logarithmic average of the counts of each group of organisms determined in the line samples are indicated.

The data show that the pasteurized milk and cream represented a principal source of all types of spoilage organisms determined. Davis and Babel (5) showed that the organisms usually responsible for slime formation in cottage cheese are destroyed by pasteurization. The lack of adequate plant sanitation represented a source of contamination in several plants. Standard Methods (1) recommends that the total swab count of plant equipment should not exceed 12.5 organisms per sq. in. In several of the plants studied swab counts made on sanitized surfaces of vats and equipment revealed less than one organism per sq. in. However, the logarithmic average count on the vats and other equipment were 54 and 38 organisms per sq. in., respectively. No official recommendations exist as to the tolerance of coliform, lipolytic, proteolytic, yeast and mold organisms, but since these types are capable of spoiling cottage cheese, it seems desirable to strive for a degree of plant sanitation which will preclude the presence of these organisms on plant equipment.

In most instances, the coagulator was not a significant source of undesirable organisms, but a few samples possessed high lipolytic, proteolytic and/or yeast and mold populations. A few starter samples and several empty cartons selected at random were found which contained yeast, mold and lipolytic organisms. No coliform bacteria were found in the starters or rinses from the cartons.

Air borne contamination in cottage cheese plants. Data in Table 2 show the yeast, mold and total counts determined on standard agar and potato dextrose agar plates exposed for 15 minutes in the manufacturing

TABLE 1 — MICROBIAL POPULATIONS OF "LINE SAMPLES" FROM 17 VATS OF COTTAGE CHEESE IN 12 COMMERCIAL PLANTS

SPOILAGE ORGANISMS IN COTTAGE CHEESE

Type of sample	Micro-organism counts per g. or ml.									
	Total		Coliform		Lipolytic		Proteolytic		Yeast and mold	
	Range	Log. ave.	Range	Log. ave.	Range	Log. ave.	Range	Log. ave.	Range	Log. ave.
Vat swab	<1 to 13,000	54	<1 to 240	1	<1 to 1,900	18	<1 to 1,100	10	<1 to 6,500	6
Equipment swab	<1 to 11,300	38	<1 to 1,400	2	<1 to 3,600	11	<1 to 5,600	24	<1 to 75	3
Coagulator	<1 to 50,000	46	<1	<1	<1 to 3,400	2	<1 to 10,000	9	<1 to 38,000	2
Wash water	<1 to 14,400	43	<1 to 4	<1	<1 to 1,800	5	<1 to 15,000	17	<1 to 25	2
Carton rinse	<1 to 2,400	290	<1	1	<1 to 620	30	<1 to 200	10	<1 to 600	28
Pasteurized milk	500 to 82,000	19,000	<1 to 1,080	4	10 to 5,100	200	2 to 8,000	140	<1 to 100	5
Starter	*	*	<1 to 50	2	<1 to 500	27	<1	<1	<1 to 100	9
Cut curd	*	*	<1 to 9,200	29	<1 to 16,000	140	<1 to 1,500,000	330	<1 to 3,000	11
Curd after draining whey	*	*	<1 to 90	2	10 to 4,000	130	<1 to 50,000	140	<1 to 35,000	20
Washed curd	*	*	<1 to 100	1	40 to 9,000	330	<1 to 300,000	650	<1 to 5,000	21
Cream	100 to 134,000	6,600	<1 to 1,400	14	10 to 30,000	180	<1 to 30,000	320	<1 to 800	14
Packaged cheese	*	*	<1 to 210	7	20 to 36,000	240	<1 to 1,500,000	430	<1 to 2,000	36
Cheese held at 50° F. until spoiled	*	*	<1 to 5,300,000	4,000	1,000 to 2,400,000,000	4,300,000	100 to 1,300,000,000	1,600,000	20,000 to 1,200,000,000	650,000
Cheese held equal time at 42° F.	*	*	<1 to 618,000	200	1,000 to 150,000,000	480,000	100 to 900,000,000	460,000	1,000 to 4,000,000	49,000

*Not determined

TABLE 2 — AIR-BORNE MICRO-ORGANISM POPULATIONS APPEARING ON 15-MINUTE EXPOSURE PLATES IN 12 COMMERCIAL COTTAGE CHEESE PLANTS

Plant source	Plates exposed in					
	Cheese manufacturing area			Cheese packaging area		
	Total	Yeast	Mold	Total	Yeast	Mold
A	13	0	0	64	2	1
C	265	2	11	*	*	*
E	7	2	1	140	2	5
G	17	0	1	58	1	1
R	82	3	4	99	0	4
T	99	2	5	192	5	9
V	290	0	6	153	2	5
Y	181	0	0	84	6	4
AA	44	2	2	*	*	*
DD	99	23	9	9	0	5
EE	46	1	0	85	5	6
FF	83	14	13	64	2	3
Logarithmic average	62.0	2.3	2.5	76	2.2	3.7
Arithmetic average	102.0	4.1	4.3	95	2.5	4.3

*Not determined

and in the packaging areas of commercial cottage cheese plants. The variations in total count are considerably greater than the variations in yeast and molds. The results indicate that the air in all plants represents a potential source of contamination and emphasizes the need to minimize the intervals during which products are exposed.

Contamination from line samples in cottage cheese plants. The "line samples" secured from each of the 12 plants were inoculated into 25 g. portions of cottage cheese which had been sterilized by autoclaving in petri dishes. The inoculated cheese samples were incubated for four days at 21° C. The type of spoilage appearing in the sterile curd is indicated in Table 3. Nine "line samples" were secured from each plant and the number of these "line samples" causing spoilage varied from one to six. Only one sample of pasteurized milk, three samples of cream and four swabs of equipment failed to cause spoilage when 1 ml. portions were inoculated into the sterilized curd. Only one sample of starter produced spoilage in the sterile curd.

Temperatures at critical points in the manufacture of cottage cheese. In each plant the temperatures were determined at various critical stages of manufacturing the cheese and are recorded in Table 4. The plants are divided into two groups, according to the shelf-life of the cheese manufactured therein. Data show that the average temperatures at the critical points in processing and packaging cottage cheese were from

TABLE 3 — TYPE OF SPOILAGE OCCURRING WHEN STERILE COTTAGE CHEESE WAS INOCULATED WITH LINE SAMPLES FROM 12 COMMERCIAL PLANTS AND HELD FOUR DAYS AT 21° C.

Source and nature of inoculating material	Type of spoilage in sterilized cottage cheese inoculated with line samples from plants											
	A	C	E	G	R	T	V	Y	AA	DD	EE	FF
Control	No fermentation											
Equipment												
Carton rinse	N	N	N	P	P	N	M	N	N	N	M	N
Equipment swab	N	N	M, P	N	P	M	M, P	F	N	P	M	N
Vat swab	N	M	S	N	M	N	N	N	N	N	P	N
Products												
Coagulator	N	N	M	P	N	N	N	M	P	M	N	N
Cream	P	N	N	P	P	P	P	N	N	P	P	P
Milk	P, Y	N	P	S, Y	N	F, Y	P	P	F	P	M, P	S
Starter	N	N	N	N	N	N	N	N	F	N	N	N
Whey	N	N	N	M, Y	M	Y	N	N	N	M	N	N
Water	N	N	N	N	P	P	M	N	P	N	N	P

Legend:

F = fruity
M = moldy

N = none or normal
P = putrid

S = sour
Y = yeasty

TABLE 4 — TEMPERATURES AT CRITICAL POINTS IN MANUFACTURING COTTAGE CHEESE IN 12 COMMERCIAL PLANTS

Plant source	Temperature in deg. F.									
	First water	Last water	Washed curd	Packaged cheese	Packaging room	Cheese in storage		Storage vaults		Shelf-life in days
						Bulk	Packaged	Bulk	Packaged	
Cottage cheese with shelf-life ranging from 5 to 10 days at 50° F.										
A	52	52	79	52	70	42	40	38	38	10
C	48	48	52	*	*	43	42	41	41	7-8
E	53	53	60	62	74	46	44	43	43	9
G	55	40	49	48	64	47	45	44	44	5
R	45	35	50	50	72	51	37	50	35	10-10
V**	54	42	51	48	64	46	40	44	37	9
Y	58	58	62	44	*	42	44	42	42	8
EE	53	53	59	66	70	44	43	42	42	8
Average	52	48	58	53	69	45	44	43	40	8.4
Cottage cheese with shelf-life ranging from 13 to 16 days at 50° F.										
T	85	44	51	56	66	39	46	34	34	13
V**	54	42	51	48	64	46	40	44	37	13-13
AA	52	52	50	*	*	40	*	33	33	14
DD	56	42	49	44	*	*	43	42	42	16-16
FF	70	48	51	58	68	43	40	41	41	16
Average	63	46	50	52	66	42	42	39	37	14.4

* not determined

** samples from plant V occurred in both groups.

2° to 8° F. lower in the vats of cheese with the longer shelf-life.

Relationship between organoleptic grade, pH, microbial populations and shelf-life of commercial cottage cheese. Data in Table 5 show the initial counts of coliform, lipolytic, proteolytic, yeast and mold organisms in packaged samples from 17 vats of cheese. At 50° F. ten samples had a shelf-life ranging from 5 to 10 days and seven samples had a shelf-life of 13 to 16 days. In the fresh cheese the logarithmic averages of the counts of coliform, lipolytic and proteolytic organisms were 50, 1,298 and 1,967 percent, respectively, greater in the group of samples with shelf-life between 5 and 10 days than in the samples with shelf-life between 13 and 16 days. The yeast and mold counts were 104 percent greater in the samples with the longest shelf-life. This relationship may be attributed to the fact that the samples with the longer keeping quality possessed a lower average pH and yeasts and molds are more acid tolerant than the other groups of organisms.

When initially analyzed, seven of the 17 samples contained less than one coliform bacterium per g., two contained less than one yeast and mold per g. and seven contained maxima of 100 organisms per g. in the lipolytic and proteolytic groups. The coliform and yeast and mold counts exceeded 100 per g. in

one and three samples, respectively. The lipolytic and proteolytic counts exceeded 10,000 per g. in one and seven samples, respectively.

The initial score, initial and terminal pH, shelf-life and type of spoilage are shown by the data in Table 5. The initial score averaged slightly higher in the group of samples with the longer shelf-life. The pH of both the fresh and spoiled samples averaged lower in the group with better keeping quality. The benefit of good refrigeration is indicated by the fact that the average shelf-life of all samples was 51 percent longer at 42° F. than at 50° F. The keeping quality of the group with the shorter shelf-life was 62 percent longer at 42° than at 50° F.; in the group with the longer shelf-life the keeping quality was extended 43 percent at the lower temperature. Slime formation was the more common type of spoilage in the group of samples with the higher pH and short shelf-life; moldiness and high acidity were the common defects in the group with the lower pH and longer shelf-life.

DISCUSSION

Proper pasteurization destroys most of the organisms which were enumerated on the differential media used in this investigation. High counts occurring in milk samples taken at the cheese vat and in cream samples taken at the time the cheese was being

TABLE 5 — RELATIONSHIP BETWEEN ORGANOLEPTIC GRADE, pH, MICROBIAL POPULATIONS AND SHELF-LIFE OF PACKAGED SAMPLES OF 17 VATS OF COTTAGE CHEESE FROM 12 COMMERCIAL PLANTS

Plant source	Initial score	pH		Organism counts				Shelf-life in days	
		Fresh	Spoiled	Coliform	Lipolytic	Proteolytic	Yeast & mold	50° F.	42° F.
10 vats with shelf-life ranging from 5 to 10 days at 50° F.									
A	39	4.62	4.88	0	100	10	0	10	20
Cl	39	4.81	5.12	33	1,800	15,000	*	7	12
C2	39	5.15	5.12	39	1,200	2,300	*	8	9
E	41	5.32	5.15	10	110	100	40	9	13
G	39	4.72	4.70	210	36,000	28,000	50	5	6
R1	39	5.10	5.20	10	400	300,000	230	10	13
R2	40	5.10	4.69	0	2,000	1,500,000	30	10	20
V3	39	5.21	5.25	0	1,000	300	10	9	13
Y	40	4.92	4.80	4	60	50	100	8	15
EE	39	5.30	5.01	20	6,000	11,000	20	8	15
Average	39.4	5.03	4.99	9	1,300	3,100	27	8.4	13.6
7 vats with shelf-life ranging from 13 to 16 days at 50° F.									
T	40	4.90	4.67	0	100	100	190	13	20
V1	40	4.81	4.86	0	50	10	20	13	17
V2	39	4.99	4.85	0	20	62,000	100	13	20
AA	40	4.62	4.42	0	*	0	2,000	14	18
DD1	41	5.37	5.15	40	100	1,000	20	16	23
DD2	40	5.21	4.92	50	1,000	34,000	0	16	23
FF	41	4.96	4.82	100	70	0	100	16	23
Average	40.1	4.98	4.81	6	93	150	55	14.4	20.6
Average of all samples	39.7	5.01	4.92	7	240	430	36	10.9	16.5

* Lost

creamed indicated either unsatisfactory pasteurization or post-pasteurization contamination.

The coliform bacteria and yeasts and molds are retarded at the temperatures at which cottage cheese is normally held. However, these temperatures are less adverse to members of the genus *Pseudomonas* which includes many of the lipolytic and proteolytic organisms commonly encountered in dairy products. According to Bergey's Manual (2), the optimum temperatures for growth of most of these organisms vary from 10° to 25° C., and growth is retarded at 5° C. (40° F.). The predominant defects which developed in the cheese samples held at 42° F. were mold, high acid and also stale or bitter flavors suggestive of enzyme activity. At 50° F. spoilage usually was caused by the formation of pigment and surface slime or gelatinous curd.

The amount of air-borne contamination varied considerably among plants, but there was little correlation between air-borne contamination and microbial population or keeping quality of the cheese. More information concerning the species identity of air-borne bacteria is desirable; however, the prevalence of yeasts and molds represents a hazard to quality. Many food plants have reduced air-borne contamination by ventilating with filtered, washed air and pressurizing processing rooms.

Yeasts and molds which tolerate low pH were the more common contaminants in starter. When starters are ripened to an acidity of about 0.83 percent, the pH is sufficiently low to retard the development of most lipolytic, proteolytic and coliform bacteria; however, starters cannot be ignored as a source of these organisms, especially those of the lipolytic group, which includes the molds. Starter acidities above 0.85 percent should be avoided because of the reduced activity of *Streptococcus lactis*.

A few samples of coagulator were badly contaminated with lipolytic, proteolytic, yeast or mold organisms, with proteolytic organisms being the most frequent contaminant. These contaminants may be introduced by using non-sterile glassware in measuring coagulator and returning unused portions of coagulator to the original supply.

The number of organisms found in rinses from empty cartons picked up at cheese packaging stations indicates a need for improvement in storage and handling procedures. Cartons should be stored in a clean, dry place free from dust, moisture and air currents with particular attention to protection of opened cases.

The water supplies of many plants present a serious hazard to cottage cheese quality. Objectionable organisms may gain access to a water system in a num-

ber of ways including entrance through exposed open ends of water lines. *Pseudomonas* organisms are capable of moving through water lines and establishing themselves in the water system of a plant, because they are psychrophilic and are relatively non-fastidious with respect to nutrient requirements. High counts of undesirable organisms are frequently found in municipal and private water supplies which have been approved by public health inspection. There is an interesting relationship between the low coliform population and the significant lipolytic and proteolytic counts in the water samples examined in this work. Regardless of source, the dairy plant water supply should be examined frequently for all types of objectionable organisms and subjected to bactericidal treatment, if contaminated. Elliker (7) recommended the addition of 5 to 10 p.p.m. of chlorine to the water supplies of cottage cheese plants. Davis and Babel (5) reported that 8 of 15 slime producing organisms survived 1-minute exposure to 5 p.p.m. of chlorine. Marquardt (11) reported that 7.5 p.p.m. of available iodine added to water inhibited or retarded the organisms which commonly caused surface slime in cottage cheese. Collins (4) showed that pH and temperature are extremely important in the bactericidal treatment of dairy plant water supplies. The dairy plant water should be chlorinated close to the source in order to allow as much contact time as possible. Chlorination of the water at or near the vat is unsatisfactory. Davis and Babel (5) showed that chlorine is inactivated as soon as it comes in contact with the cheese. Extreme care must be exercised to avoid over-chlorination because the cation of the chlorine compound may react with the curd to form a soft gelatinous surface. When the second wash water is refrigerated, the cooling equipment should be thoroughly sanitized. It is especially important that the washing process cool the curd as low as possible in order to minimize growth of spoilage and acid forming organisms during the interval prior to the time the cheese is placed under refrigeration. The introduction of insanitary water or steam hose, straining cloths, iron pipe, etc., into the vat during the cooking or washing operation should be avoided. A threaded sanitary cap should be used to cover the end of the water line when not in use.

The presence of spoilage organisms on vat surfaces and on various items of equipment was an important source of contamination. Sanitized equipment should be protected from splash and subjected to a chlorine solution of 100 p.p.m. immediately prior to use. Protection against condensate dripping from overhead pipes is necessary. Wooden equipment is virtually impossible to sanitize and should be discarded.

Without exception, swabs of wooden equipment were extremely high in count.

SUMMARY

Seventeen vats of cottage cheese were manufactured in 12 commercial plants. Microbiological analyses were performed on samples of all raw materials and of the cheese at various stages of manufacture. When held at 50° F., representative samples from 10 of the vats possessed shelf-life ranging from 5 to 10 days and the shelf-life of samples from 7 vats ranged from 13 to 16 days. In the fresh cheese the logarithmic averages of the counts of coliform, lipolytic and proteolytic bacteria were 50, 1,298 and 1,967 percent greater in the group of samples with the short shelf-life than in the group with the shelf-life of 13 to 16 days.

The initial organoleptic quality scores were only slightly higher in the group with the longer shelf-life. The pH of the cheese and temperature at which the product is washed and handled are important factors in keeping quality. The shelf-life of samples at 42° F. averaged 51 percent longer than corresponding samples held at 50° F.

Improperly pasteurized milk and cream, coagulator, starter, water, air and contaminated equipment were found to be sources of spoilage organisms. Samples of several of the above caused spoilage when inoculated into sterile cheese and incubated at 21° C. for 4 days. Several water supplies were found which contained high populations of lipolytic and proteolytic organisms, but were free of coliform bacteria which are commonly used as an index of acceptability for water supplies. The varied sources of spoilage organisms in-

dicate the need for observance of proper pasteurization procedures, equipment sanitation, precaution in handling raw materials and necessity for proper bactericidal treatment of wash water.

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QUESTIONS AND ANSWERS ABOUT 3-A SANITARY STANDARDS FOR DAIRY EQUIPMENT¹

Editorial Note: Here is a discussion of the 3-A Standards program for dairy equipment which is presented in question and answer style and in greater detail than ever before attempted. This article, prepared largely through the efforts of T. L. Jones of the Dairy Industries Supply Association, Inc. staff, should serve to supply sanitarians everywhere with authentic and up-to-date information about this important program.

If you are a sanitarian, do you remember when you had to make Solomon-like rulings on the sanitary performance of dairy equipment — without having had the assurance that the manufacturer was fully aware of all the sanitary considerations involved in design and construction and without knowing whether the design was in accord with the views of other experienced men in your field?

If you are a dairy equipment manufacturer, do you remember when it was necessary to modify your equipment designs and unsettle your production schedules in order to meet differing sanitary specifications — often enforced in adjacent localities?

If you are a dairy processor, do you remember when you had to set aside or return to the manufacturer equipment which you had ordered in good faith, because once you received it, you found — for the first time — it did not meet all sanitary requirements for your area?

If you are a teacher of dairy technology, do you remember when you omitted teaching what constituted sanitation in design of dairy equipment because, generally, there was no uniformity of design?

You may not remember these things; for in recent years, thanks to the standards formulation procedures of the 3-A Sanitary Standards for Dairy Equipment program, sanitarians and dairy equipment manufacturers and dairy processors have met jointly to decide on standards of sanitary performance for numerous items of equipment.

If you've been active in the dairy industrial field for two decades or more, however, you probably remember these things only too well — and the memories are not pleasant ones, either! The industry veterans, in all branches, generally have a healthy respect and admiration for the 3-A Sanitary Standards program, because they know what it has done, what it continues to do, and how much better the future looks because of the hundreds of thousands of man-hours devoted over the years to the voluntary 3-A program.

Because many of the new personnel entering the dairy industries today may not be fully aware of the 3-A program and its history; and because some manufacturers newly come to the equipment field may not know fully of the significance of the 3-A Symbol, the following questions and answers may make interesting — and worthwhile — reading for numerous men and women now engaged in or serving the dairy industries!

Q. What is a 3-A Sanitary Standard?

A. A 3-A Sanitary Standard for Dairy Equipment is a voluntary standard, developed by conferees representing sanitarians, equipment fabricators, dairy processors, and the U. S. Public Health Service. It covers features of sanitary design for the particular item of machinery or process referred to in the standard.

Q. Why is it called "3-A"?

A. The 3-A designation is a contraction of *three associations*. In the 1920's, two trade associations and one professional association formulated uniform standards for fittings used on milk pipe lines. The trade groups are now known as Milk Industry Foundation and Dairy Industries Supply Association; the professional group is now known as International Association of Milk and Food Sanitarians. The standards for fittings evolved in those early days became popularly known as "3-A" standards. Since 1944, every major dairy processing group and the U. S. Public Health Service have participated in the formulation of the voluntary standards, which are still referred to, however, as 3-A Sanitary Standards.

Q. Who develops a 3-A Sanitary Standard?

A. Standards are formulated by the 3-A Sanitary Standards Committees — which regularly meet twice a year. They are:

1. The Committee on Sanitary Procedure of International Association of Milk and Food Sanitarians.
2. The Sanitary Standards Subcommittee of Dairy Industry Committee, representing the following associations of processors — American Butter Institute, American Dry Milk Institute, Evaporated Milk Association, International Association of Ice Cream Manufacturers, Milk Industry Foundation, National Creameries Association and National Cheese Institute — and also representing the association of equippers and suppliers, Dairy Industries Supply Association.

¹For further information see *J. Milk and Food Technology*, 19: 188-191, 1956.

3. Representatives of the Milk and Food Program, Division of Sanitary Engineering Services, B. S. S., U. S. Public Health Service.

Invited to a regular meeting of all the Committees, moreover, are representatives of *all* manufacturers of record (regardless of association affiliation) of equipment of the type or types under consideration there.

Q. How are 3-A Sanitary Standards formulated?

A. The primary suggestion for a 3-A Sanitary Standard may come from anyone — public health officials, dairy processors, or equipment manufacturers. The suggestion may be communicated to any of the groups participating in the 3-A program which will pass it on to the Executive Committee of the 3-A Sanitary Standards Committees. If the suggestion is considered by the Executive Committee to have merit and timeliness, it is passed on in due course to the Technical Committee of Dairy Industries Supply Association. DISA's Technical Committee appoints a Task Committee of representatives of all known manufacturers of the equipment involved in the suggestion. The Task Committee develops a tentative draft of a standard which is sent, in suitable stages, to the appropriate committees and officers of Dairy Industry Committee, International Association of Milk and Food Sanitarians, and U. S. Public Health Service. It should be noted that in these and the subsequent stages of the formulation procedure DISA does not act through, or as a part of, the Sanitary Standards Subcommittee of Dairy Industry Committee but separately as the medium through which the views of the equipment fabricators are presented. The three groups to which the tentative draft of a standard is presented by the DISA Task Committee suggest changes — often many changes! Sometimes, they even request a complete re-draft of the tentative standard which they have received. Their suggestions and recommendations are returned to the DISA Task Committee which adopts them or seeks a common ground for further consideration by all the groups of the matters that are involved.

Usually many re-writings are necessary before a tentative standard is drafted which merits discussion at a semi-annual meeting of the 3-A Sanitary Standards Committees. Frequently, even after a tentative sanitary standard has progressed that far, it may be sent back to a Task Committee for further work. If the tentative standard is agreed to by all participating parties at a semi-annual meeting then it is formally approved by:

1. The Chairman of the Committee on Sanitary Procedure of International Association of Milk and Food Sanitarians;

2. The Chief of the Milk and Food Program, Division of Sanitary Engineering Services, B. S. S., U. S. Public Health Service;
3. The Chairman of the Sanitary Standards Subcommittee of Dairy Industry Committee; and
4. The Chairman of the Technical Committee of Dairy Industries Supply Association.

Immediately following this, the 3-A Sanitary Standard is published in *The Journal of Milk and Food Technology*, and thousands of re-prints are circulated to all persons involved. Additionally, copies of each 3-A Sanitary Standard are maintained on file in the national headquarters of the major trade groups, and are always available to any interested party.

Q. For what equipment are there currently 3-A Sanitary Standards?

A. Seventeen standards have been approved and published, as follows:

- Fittings Used on Milk Products Equipment
- Thermometer Fittings and Connections
- Storage Tanks (Revised)
- Milk Pumps
- Weigh Cans and Receiving Tanks
- Homogenizers
- Electric Motors and Motor Attachments
- Can-Type Milk Strainers
- Filters Using Disposable Filter Media
- Determining Holding Time of High-Temperature Short-Time Pasteurizers
- Plate Type Heat Exchangers
- Internal Return Tubular Heat Exchangers
- Installation and Cleaning of Cleaned-In-Place Pipelines
- Holding and/or Cooling Tanks
- Automotive Milk Transportation Tanks for Bulk Delivery and/or Farm Pick-up Service (Revised)
- Inlet and Outlet Leak Protector Plug Valves for Batch Pasteurizers
- Manually Operated Bulk Milk and Milk Products Dispensers, Multi-Service Milk Containers, and Dispensing Mechanisms

Additionally, standards for numerous other items are now under consideration, including:

- Milk Evaporators
- Paper Bottle Fillers and Sealers
- Separators & Clarifiers
- Farm Holding and/or Cooling Tanks (Revised)
- Rubber and Rubber-like Materials
- Ice Cream Freezers
- Coin-Operated Bulk Milk Vending Machines
- Suggested Procedure for Installing HTST Pasteurizers

Q. How can a prospective buyer or inspecting sanitarian determine whether a piece of equipment complies with existing 3-A Sanitary Standards?

A. There are two possible ways: (a) the buyer or sanitarian can look for a 3-A Symbol, which may be applied or affixed by the manufacturer to equipment now covered by existing standards, provided the manufacturer has received authorization from

the 3-A Sanitary Standards Symbol Administrative Council to apply or affix the symbol; or (b) if the symbol is not readily discovered he can inquire of the equipment manufacturer whether the equipment does comply with the existing pertinent 3-A standard, and he can obtain copies of the relevant standard or standards against which carefully to check the equipment himself.

Q. What is the 3-A Sanitary Standards Symbol Administrative Council?

A. (Before answering, the editors wish to remark that colloquially, and for correspondence purposes, the name of the Council is frequently shortened to "The 3-A Symbol Council.") The 3-A Symbol Council is the body of eight persons which authorizes the use of the 3-A Symbol on complying dairy equipment, or acts appropriately in an unlikely instance of abuse of the Symbol's purpose. Four of the Council members are representatives of International Association of Milk and Food Sanitarians; two are representatives of processors, chosen by the Sanitary Standards Subcommittee of Dairy Industry Committee; and two are representatives of equipment manufacturers, chosen by the Technical Committee of Dairy Industries Supply Association. C. A. Abele, 2617 Hartzell Street, Evanston, Illinois, currently is Secretary-Treasurer of this body.

Q. How — in greater detail — does the 3-A Symbol Council proceed?

A. Under carefully developed by-laws it:

1. Receives and processes applications from equipment manufacturers desiring to use the 3-A Symbol,
2. Grants authority for the use of the 3-A Symbol on dairy equipment which is acceptably certified by the manufacturer to comply with applicable 3-A Sanitary Standards,
3. Publishes the names of manufacturers to whom, and for which types of equipment, such authority has been granted,
4. Investigates, and takes appropriate action, in instances of alleged improper or unauthorized use of the 3-A Symbol.

Q. What does the 3-A Symbol look like?

A. Like this:



Q. What is the procedure to be followed in obtaining permission to use the 3-A Symbol?

A. This is the procedure to follow:

1. Manufacturers desiring to apply the 3-A Symbol to their equipment will request from the Secretary of the Council (C. A. Abele, 2617 Hartzell Street, Evanston, Ill.) the proper application forms, on the reverse side of which will appear detailed instructions for each manufacturer to follow.
2. Application can then be made, on the supplied forms, for authorization to use the 3-A Symbol. A separate application is made for each type of equipment on which it is desired to place the symbol. Each application must be accompanied by full data and sworn certification, and also by an initial annual fee for the authorization (\$25.00 for each type of equipment).
3. Within thirty days of receipt of applications which are in order, authorization for use of the 3-A Symbol will be issued. This authorization will be valid for one year.
4. Authorizations may be renewed four times without re-filing applications, except in the event that the existing 3-A Sanitary Standards have been amended; in that case, a new application must be filed.
5. Names of manufacturers to which authorizations have been issued are published in The Journal of Milk and Food Technology.

Q. Once a 3-A Sanitary Standard has been developed, does that mean that no further sanitary refinements in it are possible, probable or expected?

A. No! A 3-A Sanitary Standard does not purport to fix a "ceiling" on sanitary effectiveness of design or performance in equipment.

Moreover, even though a 3-A Sanitary Standard exists, it may, as sanitary science, equipment designing and manufacturing efficiencies and dairy processing techniques advance, be amended or modified at any time, through the same channels of procedure along which the original standard has taken form. Naturally, in a vital, living field of industry, science and technology, progress is a constant goal. Progress causes, or comes from, change. The 3-A Sanitary Standards are not limiters of progress.

Q. Has the 3-A program proved its worth?

A. Definitely! Many endorsements of it have been willingly given by responsible industry leaders.

Q. What is the nature of these "endorsements"?

A. Here are some representative quotes from letters in the files of the 3-A Sanitary Standards Committees.

A *processor* writes: "A processor desires the assurance the equipment he is buying will, first of all, be acceptable to sanitarians and other authorities governing sanitary requirements. The 3-A approval puts some stability into what is accepted and what is not. The money outlay for equipment these days is tremendous and as operators, we have to have some assurance that the equipment will not be obsolete from the sanitary standpoint after a short period of use. The 3-A seal gives the operator the assurance that the equipment has been designed and built using a breadth of experience."

Another *processor* writes: "Milk dealers, in buying equipment, know that if it bears a 3-A Symbol, it will be approved by their local sanitarians. They also know that they are buying equipment which has been built in accordance with standards that have received close scrutiny and approval by the finest engineers and technologists in their own industry. In many cases, the equipment has been improved, performance-wise, by this means. The medium which 3-A provides for the interchange of ideas among sanitarians, processors and equipment manufacturers cannot do otherwise than to result in better equipment."

Another *processor* writes: "There are many reasons why processors should look for assurance that equipment they buy should at least meet 3-A Sanitary Standards. The 3-A program has tended to take the burden of faulty sanitary design of equipment 'off the backs' of the processing industry where equipment design problems were involved. It has placed responsibility on the fabricators where it belongs . . . I feel it has created a tendency to reduce the manufacture of poor equipment . . . To sum up, the processor can't help getting a better break if he insists on 3-A standardized equipment."

Another *processor* writes: "The purchasing departments and engineering representatives of dealers and processors should be acquainted with the purposes of the 3-A Sanitary Standards Committees and the recognition of the 3-A Symbol which is emblematic of compliance to standards of sanitary design. The 3-A Committees, acting as a body, have minimized confusion relative to accepted standards of sanitary design."

A large city's *Department of Health officer* writes: "The 3-A Symbol on an item of dairy equipment serves as an index or guide to its acceptability. This is particularly true in the case of new types of equipment, or newer models of recognized equipment. The 3-A standards represent the collective thinking of people from all parts of the country and from every segment of the dairy industry and regulatory groups. While standards are not absolute, they serve as a good guide for all concerned."

A state *Department of Agriculture official* writes:

"Published 3-A Sanitary Standards have been of tremendous aid in identifying new or replacement equipment as to sanitary design and proper installation. They have helped us avoid equipment or type of installation which may have been impractical or of poor design or of unsatisfactory material. The 3-A program eliminates duplication and promotes uniformity as representatives of all phases of the dairy industry, equipment manufacturers and official personnel work together. The program prevents confusion and delay, and lends valuable aid to all groups in the field."

A southern city's *Health Department Officer* writes: "A 3-A Symbol on an item of dairy equipment immediately tells the sanitarian that the equipment is probably satisfactory — that it conforms to the requirements of the state and the recommendations contained in the USPHS Milk Ordinance and Code. All sanitarians agree that the published standards are a great guide for them to follow in inspecting equipment."

An *extension specialist* at a major dairy school writes: "To a public health interested person, the 3-A Symbol on dairy equipment assures him of quality merchandise, easy cleanability, and standards of perfection, as we now know them, of equipment."

A *Deputy Commissioner of Agriculture* of a state writes: "During the years just before and after the 3-A program started, there existed wide differences of opinion among sanitarians and others as to what constituted an approved piece of dairy equipment. Some sanitarians or health departments objected to the use of equipment which others had approved. There might be chaos in a producing area that supplied milk or cream to different cities or states. The 3-A Committees became the one body which was able to agree, or to resolve their differences if at first they disagreed, so that standards for material, fabrication and usefulness were satisfactory to all concerned."

A *deputy health commissioner* of a major mid-western city writes: "To me, the 3-A Symbol on a piece of dairy equipment indicates that the equipment has been made by a responsible company which is interested in marketing equipment that can be readily cleaned and that is made according to sanitary standards. The symbol means to me that this equipment has been produced in compliance with the best thinking in the manufacturing company, the industry that uses the equipment and public health engineers. The symbol means to me that I as a sanitarian can accept this equipment without reservations and without conducting lengthy investigations. It means to me that men better qualified than I have studied the equipment and that its construction is in compliance with the best judgment of these men which qualifies it for use within my jurisdiction. The 3-A Symbol

also means to me the protection of the industry from the idiosyncrasy of the individual sanitarian. The will of the majority of recognized expert sanitarians governs, rather than the wishes of a well-meaning but misguided minority."

A *milk consultant* to a state Board of Health writes: "The 3-A program represents the best collective thinking and action on the part of the group of individuals, both from industry and control agencies. The 3-A Symbol is beginning to create a confidence in the minds of the public health officials concerned for the item of dairy equipment which bears the symbol. Public health officials realize that a terrific amount of time and study has been devoted to dairy equipment bearing this symbol, which individual officials might have neither the knowledge nor the time to give such study to themselves."

An *official in the Milk and Food Program, U. S. Public Health Service* writes: "Dairy equipment designed and constructed in accordance with 3-A Sanitary Standards conforms with the criteria set forth in item 10p of the Milk Ordinance and Code - 1953 Recommendations of the Public Health Service, which has been adopted by more than 2000 local jurisdictions. The 3-A Symbol provides a means whereby State and local public health officials can immediately recognize equipment which has been manufactured in compliance with such standards and which may be accepted with confidence."

A *dairy technologist* on the staff of an international trade group writes: "The 3-A Symbol assures recognition by regulatory officials that a piece of equipment meets a standard in the formulation of which they have shared, either directly or indirectly, through their professional organization. The 3-A Symbol is the basis for reciprocity of acceptance by health officials throughout the country, by virtue of which further costly inspection of equipment fabrication at the source is eliminated."

A *manufacturer of dairy equipment* writes: "The 3-A Symbol to the dairy equipment manufacturer is, in part, an insurance policy. It assures the manufacturer that by manufacturing to the set standards, his equipment will be acceptable from the sanitary standpoint by both the user and the sanitarian. The use of the 3-A Symbol also acts as an incentive to the dairy equipment manufacturer to produce equipment having even higher standards than those established by the 3-A Standard, assuring continued improvements in the sanitary aspects of dairy machinery. Undoubtedly,

ly, the 3-A program has been of real value to the dairy industry. It has tended to standardize machinery along sound sanitary lines, which mean lower manufacturing costs. The days of custom-built, extremely expensive machinery to suit individual sanitarians' whims and fancies are probably now a thing of the past."

Another *manufacturer of dairy equipment* writes: "The 3-A program has been of definite economic value to the dairy industry but has in no way reached its ultimate potential in this respect. The 3-A program should be of the most definite economic value to the user or purchaser of equipment and should allow him to obtain completely satisfactory equipment quickly and at the lowest possible price. To the manufacturer, there is value in standardization in lower cost of manufacture and administration throughout his operation. Finally, the 3-A program should make possible quicker, more effective and cheaper regulatory control. All three of these factors may eventually result in a cheaper product at the consumer level."

Another *dairy equipment manufacturer* writes: "The 3-A program has meant standardization, and there is probably no one other thing that is of greater importance to a manufacturer in his factory operation. It means efficient use of time and engineering talent; it provides production efficiency; it reduces inventories. Standardized methods result in the production of better equipment that provides the processor with better equipment at lower service and up-keep costs."

- Q. If a person desires more information about specific aspects of the 3-A Sanitary Standards for Dairy Equipment program, where should he turn?
- A. To the headquarters of any national dairy industrial trade association; or, more specifically, to C. A. Abele, Secretary-Treasurer of the 3-A Symbol Council, 2617 Hartzell Street, Evanston, Ill., on matters relating to the use of the 3-A Symbol; to the Secretary of the Technical Committee of Dairy Industries Supply Association, 1145 19th Street, N. W., Washington 6, D. C., on matters pertaining to equipment design or fabrication; to the Chairman of the Sanitary Standards Subcommittee of Dairy Industry Committee, Barr Building, Washington, D. C. on matters of especial pertinence to equipment users; and to the Executive Secretary of International Association of Milk and Food Sanitarians, P. O. Box 437, Shelbyville, Indiana, to purchase published copies of existing 3-A Sanitary Standards.

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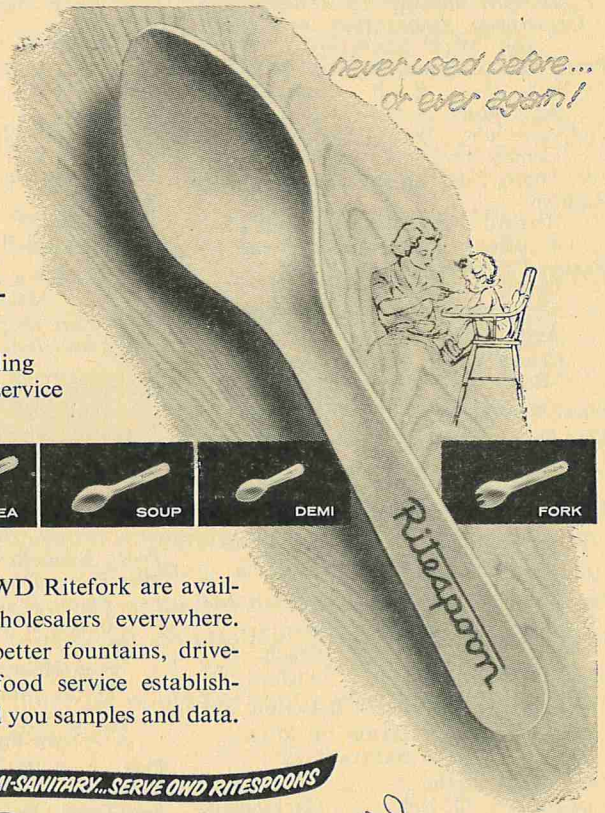
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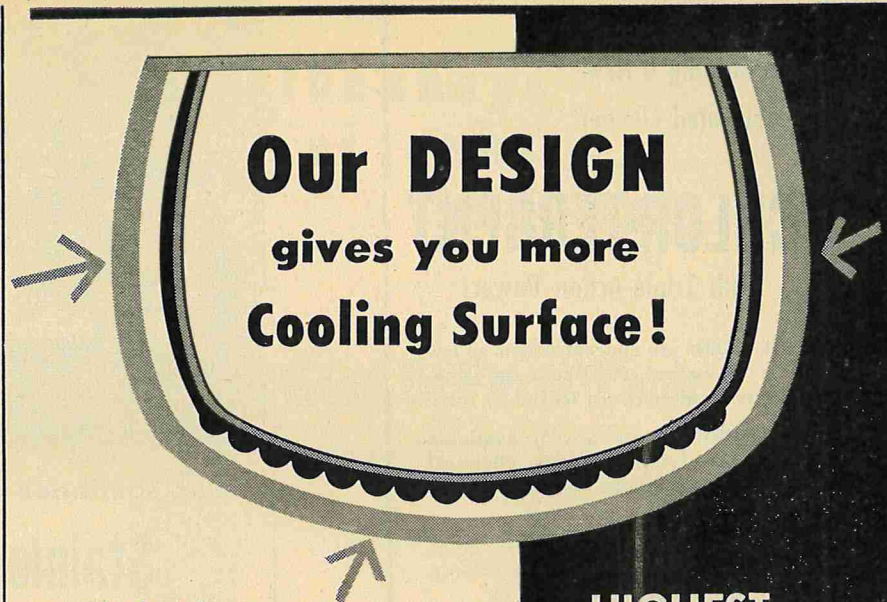
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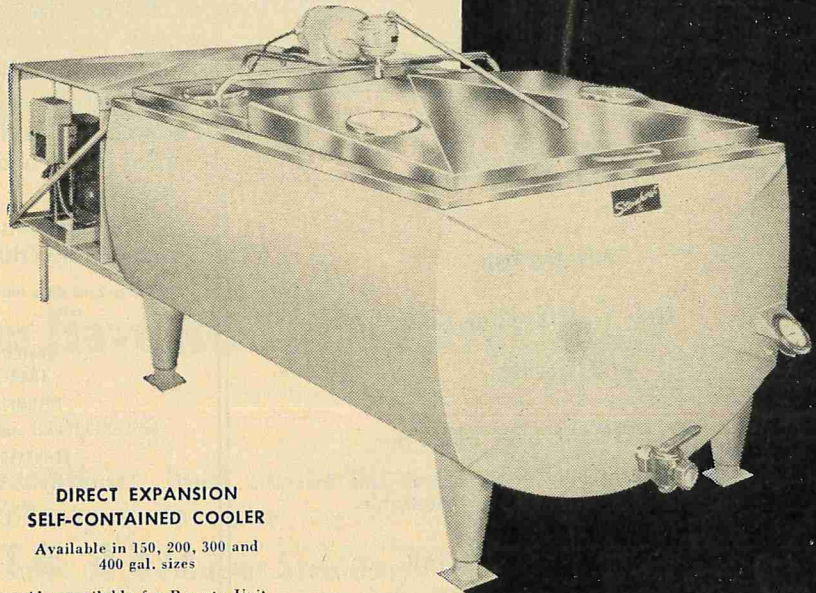
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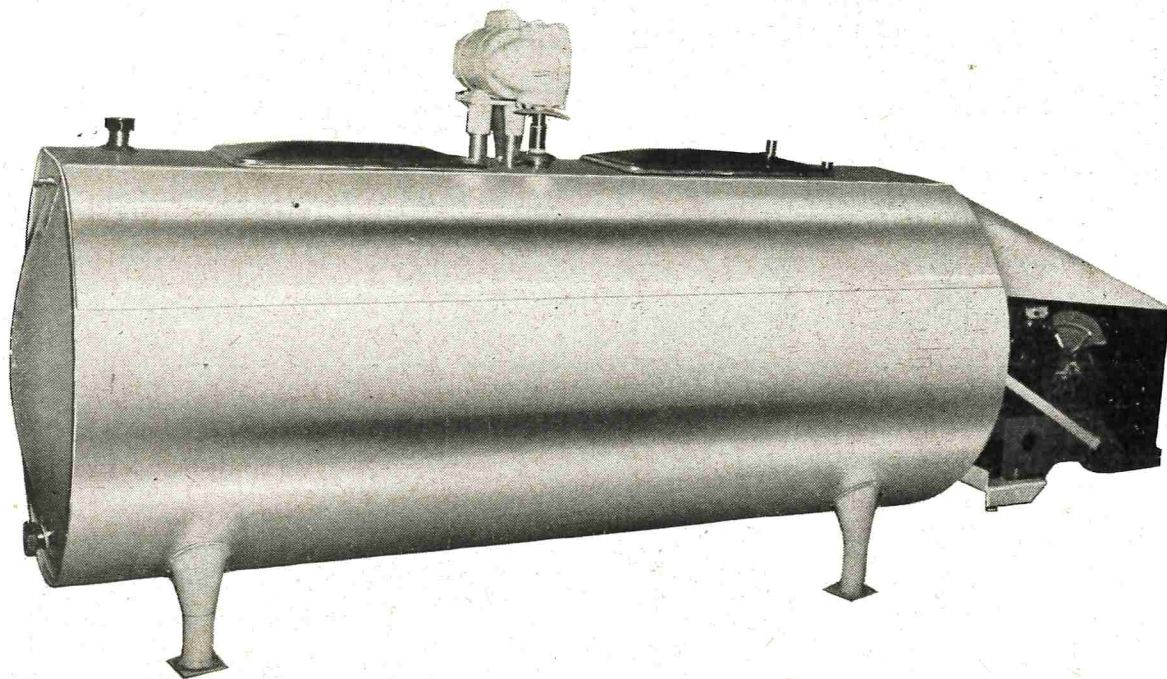
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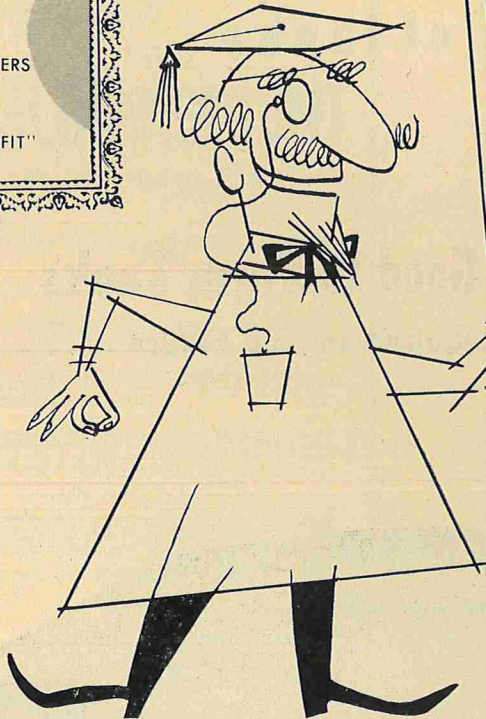
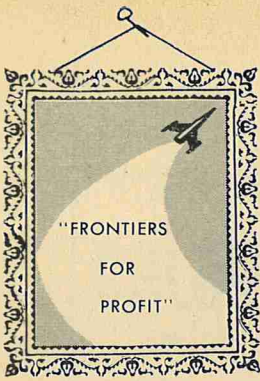


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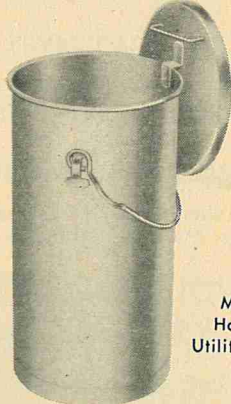
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last longer

Seamless, solderless, easily cleaned Superior pails stand up under hardest wear. Gleaming smooth surfaces provide easier, more thorough cleaning and sanitation. Available with or without sturdy welded steel-hoop for added bottom protection. 8, 10, 12 and 14 quart sizes.

Milk House Utility Pails are designed for easy handling of milk from milker to farm holding tanks.

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Utility Pail

JOHN WOOD COMPANY

Superior Metalware Division
509 Front Ave., St. Paul 3, Minn.

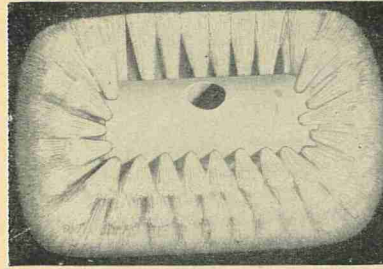


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Exposition, Octo-
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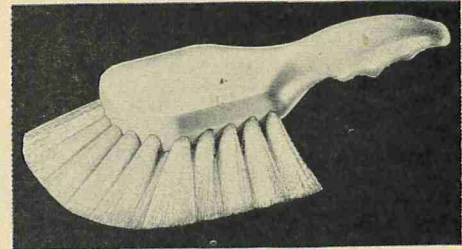
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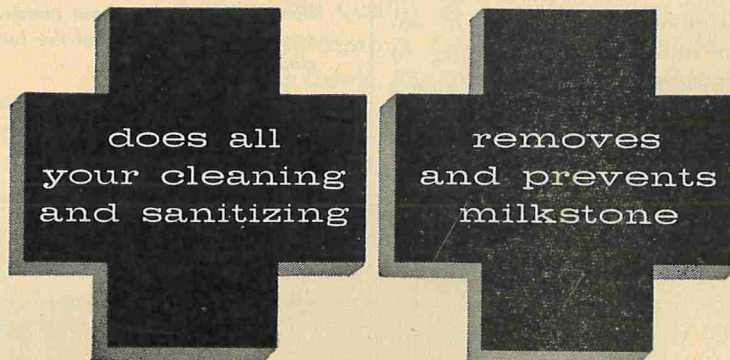
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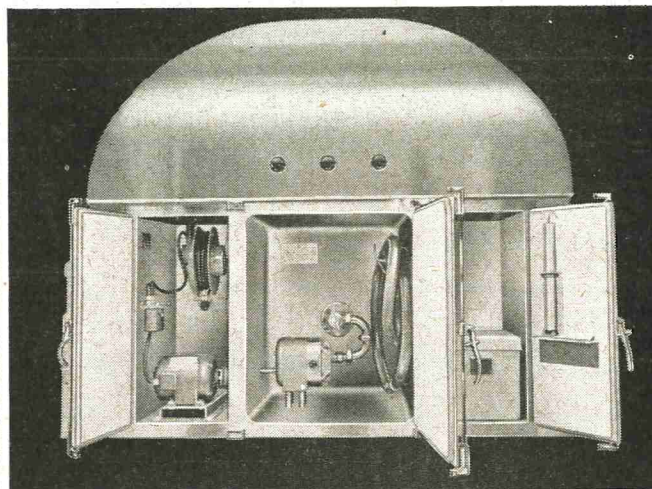
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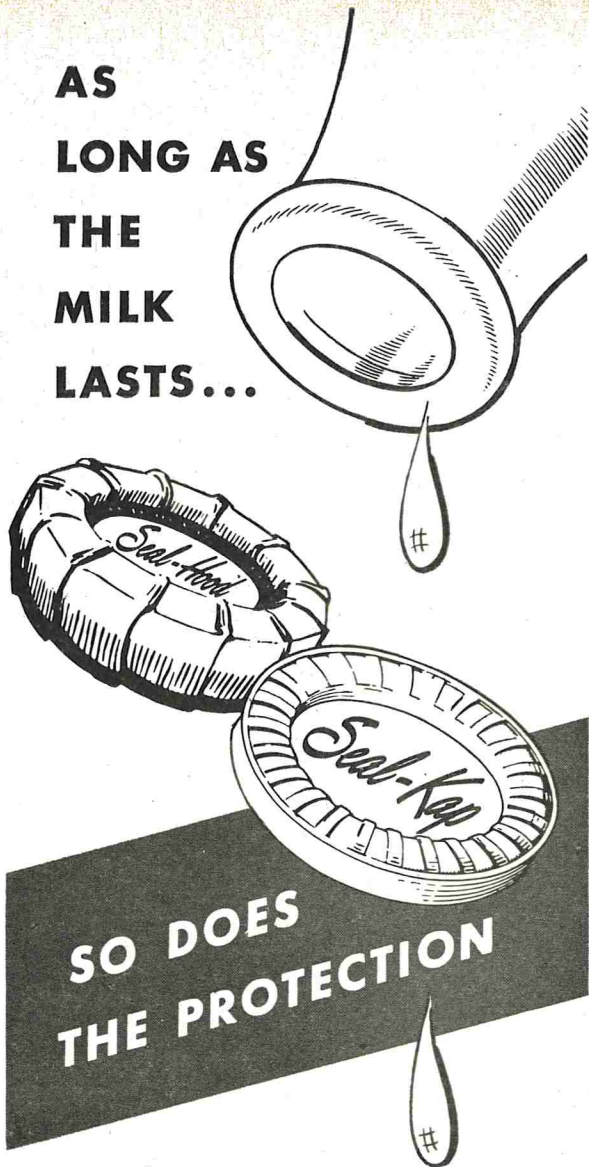
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In our business, sanitation is a most vital aspect of quality. While we as manufacturers undertake the necessary research and inspection to keep DARI-RICH at the top in quality . . . it is your important function to *maintain* such standards in the field.

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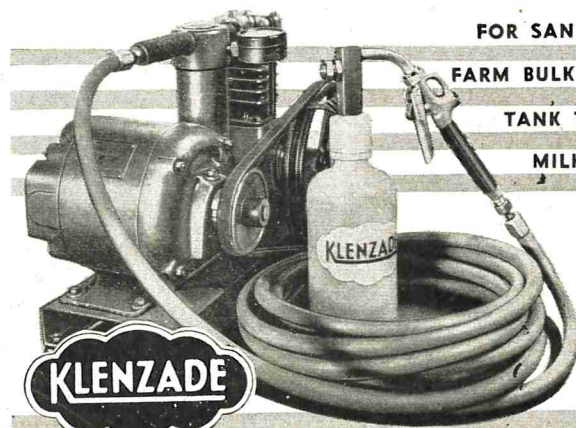
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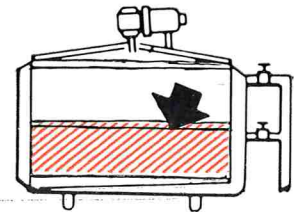


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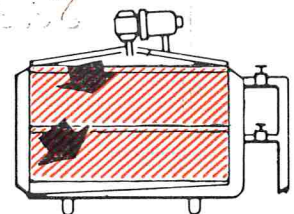
KLENZADE FOG SANITIZER

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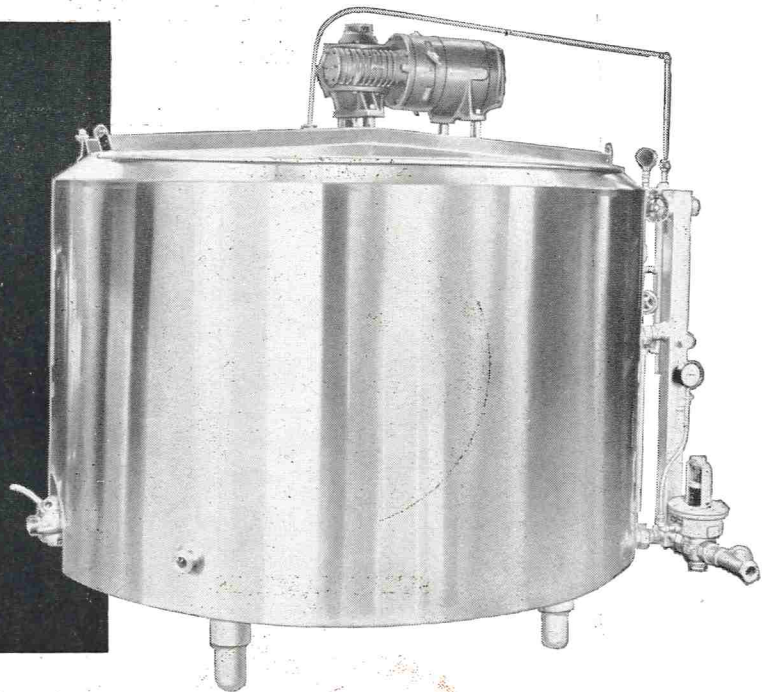
puts the heat or cold
where you want it...



In lower area of tank for small runs or throughout the tank for big runs



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PRESSURE
WALL
Multi-Process
TANKS**

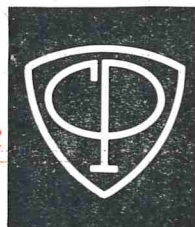


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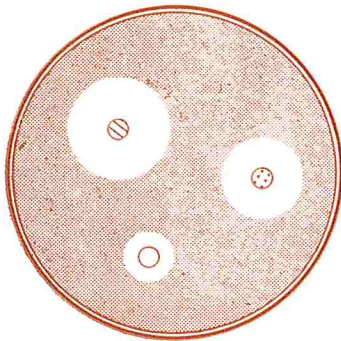


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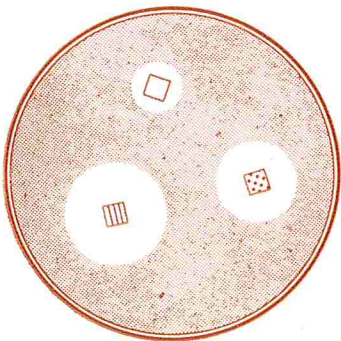
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