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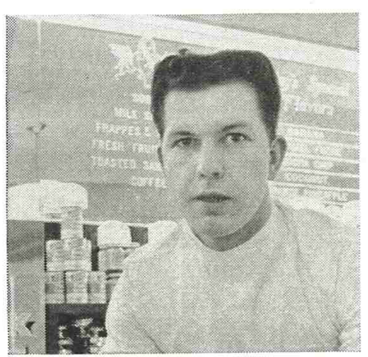

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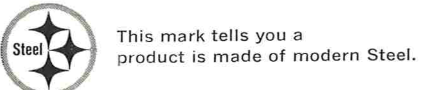

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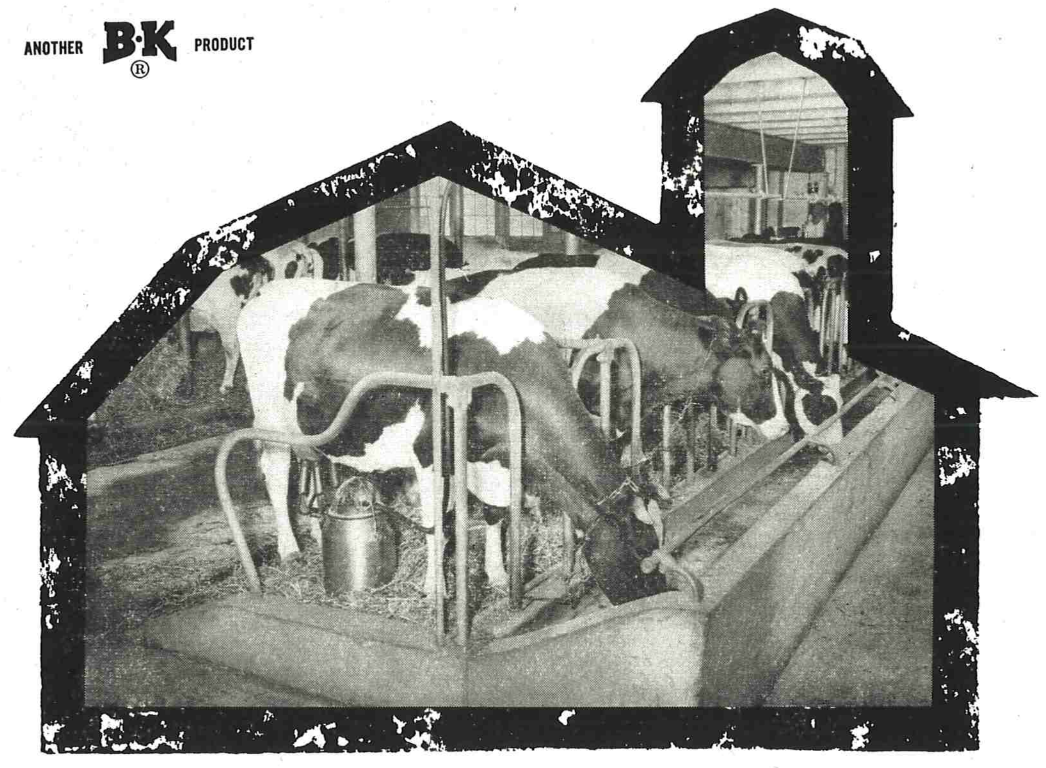

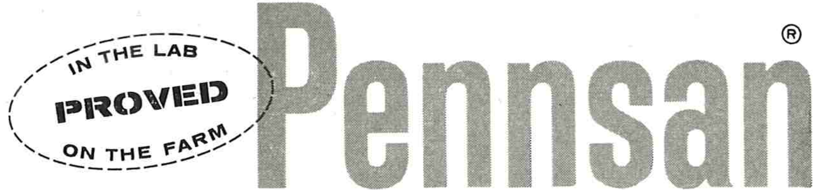

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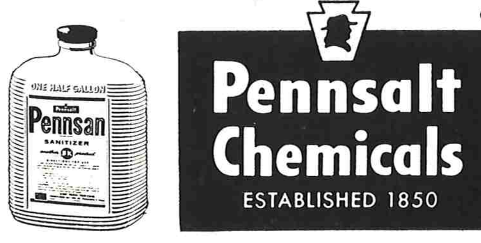

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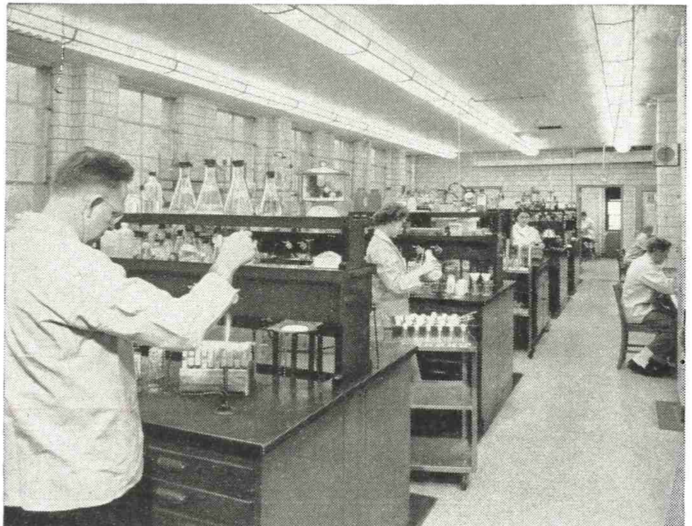

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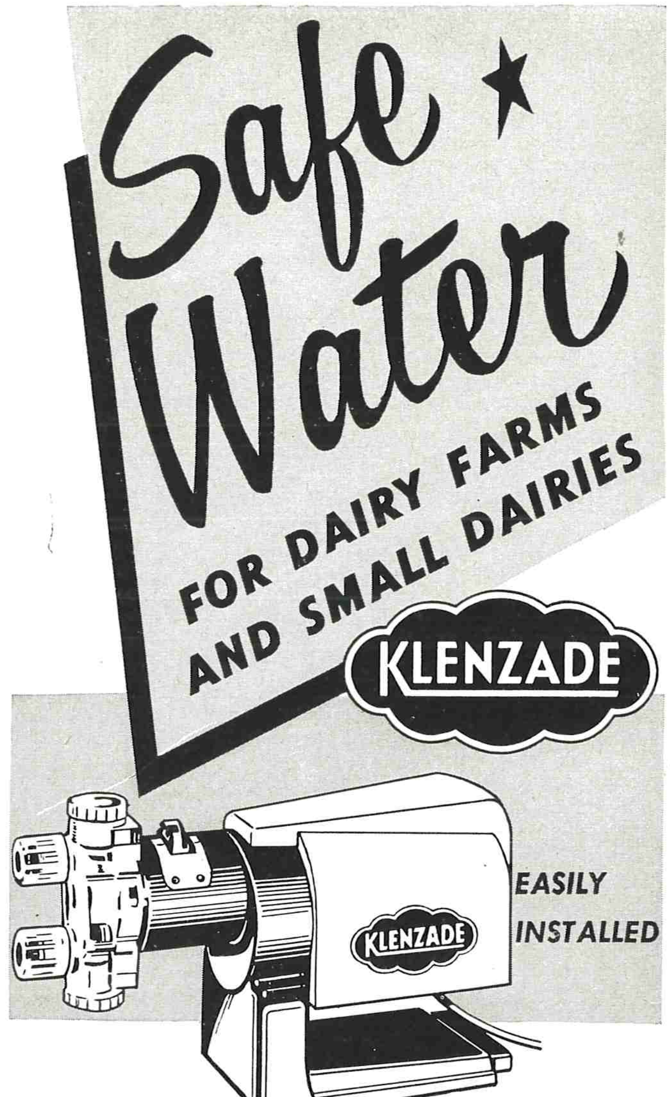

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EDITORIAL

RADIOACTIVITY AND OUR FOOD SUPPLY

Radioactive fallout is a by-product of the nuclear weapons. As most of the testing of nuclear weapons has been done in the North Temperate Zone, the heaviest fallout has been here. When the possible health hazard of fallout, and especially of the longer-lived radionuclides such as strontium 90 and cesium 137, was recognized, various countries began monitoring their food and water supplies. Because of its widespread availability and year-round production, milk has been the food most widely tested. Unfortunately, the public now has strontium 90 and milk so closely associated in its mind that milk is regarded by many as a source of danger to health. Many have mistakenly reduced the milk consumption of their children, in some cases to levels so low as to be dangerous from the standpoint of nutrition.

This is a most unfortunate situation. How can it best be combatted? Not by official pronouncements by government officials or bodies, for many people are suspicious of such statements. They feel that in order to avoid alarming the public, government spokesmen tend to play down the dangers arising from fallout. To try to combat the distorted picture presented by some of the sensational magazines and newspapers through having them publish a more accurate account is unlikely to get to first base. Such magazines are seeking sensation, not the true facts. It would seem, therefore, that the best approach may be for us *as individuals,* in our contacts with our fellow-citizens, to try to correct erroneous impressions and present a more balanced view of the situation.

In discussing fallout in relation to the food supply, several points need stressing. First and foremost, fallout — and especially strontium 90 — must be put in proper perspective. We are all exposed to an appreciable amount of radiation from natural, as well as from man-made, sources, such as medical x-rays. The amount of radiation coming from fallout is a small fraction of the total. It has been stated that a reduction of 10% in radiation by the more careful application of x-rays would be equivalent to the complete elimination of all other man-made radiation, including that from fallout.

As strontium 90 falls from the skies, it contaminates everything on the earth's surface. Plants absorb it from the soil, in addition to what is deposited directly on their surfaces. Animals eating plant food thus take in appreciable amounts of strontium 90. Fortunately, in producing milk the cow discriminates against strontium 90 in favor of calcium, and only one-eighth as much strontium 90 appears in the milk as was present in its food. The human body discriminates still further and only one-fourth to one-half of the strontium 90 is available for deposition in the bones.

A second point, and also a very important one, is that milk, far from being a dangerous source of strontium 90, is really the reverse. Milk actually reduces the danger. Comparison of the amounts of strontium 90 in the bones of North Americans and of Filipinoes and Thailanders shows that those of the latter group contain somewhat more strontium 90 than ours, despite the lower levels of fallout in their countries. The explanation is simple. Strontium and calcium are closely related chemically, so the human bone can absorb strontium in place of calcium. The wider the ratio between calcium and strontium in the food, the less strontium will be absorbed. Milk, although it contains moderate amounts of strontium 90, has a very high calcium content and therefore a wide ratio. Cereals contain very small amounts of calcium along with much larger amounts of strontium 90; thus the ratio here is much narrower. Consequently, much larger quantities of strontium are absorbed by the vegetable and rice-eating races. The North American, who derives roughly 85% of his calcium from dairy products, is thus incorporating much less strontium 90 into his bones than is his cereal-eating counterpart. His calcium intake is also roughly three times as large; this would lead to a lower level of strontium 90 in his bones even if his intake of this compound was as high as that of the rice-eating peoples.

It has been suggested that, unless a person is consuming more than a quart of milk per day, he may actually *reduce* the number of strontium units in the total diet by *increasing* his consumption of milk! This contention is supported by the results of analyses reported in Consumer Reports for June 1960, where the total diet in 8 cities averaged 13.2 strontium units while the milk by itself averaged only 10.9 units. *We should therefore be urging people to increase, rather than curtail, their consumption of milk and its products as a means of reducing the potential hazard from strontium 90.*

Now a word about the hazard. With various authorities voicing different opinions, and with the Maximum Permissible Concentration (now called the Radiation Protection Guide) being lowered from time to time, it is no wonder that some people are disturbed, especially when values in excess of the M.P.C. have occasionally been reported for milk and for certain other foods. It should be pointed out that the M.P.C. represents *the lifetime level* above which it is postulated that harmful effects *may* appear. The point to emphasize is this: only if this level were exceeded every day of a man's life is it believed that harm would result. Competent authorities agree that unless further nuclear explosions occur through testing, accident or war, *it is extremely unlikely that we shall ever reach a hazardous level of strontium 90 in our food supply.* A further cheering thought is that the decay of existing fallout means a steadily declining concentration of strontium 90 in our foods — provided there are no more explosions. Values for milk in 1960 are appreciably lower than they were in 1959.

There has been a great deal of discussion concerning the genetic effects of fallout. It should be sufficient to point out that strontium 90, being localized in the bone, has little or no chance of affecting adversely the gonads, since the rays given off only penetrate tissue about 2 mm. Cesium 137, which has a long life and enters the softer tissues, could present more of a genetic hazard, but so far the concentrations found in milk have been far below the level which might give rise to concern.

While it is highly desirable that the hazards from fallout in the food supply be placed in proper perspective, this is not to say that they should be brushed off as unworthy of attention. There is an obvious need for more research to fill the numerous gaps in our knowledge, and such research is increasing. Steps are already being taken to obtain such knowledge concerning the removal of strontium 90 from milk. If laboratory tests can be translated into a practicable commercial process, the latter may have great survival value if the worst comes to the worst.

All in all, we can conclude that the possible hazards from fallout in our food supply are very small compared to those already accepted in any technically advanced community. Let's get busy and tell this side of the story at every opportunity.

C. K. Johns.

EFFECT OF CHELATING AGENTS ON DESTRUCTION OF *STREPTOCOCCUS CREMORIS* BACTERIOPHAGE BY QUATERNARY AMMONIUM COMPOUNDS[1]

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Corvallis, Oregon

(Received for publication June 17, 1960)

As observed in earlier trials with bacterial cells, destructive activity of a quaternary ammonium compound against *S. cremoris* phage was increased by addition of chelating agents to the virucide. Concentrations of 50 to 100 ppm ethylenediamine tetraacetate and tetrasodium pyrophosphate sharply increased virucidal activity of 25 ppm quaternary, an effect observed earlier with chelating agents and quaternaries against certain bacterial species. Results suggest desirability of incorporation of chelatiing agents in quaternaries for sanitization not only for bacterial but also for bacteriophage destruction. The results also provide new information that may lead to a better understanding of mechanism of action of quaternaries against microorganisms.

The potentiating action of chelating agents on bactericidal activity of distilled water solutions of quaternary ammonium compounds (QACs) has been described briefly in a previous report (*5*). Subsequent unpublished studies in our laboratories have demonstrated this phenomenon not only for tetrasodium pyrophosphate but also for sodium tripolyphosphate (STPP) and ethylenediamine tetraacetate (EDTA). Other investigations have demonstrated superiority in action of hypochlorites over QACs in destruction of bacteriophage (virucidal action) of lactic acid streptococci (*1, 3, 6, 7*). For this reason and in view of the action of chelating agents on QAC activity against certain bacterial species, it was considered desirable to determine whether or not QAC activity against bacteriophage could be accelerated in the same manner. Furthermore, it was considered possible that additional studies on bacteriophage destruction by QAC, particularly with respect to effect of added chelating agent, might provide information useful in elucidating mechanism of action of these agents on microorganisms in general.

EXPERIMENTAL

Accelerating or potentiating effect of chelating agents on bactericidal activity of QAC was observed originally in studies on detergent-sanitizers. These preparations in use-dilution contained QAC (alkyl dimethyl ethyl benzyl ammonium chloride), nonionic wetting agent (NIWA), trisodium phosphate, sodium carbonate (Na_2CO_3), and either tetrasodium pyrophosphate (TSPP), or sodium tripolyphosphate (STPP). A modified Weber and Black (*8*) method was employed in these studies. It was noted in both distilled and hard water solutions that the detergent-sanitizer always exhibited far greater bactericidal activity than the same concentration of QAC in the absence of the other detergent-sanitizer ingredients. Some of the representative data of such trials are presented here (Table 1) to illustrate this effect and provide comparison with virucidal effects of the present study.

Table 1 shows one of a number of similar trials in which *Pseudomonas fluorescens* was exposed to 50 ppm QAC alone and 50 ppm QAC with different compounds constituting the detergent-sanitizer in the same concentration found in the constituent, combined finished product. Tests were conducted at pH

TABLE 1 — EFFECT OF VARIOUS DETERGENT-SANITIZER INGREDIENTS ON BACTERICIDAL ACTIVITY OF A QAC AGAINST *Pseudomonas fluorescens*

Agent	ppm. conc.	Number of survivors				
		15 sec.	30 sec.	60 sec.	120 sec.	300 sec.
QAC	50	$5x10^5$	$3x10^5$	$2x10^5$	$2x10^5$	$1x10^5$
QAC + NIWA	50 50	$7x10^5$	$5x10^5$	$5x10^5$	$5x10^5$	$2x10^5$
QAC + Na_2CO_3	50 250	$1x10^6$	$5x10^5$	$5x10^5$	$4x10^5$	$3x10^5$
QAC + TSP	50 250	$7x10^5$	$5x10^5$	$3x10^5$	$4x10^5$	$2x10^5$
QAC + TSPP	50 250	$<1x10^1$	$<1x10^1$	$<1x10^1$	$<1x10^1$	$<1x10^1$
QAC + STPP	50 250	$<1x10^1$	$<1x10^1$	$<1x10^1$	$<1x10^1$	$<1x10^1$

QAC — Alkyl dimethyl ethyl benzyl ammonium chloride
NIWA — Nonionic wetting agent
TSP — Trisodium phosphate
TSPP — Tetrasodium pyrophosphate
STPP — Sodium tripolyphosphate

[1]Technical Paper No. 1334 Oregon Agricultural Experiment Station. Contribution of the Department of Bacteriology.
[2]Present address: Lucky Lager Brewing Co., Research Department, San Francisco, California.

9.2, the level observed in use dilutions of the detergent-sanitizer. Results emphasize the striking role of the sequestering or chelating agents, TSPP and STPP, in stimulating bactericidal activity of QAC, and the lack of any effect by the nonionic wetting agent, sodium carbonate, or trisodium phosphate.

In the virucidal studies ethylenediamine tetraacetate (EDTA) and tetrasodium pyrophosphate (TSPP) were employed as typical organic and inorganic chelating agents, respectively. Alkyl dimethyl ethyl benzyl ammonium chloride was used as a representative QAC. Concentrations of QAC were adjusted by the Furlong and Elliker method (*2*). Virucide solutions with and without chelating agent were prepared in M/100 borate buffer at pH 8.0. The bacteriophage suspension used was a 1:50 distilled water dilution of a whey filtrate of *Streptococcus cremoris* 144-F. Inactivator solutions consisted of 2.2 g Asolectin and 15.8 ml. Tween 80 per 1. of M/100 phosphate buffer at pH 7.2 (*8*). Prior to virucide trials, 4.5 ml. of inactivator solution were mixed with an equal volume of $CaCl_2$ solution to provide a final concentration of 400 ppm $CaCl_2$ in the inactivator tube to overcome the effects of the chelating agent.

The test method consisted of placing 5 ml. of bacteriophage suspension into 30-ml wide mouth, screw cap bottles. At the beginning of each test-run, 5 ml. of virucide were added and the contents mixed immediately. After 30 seconds a 1-ml. aliquot of phage-virucide mixture was transferred to an inactivator tube. Bacteriophage surviving treatment was assayed by the plaque count method. Dilutions of surviving bacteriophage for plaque preparation were made in M/100 phosphate buffer containing 8.5 g. NaCl per 1. at pH 7.1. Method of preparation of plaques was similar to that described in a previous paper (*7*).

Results shown in Table 2 indicate that EDTA increased the virucidal activity of QAC against phage in concentrations from 25 to 200 ppm. A sharp increase in activity occurred when 100 ppm. EDTA was used. At 200 ppm. EDTA the QAC destroyed all but a small percentage of the phage particles present. Results with TSPP shown in Table 2 indicated that this sequestering agent exerted a comparable acceleration of virucidal activity when added in varying concentrations to QAC. Controls run in both trials indicated no inactivation of phage due to chelating agents alone.

Another series of control studies was conducted to determine if phosphates other than TSPP would increase activity of the QAC against phage. The data in Table 3 demonstrate that when various phosphate systems were employed, only polyphosphate, TSPP, increased the virucidal activity of the QAC.

Discussion

The potentiating effect of the chelating agents on QAC action against both bacterial cells and bacteriophage is clearly indicated in these experiments. The effect may be due to removal of inhibitory ions such as calcium from cell or phage sites which react with QAC. A concentration of 50 to 100 ppm EDTA was required before a sharp increase in rate of bacteriophage destruction was observed. At lower concentra-

Table 2 — Effect of Ethylenediamine Tetraacetate (EDTA) on the Virucidal Activity of 25 ppm. QAC Against S. *cremoris* Phage 144F

Conc. of EDTA	Final pH	Plaque count per ml. after 30 seconds
(ppm)		
0	8.0	$7.1x10^5$
25	7.9	$6.6x10^5$
50	7.95	$1.0x10^5$
100	7.9	$3.3x10^3$
200	7.9	$4.0x10^1$

Initial count of phage suspension: $6.5x10^7$ per ml.

Table 3 — Effect of Tetrasodium Pyrophophate (TSPP) on the Virucidal Activity of 25 ppm. QAC Against S. *cremoris* phage 144F

Conc. of TSPP	Final pH	Plaque count per ml. after 30 seconds
(ppm)		
0	7.85	$2.8x10^5$
25	7.95	$1.8x10^5$
50	8.0	$1.1x10^5$
100	8.0	$2.2x10^2$
200	8.0	$4.0x10^1$

Initial count of phage suspension: $7.4x10^7$ per ml.

Table 4 — Effect of Type of Phosphate on Virucidal Activity of 25 ppm Quaternary Against S. *cremoris* Phage 144F

Type of Phosphate	Final pH	Plaque count per ml. after 30 seconds
M/200 borate buffer plus no phosphate	7.9	$1.8x10^6$
M/200 borate buffer plus 200 ppm Na_3PO_4	7.8	$1.3x10^6$
M/200 borate buffer plus 200 ppm $Na_4P_2O_7$	7.6	$3.4x10^2$
M/200 phosphate buffer	7.8	$2.0x10^5$
M/200 phosphate buffer plus 200 ppm $Na_4P_2O_7$	7.8	$3.5x10^2$

Initial count of phage suspension: $9.5x10^7$ per ml.

tion levels it is possible that all or most of the chelating agent was reacting with certain cations in the medium with no excess to react with phage particles. The results suggest the desirability of incorporating some form of chelating agent into QAC preparations to be used for both bacterial and bacteriophage destruction regardless of hardness of water in which the use solution is prepared.

In previous studies, bacteriophage for lactic streptococci has demonstrated greater resistance to destruction by QAC than might have been expected on the basis of hypochlorite and QAC action against vegetative cells of various species of bacteria. It is possible that the protein shell or coat of the phage particle sets up a barrier that interferes with QAC action to a greater degree than with a compound such as a hypochlorite. There is some evidence that cell permeability may be an important limiting factor with respect to QAC activity against resistant strains of nonsporeforming bacteria (*4*). It is interesting in considering mechanism of action of QAC against microorganisms that chelating agents appear to exert a similar favorable effect on action of QAC against both bacterial cells and bacterial viruses.

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PRELIMINARY REPORT ON A BACTERIOLOGICAL STUDY OF SELECTED COMMERCIALLY PREPARED, WRAPPED SANDWICHES[1]

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(Received for publication August 12, 1960)

"Wet" and "dry" type sandwiches were examined bacteriologically and evidence has been found that growth of contaminating organisms took place in the "wet" or moist salad types. This growth is believed to be a reflection of the fact that the sandwiches are prepared 17-20 hours prior to sale and held for this time at ambient air temperature (23°-30°C in this area). It is felt that the salad type sandwiches present a potential food poisoning hazard.

The large scale production of wrapped sandwiches has developed principally in metropolitan areas and has a relatively recent history as a specialty food product. While consumption figures are not available, Senn and Logan (*5*) believed the figure would be impressibly high. In support of this, one large Southern California manufacturer estimated his average production for 1960 at forty-five thousand units per day.

The fact that these products are essentially hand made, are composed of materials affording bacterial growth, are not given subsequent heat treatment, and are not refrigerated or cooled prior to sale (which may be up to 36 hours after fabrication) have made these products of great concern to public health authorities. Although from their nature one might expect more reports of food poisoning, only a few have been reported definitively in the literature (*1, 2, 3*) and few if any studies of the bacterial flora of sandwiches have been reported.

With the above in mind a survey has been made of various kinds of commercially wrapped sandwiches. Since these sandwiches are highly variable products, differing greatly in formulation from manufacturer to manufacturer it was felt that the preliminary survey should be limited in scope to those available to the campus population at the University of California, Los Angeles. These sandwiches were all made by a single manufacturer and sold at three locations on the campus. Approximately 1200 to 1500 sandwiches a day are sold from these three stands.

[1]This study was supported in part by U. S. Public Health Service Traineeship Grant 59-201.

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Two types of sandwiches were chosen for study: (*a*) relatively moist "salad" types; and, (*b*) relatively dry cooked meat and/or cheese types. Greater emphasis was placed on the former group because of the more favorable conditions for bacterial growth and thus greater potential for food poisoning.

PROCEDURE

Samples were purchased from the food vending stand just prior to the noon-hour and laboratory procedures were performed immediately. A total of ten egg salad, ten tuna salad, two American cheese, two ham, two salami, two "hot" ham and cheese and two "hot" roast beef and cheese sandwiches were examined. All sandwiches, except the "hot" types were sold to the customer at room temperature (average 27.5°C). "Hot" sandwiches were those heated in a warming oven at 55.5°C prior to sale and sold at that temperature.

One half of the sandwich was removed aseptically from its plastic film wrapper, weighed to the nearest 0.1 gm., transferred to a sterile Waring blendor and triturated with sufficient water to obtain a 1-10 dilution. Decimal dilutions were made as needed. Bread and fill were homogenized together to insure counting organisms growing in material soaked into the bread. Incidental to several runs, the fill of the remaining sandwich half was removed and weighed separately to obtain an estimate of the bread to fill ratio.

Standard plate counts were obtained by serial dilution plating in duplicate with tryptone glucose extract agar. Coliform and enterococcus determinations were made using the most probable number (MPN) technique, with brilliant green bile broth and eosin methylene blue agar for the coliforms and the technique of Litsky *et al.* (*4*) for enterococci.

Staphylococci were determined by serial dilution surface plating on Chapman-Stone agar (CS) and Tellurite glycine agar (TG). After 24 hours incubation at 36°C, all colonies on CS and TG were counted. Jet black colonies on TG agar were subcultured on CS. The coagulase test, using Difco reconstituted plasma, was performed with representative colonies from both CS and TG subcultures.

TABLE 1 — COMBINED RESULTS OF EXPERIMENTAL RUNS OF EGG SANDWICHES

Run	Std. Plate (Count/gm)	Coliforms (MPN/gm)	Enterococci (MPN/gm)	Staphylococci CS[a] (Count/gm)	TG[b]	Spore Counts (MPN/gm)	pH
I	—[c]	—[c]	—[c]	—[c]	—[c]	—[c]	6.01
II	—[c]	—[c]	—[c]	—[c]	—[c]	—[c]	5.55
III	10,300,000	24,000	3,500	4,100,000	86,000	2,200	6.03
IV	14,300,000	54,000	1,700	4,200,000	60,000	3,500	5.50
V	13,700,000	54,000	4,700	4,300,000	420,000	5,400	6.20
VI	90,000,000	240,000	5,400	280,000	410,000	240,000	5.40
VII	30,000,000	35,000	3,500	2,800,000	180,000	1,600	4.90
VIII	32,000,000	35,000	54,000	4,500,000	2,700,000	5,400	5.25
IX	5,800,000	5,400	1,700	290,000	230,000	2,800	5.90
X	26,000,000	35,000	140,000	12,000,000	2,300,000	5,400	5.70

[a]Chapman-Stone medium

[b]Tellurite Glycine medium

[c]Data not usable due to use of limited range of dilutions.

Anaeroboic spore counts were made using a MPN method with litmus milk, a modification of a method for water (*6*). Tubes inoculated with the sample portion were heated to 80°± 1°C for ten minutes and after prompt cooling, layered with 3 cm. of sterile mineral oil and incubated at 36°C for 72 hours. Tubes were recorded positive on the basis of "stormy" fermentation, growth, curd formation and/or peptonization.

Salmonella and *Shigella* tests were performed using selenite enrichment followed by streaking on *Salmonella-Shigella* agar and bismuth sulfite agar. All media were incubated at 36°C for 18-24 hours.

After all media had been inoculated, the pH was determined with a Beckman Model H2 pH meter.

DISCUSSION OF RESULTS

The results of the bacteriological study will be found in Tables 1, 2 and 3.

The salad type sandwiches appeared very moist and were made of materials which could very easily support bacterial growth, whereas the "drier" sandwiches appeared to offer a less desirable substrate for growth. This difference in moisture content between the two types of sandwiches is also reflected in the fill-to-bread ratios which were 1-3 for the "wet" types and 1-5 for the "dry" types. The results reported in the tables include the bread. The counts would be higher if calculated as "per gram of fill."

A trip through the processing plant indicated that all sandwiches were fabricated by hand and the salad types were made from essentially bacteria free ingredients. An examination of the data shows that the "wet" or salad types were generally much higher in the various bacterial counts (Table 1 and 2) than the relatively "dry" types (Table 3). Since all of these sandwiches were fabricated by hand and held at ambient air temperature (23°-30°C) 17 to 20 hours prior to purchase, it is assumed that the "wet" and "dry" types received a similar initial contamination and the resulting numbers represent growth of these organisms in the product. To what extent growth had taken place in the "dry" types cannot be determined from these data, however, the counts in the "wet" type clearly represent growth of the organisms. The lower numbers of organisms in the "dry" types probably reflect less favorable growth conditions.

In general the total counts of the egg (Table 1) and the tuna (Table 2) salad sandwiches differed in magnitude from each other and this is believed to be due to the lower pH of the tuna salad, although no relationship between total count and pH is apparent within each type.

Coliform and enterococcus MPN's appear to follow the total count pattern in general and there seemed to be no apparent relationship with each other, with total count or with pH. It is believed that these MPN's represent growth of these organisms but to what extent the products were initially contaminated has not yet been determined. The coliform counts in the "dry" sandwiches again probably represent less favorable growth conditions compared to the "wet" types and, in the case of the "hot" sandwiches,

TABLE 2 — COMBINED RESULTS OF EXPERIMENTAL RUNS OF TUNA SANDWICHES

Run	Std. Plate (Count/gm)	Coliforms (MPN/gm)	Enterococci (MPN/gm)	Staphylococci CS[a] (Count/gm)	Staphylococci TG[b] (Count/gm)	Spore Counts (MPN/gm)	pH
I	—[c]	—[c]	—[c]	—[c]	14,300	—[c]	4.90
II	—[c]	—[c]	—[c]	—[c]	6,700	—[c]	5.01
III	3,800,000	1,600	920	31,000	730	110	4.95
IV	67,000	350	79	10,000	370	220	5.05
V	390,000	220	350	100,000	900	49	5.10
VI	380,000	54	350	3,500	5,900	2,200	4.95
VII	4,500,000	35	240	390,000	4,200	240	4.65
VIII	8,000,000	28	350	42,000	6,700	540	4.60
IX	270,000	35	240	3,100,000	63,000	540	4.95
X	420,000	110	700	61,000	7,300	3,500	5.35

[a]Chapman-Stone medium

[b]Tellurite Glycine medium

[c]Data not usable due to use of limited range of dilutions

organisms probably were killed by the heat. The enterococci, while they may also grow poorly under these conditions, are not so readily affected by heat. The coliforms were about evenly divided between *Escherichia coli* and *Aerobacter aerogenes* types.

The high *Staphylococcus* counts indicate that food poisoning strains might be able to grow, although no organisms characteristic of these types (coagulase positive) could be recovered from either CS or TG agars. These cannot be considered to be completely absent since the sampling procedure may have missed them. In several instances the *Staphylococcus* count was higher than the total count. The reason for this was not investigated during this preliminary study and this phenomenon has also appeared in later work on the dry sandwiches.

No evidence of *Clostridium perfringens* was found. Tubes of litmus milk usually showed peptonization

TABLE 3 — COMBINED RESULTS OF EXPERIMENTAL RUNS OF HAM, CHEESE, SALAMI, HOT BEEF AND CHEESE, AND HOT HAM AND CHEESE SANDWICHES

Run	Std. Plate (Count/gm)	Coliforms (MPN/gm)	Enterococci (MPN/gm)	Staphylococci CS[a] (Count/gm)	Staphylococci TG[b] (Count/gm)	Spore Counts (MPN/gm)	pH
A. Ham Sandwiches							
I	67,000	1.0	240	83,000	41,000	None	6.10
II	73,000	1.0	350	180,000	70,000	None	5.90
B. Cheese Sandwiches							
I	27,000	1.0	240	370,000	31,000	40	6.30
II	23,000	None	350	24,000	270	1.0	5.70
C. Salami Sandwiches							
I	180,000	1.0	130	520,000	140	33	5.40
II	3,600	1.0	240	5,200	10,200	1.0	5.50
D. Hot Beef and Cheese Sandwiches							
I	81,000	None	220	18,000	None	49	5.50
II	19,000	None	23	13,000	None	6	5.60
E. Hot Ham and Cheese							
I	58,000	1.0	130	4,700	890	1.0	6.00
II	46,000	None	49	29,000	140	350	5.60

[a]Chapman-Stone medium [b]Tellurite Glycine medium

with reduction or less commonly reduction alone. These organisms were not identified.

No *Salmonella* or *Shigella* were recovered from any sample.

The conclusions of this preliminary report are that: (*a*) the products are contaminated during fabrication by hand, and (*b*) growth of the initial contaminants takes place at least in the salad type sandwiches as a result of being held at ambient air temperatures (23°-30°C) for 17-20 hours (which may be extended up to 30 hours for late afternoon sales) prior to sale.

The initial contamination level has not been determined, although it is believed to be no higher and probably considerably lower than the counts from the "dry" sandwiches. This growth is strong evidence for the potential danger of food poisoning from the "wet" or salad type sandwiches. Care should be taken not to assume that the "dry" type sandwiches are free from danger. The potential danger of this type sandwich is not so clear and more work must be done to ascertain their potential; however, it is assumed to be much less than the "wet" types. There seems to be no reason why sandwiches from other producers, made from similar materials and under similar conditions of fabricating and holding, should not show similar patterns of growth. However, this requires more thorough study before a definite assertion can be made.

The foregoing would indicate that a great deal has yet to be done to improve the sanitary quality of commercially prepared, wrapped sandwiches as received by the consumer. This probably should be centered around control of bacterial growth in the product.

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THE EFFECT OF THE FOOD ADDITIVES AMENDMENT ON FOOD PROCESSORS AND OTHERS[1]

BY FRANKLIN M. DEPEW

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In order to evaluate the tremendous impact of the Food Additives Amendment on the regulated industries as well as on the Food and Drug Administration, I sketch a brief history of the events leading to its enactment. This history shows the law to be part of a creative evolution whereby government and industry are continuously working together to better protect the public health.

Some years ago the Congress became concerned about the increased use of chemicals in the manufactture of food and the increased development of pesticide chemicals which might leave residues in food. The great technological advance since the War made available an infinite variety of new substances for preserving and improving food. The food industry had spent millions in improving the handling of raw materials and in food processes to produce cleaner and safer foods. They had also spent millions in testing new substances used in food but questions were raised as to whether these tests were adequate.

Investigations of these new substancs were commenced by the House Delaney Committee which held public hearings in 1950-52. Subsequently the House Commerce Subcommittee on Health and Science held hearings during 1956-58 and unanimously recommended that a law be passed requiring that food additives be pretested in a manner analogous to that required for new drugs.

This recommendation was made even though there was no evidence to show that any responsible food processor was using a harmful substance. There was a general conviction that despite this the public was in need of protection against small, irresponsible ele-

[1]From a paper read at the meeting of the American Bar Association, before the division of Food, Drug and Cosmetic Law of the Section of Corporation, Banking and Business Law, in Washington, D. C., on August 31, 1960.

ments, as well as against the possible inadvertent mistakes of reputable food processors.

The recommendation for pretesting was supported by the food industry generally. The industry concluded that it was essential to resolve all doubts in favor of protecting the integrity of food products. Thus in deference to the national welfare, the members of the industry voluntarily recommended the relinquishment of some of their individual rights. By doing so they gave up the privilege that had been exercised by manuafcturers through recorded history —the right solely to determine the safety of the food they manufactured in the manner it had been determined in the past, i.e., by relying on the exercise of discretion and scientific judgment of their experts that it did not contain a poisonous or deleterious substance.

Prior to the enactment of the Amendment such a poisonous or deleterious substance might properly have been called a food additive within the meaning of the then existing law. That law prohibited the food processor from using any poisonous or deleterious substance (i.e. a food additive) except that if the substance was required in the production of a food or could not be avoided in good manufacturing practice, its quantity was not to exceed the limits of an administrative safety tolerance for it. During some twenty years no food additive was found to meet this exception in the law. As a result where there was any question as to whether or not a new substance was poisonous or deleterious the food processor usually reviewed his expert's conclusions with the Food and Drug Administration (FDA). Thus, these technological advances since the War had created a situation where the food processor, as a practical proposition, frequently felt he should not rely entirely on his own experts. Accordingly, with respect to such practices the Amendment has but legally required the substantial equivalent of that which was theretofore done voluntarily.

I believe that most of the food processors will agree that up to the present time the Amendment has not greatly changed their operations, so far as they relate to ingredients and processing substances, because it has only made mandatory what was previously done voluntarily. The situation, however, has been different with respect to packaging items. Food processors have had to explore more carefully the substances used in packaging materials and thus they have brought to these suppliers a fuller realization of the law's requirements. I said "up to the present time" because the status of certain substances used in small amounts, such as many flavoring ingredients, is still unresolved. These substances are used in such small amounts they were not considered toxicologically significant in the past. The cost of testing each of these substances seems to be out of all proportion to the price at which the substance can be sold. The solution of the problem has been postponed by the granting of extensions for most of these substances until next year. It has been suggested that the Amendment has presented FDA and industry with an insuperable problem in regard to these substances in that the requirements of the law may have outstripped our fundamental knowledge of toxicity. I do not believe that this will be the case. Much imagination and resourceful thinking may be necessary to solve the problem but I feel confident a satisfactory solution will be reached.

As it has turned out, not only must the members of the food industry conform to the provisions of the Amendment but the members of many other industries as well. It is doubtful that many of these other industries comprehended the manner in which the law would be applied to them. It is even doubtful that a portion of the food industry realized that the law would apply to those many substances present in foods in such small amounts they had been considered to be inconsequential from the standpoint of health hazard.

The definition of the term "food additive" necessarily had to be broad in order to accomplish the desired purpose. It is so broad that it is now recognized that a company supplying processing materials, handling equipment or packaging material—in fact, almost anything—may be supplying a substance that constitutes a food additive. This is so because of the possibility that some portion of any substance coming in contact with food may migrate to the food. If that substance or any substance resulting from the interaction is not generally recognized as safe, then both would constitute a food additive.

It seems obvious that it is mathematically possible for many millions of chemical reactions to occur almost daily as a result of the numerous contacts of various substances with food from the time the seed is planted until it reaches the consumer's table. In the past little consideration has been given to many of these possible reactions in the absence of any scientific warning that they constituted an imminent or even a potential danger to health. The new law has changed all this for it poses a basic problem to the food processor and his suppliers—that of determining whether these multitudinous substances, many of which present serious practical difficulties of analysis, are generally recognized by qualified experts as safe for their intended use.

The food and related industries have the primary responsibility of resolving this problem under the law. In order to answer the problem intelligently it seems

clear that all ingredients of all the processing and other materials must be disclosed to someone who is able properly to evaluate them and to determine whether the finished food does, or does not, contain or constitute an additive within the meaning of the law. At the outset this has presented the food processor with a vexing dilemma since the formulas for many of these items are regarded as industrial secrets of great value, which the proprietors are loath to reveal. So far as the exercise of this responsibility by the food processor is concerned, it is clearly essential that he be permitted a reasonable discretion in relying on the representations and guaranties made by his suppliers relative to the ingredients in the materials purchased even though a guaranty may not fully excuse him from liability. Once the food processor has collected this data, and has determined what all these materials are, it is still most difficult for him to find qualified experts who can evaluate the information.

It is most important to recognize however that the responsibility to solve this problem rests on management. In this connection it behooves the newly regulated industires, including the food industry, to reflect on the stern admonition of the case of *United States v. Dotterweich,* 320 U. S. 277 (1943). This far-reaching decision, rendered only five years after the enactment of the Federal Food, Drug and Cosmetic Act, emphasizes that the remedial purposes of the Act require that it be liberally construed. The case involved a Government prosecution against a drug jobber and its president and general manager. It charged that the corporation purchased certain drugs, repacked and labeled them in an adulterated and misbranded condition, and so shipped them in interstate commerce. The corporation was acquitted on technical grounds but the company officer was convicted. In the course of its opinion the Court said:

"The prosecution to which Dotterweich was subjected is based on a now familiar type of legislation whereby penalties serve as effective means of regulation. Such legislation dispenses with the conventional requirements for criminal conduct—awareness of some wrongdoing. In the interest of the larger good it puts the burden of acting at hazard upon a person otherwise innocent but standing in responsible relation to a public danger. United States v. Balint, 258 U. S. 250. And so it is clear that shipments like those now in issue are 'punished by the statute if the article is misbranded (or adulterated), and that the article may be misbranded (or adulterated) without any conscious fraud at all. It was natural enough to throw this risk on shippers with regard to the identity of their wares . . . ' United States v. Johnson, 221 U. S. 488, 497-98."

These words of the court warn of the extent to which management is held responsible for violations of the Federal Food, Drug and Cosmetic Act. They merit most careful consideration at this time because of the new and difficult duties imposed on management by the Food Additives Amendment and the Color Additive Amendments.

The following further quotation from the Dotterweich decision gains increased significance in the light of these amendments:

"The purposes of this legislation thus touch phases of the lives and health of people which, in the circumstances of modern industrialism, are largely beyond self-protection. Regard for these purposes should infuse construction of the legislation if it is to be treated as a working instrument of government and not merely as a collection of English words."

The Dotterweich decision is a precedent for the belief that the management of a corporation, as well as the corporation itself, which causes or allows a food additive to become a part of food are responsible for the adulteration of the food, even though they may have no personal knowledge of guilt. The law thus places great responsibility on management.

It has been said that even the most perfectly planned democratic institutions are no better than the people whose instruments they are. We see from the history of the Food Additives Amendment that it was framed in a democratic manner to further the public welfare. But the many unexpected problems created by its enactment leaves some doubt about the perfection of its legislative planning from the viewpoint of the many hazards involved in determining compliance. It is clear, however, that the language relative to "generally recognized as safe" expresses the philosophy that the amendment was not intended to make the law one of governmental permissive control. The success or failure of this new law will depend to a great extent on the measures taken to implement it by the officials responsible for its enforcement and by the management of the regulated industries. The FDA has responded admirably to the problems created by this enactment. Its regulations and interpretations demonstrate a helpful recognition of the difficulties which confront industry. Its "white lists" have been a major contribution in aiding industry to solve many of these problems. We believe this is what could be expected from this expert professional agency with its long record of distinguished administrative success.

However, the purpose of the Amendment will not be achieved in time to come unless government and the regulated industries continue to use this same

high degree of statesmanship in determining how compliance with its provisions can best be accomplished. We firmly believe that the regulator and the regulated have recognized that this is the case and thus we conclude that the basic impact of the Amendment has been to bring about a realization that it is necessary for all concerned to exert every effort toward making the Amendment function in such a way that these multitudinous problems will be solved justly, fairly and effectively, and with a minimum of conflict. We believe the law is largely and best self-enforced by industry on a voluntary basis and that every effort should be made to promote voluntary industry compliance through educational means before more drastic enforcement action is taken. The problems are so intricate and perplexing for scientists, as well as for lawyers, that they must be approached in a spirit of cooperation. If a dispute arises as to whether a substance is generally regarded as safe it should only be carried to the courts with a sound appreciation by both sides of the issues involved. If the issue reaches the courts it should then be determined impartially in accordance with our long established history of fairness and justice. We believe we can look forward to the continued prudent exercise of responsibility and power which is so needed to make the law bring forth those ends which the Congress intended. We have faith that the result will be in accord with the creative evolution which brought about the enactment.

In this connection it should not be forgotten that a major contribution in the past to the successful enforcement of the Federal Food, Drug and Cosmetic Act has been the FDA's program of education and cooperation. The program has included FDA's "open door policy" whereby voluntary industry compliance has been promoted by exchange of ideas about the interpretation of various provisions of the law. This program has been highly praised by all concerned with the problems of enforcement.

The FDA has deliberately adapted this tested policy to furthering compliance with the Food Additives Amendment. Not only has FDA cooperated with The Food Law Institute in holding national FDA-FLI conferences on this subject but it has also expanded its "open door policy" to invite full and free discussion with its experts and other key personnel. These meetings have clearly demonstrated that a full explanation of all the facts relating to a problem, if presented in a spirit of cooperation, almost inevitably produce a satisfactory solution.

We of FLI commend the FDA for this policy as the democratic way in which to develop respect for and compliance with any law. Such cooperation is in complete accord with the philosophy of our free institutions and it should continue to have the full support of government and industry alike. One of the basic reasons why The Food Law Institute was created was to develop the needed knowledge about this and other aspects of the food and related laws by research studies, by university education and by other educational means. The FLI program of education will continue to be a bulwark of support for this method of law enforcement. We believe it is a privilege to participate in furthering this creative evolution by working together in this manner.

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EXTENDED METHYLENE BLUE TEST FOR ANTIBIOTICS IN MILK[1]

Burdet Heinemann
Producers Creamery Company,
Springfield, Missouri

(Received for publication August 3, 1960)

In order to maintain adequate control over the presence of antibiotics in milk by the dairy plants, simplified platform tests are highly desirable. Such tests should be capable of performance by any laboratory technician and yet be sensitive to low levels of penicillin or other antibiotics. Several procedures were studied and the most satisfactory procedure is presented below. This procedure may be performed using the same equipment which is required for making the methylene blue test for grades of milk. The only additional requirement is the use of a culture of S. *thermophilus,* which may be obtained from commercial laboratories supplying the dairy industry with freeze-dried cultures.

Methods and Observations

The following methods were studied: (*a*) the extended methylene blue test and curd observations made on raw milk samples using lactic cultures (16 hours at 70-72°F.); (*b*) extended methylene blue and curd tests on pasteurized milk samples using lactic cultures; (*c*) extended methylene blue and curd tests on pasteurized milk samples using S. *thermophilus* cultures (4-6 hours at 98°F.) (*d*) five-hour methylene blue tests on pasteurized milk samples using lactic cultures and color change as an endpoint; and (*e*) four to eight hour methylene blue tests on pasteurized milk samples using S. *thermophilus* cultures and both color change and curd formation as endpoints.

The results obtained using these methods are given in Table 1. It will be noted that one-tenth of a unit of penicillin per ml of milk is not detected when raw manufacturing grade milk is tested. When raw Grade A milk is tested to which one-tenth unit penicillin has been added per ml of milk, 100 per cent of the samples are detected. When manufacturing milk is pasteurized before the lactic starter is added and when curd is used as the endpoint, 97 samples out of 102 were detected. Using color change as an endpoint and S. *thermophilus* as the culture 162 samples were detected out of 165, and when lack of curd formation was used as an endpoint all of the samples were detected. Because of these observations the test selected involved pasteurizing the samples and using S. *thermophilus* as the test organism. It is based on the method described by Neal and Calbert (*1*).

The antibiotic test is performed after the completion of the methylene blue test described in Standard Methods (2). When grading manufacturing milk by the methylene blue test the No. 4 grade tubes are removed, identified, and placed in an ice bath. When the No. 3 tubes have reduced, these also are placed in an ice bath after identifying each tube. At the completion of the 3½ hour reading, the No. 4 and No. 3 tubes are returned to their original position in the tray. At this time control samples with and without added antibiotics containing 10 ml of milk and 1 ml of methylene blue solution are placed in

[1]Presented at the Annual Meeting of the American Dairy Science Association, Logan, Utah, June 20, 1960.

Table 1 — Effect of Method on Detection of 0.1 Unit Penicillin G. added per ml Milk

Method[a]	Type milk	Starter	Raw or past.	No. samples	Incubation conditions	Number detected by observation of	
						Color (blue)	Curd (none)
1	Grade A	S. *lactis*	Raw	94	16 hrs/72°F.	94	84
1	Mfg.	S. *lactis*	Raw	102	16 hrs/72°F.	0	10
2	Mfg.	S. *lactis*	Past.	102	16 hrs/72°F.	3	97
3	Mfg.	S. *therm.*	Past.	165	4-6 hrs/98°F.	162	165
4	Mfg.	S. *lactis*	Past.	56	5 hrs/98°F.	47	—
5	Mfg.	S. *therm.*	Past.	56	4-8 hrs/98°F.	56	56

[a]See text for description of each method.

TABLE 2 — EFFECT OF PASTEURIZING TIME AT 180°F. ON REDUCTION TIME IN HOURS USING S. *thermophilus;* AVERAGE OF 4 TRIALS (AFTER COMPLETION OF METHYLENE BLUE TEST FOR GRADE)

Minutes held at 180°F.	Reduction times when units of penicillin G added per ml were:		
	0.0	0.05	0.10
0	5.4	7.3	7.3
1	6.7	10.8	11.5
2	6.2	10.3	12.5+
3	6.4	9.5	10.1
6	6.2	12.1	9.1

one of the trays and the trays then placed in water at a temperature of 180°F. for a total period of 2 minutes.

Table 2 shows that pasteurization of the milk samples is necessary but that excessive holding time tends to reduce the sensitivity of the test. For this reason a total time of 2 minutes at 180°F. was selected as the pasteurization conditions.

A sample of milk taken from a large volume of mixed milk in a storage tank may be used as the control or any sample of milk known to be free from inhibitors. After pasteurization the trays must be placed immediately in ice water and may be held overnight at 35°F. to 40°F. for completion in the morning. If nonfat dry milk is used as a control, it should not be pasteurized after reconstituting.

The same procedure as above may be followed using the Grade A grading system and pasteurizing the tubes after 5½ hours in the methylene blue water bath. If methylene blue grading is not required, this portion of the test may be eliminated and the 10-ml samples simply pasteurized after collection.

The next morning the samples are warmed to 98°F., 0.5 ml of an active culture of S. *thermophilus* added to each tube and the tubes mixed. One ml of methylene blue solution is then added to each tube regardless of whether it has reduced or not on the methylene blue grade test and the tubes again mixed. The trays are then placed in the water bath at 98°F. for 3½ hours or for a period of ½ hour after the control containing no inhibitor has reduced. Read all tubes which are still blue at this time as being positive for bacterial inhibitors.

Table 3 shows that various strains of S. *thermophilus* vary in their sensitivity to penicillin. Strain No. 6 was not satisfactory and strain No. 9 was the culture which was used in these experiments.

Dry cultures may be obtained from commercial laboratories providing penicillin sensitive cultures are requested. Canned sterile culture milk is also available commercially. For convenience the sterile starter milk may be placed in the methylene blue water bath and brought to temperature. The dry S. *thermophilus* culture may then be added to the milk on the night prior to testing for antibiotics. The culture is incubated at 98°F. overnight and is then ready for use in the morning. Experience has shown that this procedure results in a more nearly uniform culture from month to month. It also eliminates the need to carry S. *thermophilus* cultures in the plant laboratory.

Table 4 indicates that the small quantities of S. *thermophilus* are more sensitive to penicillin. The differences, however, are not great and it was found that 0.5 ml resulted in slightly more uniform rates of methylene blue reduction.

In order to become familiar with the test, preliminary trials should be made on milk samples to which known quantities of antibiotics have been added. For this purpose, infusion kits may be obtained from drug stores handling veterinarian supplies. Standards may be prepared containing per ml of milk, 0.1 unit of penicillin or 1 microgram of terramycin or aureomycin. Several brands have been tested and found satisfactory. It also has been found that prepared milk samples containing added antibiotics may be held frozen in test tubes for at least 2 months. These test tubes, containing 10 ml of milk, may be removed and used as positive controls every time a series of tests is run.

TABLE 3 — EFFECT OF STRAIN OF S. *thermophilus* ON METHYLENE BLUE REDUCTION TIME

Strain No.	Hours Reduction Time	
	No penicillin added	0.1 unit penicillin G/ml
1	3.16	6.24
2	4.83	6.23
3	5.00	6.25
4	5.00	5.83
5	4.75	6.33
6	2.92	3.23
7	2.92	4.17
8	7.00	8.58
9	4.92	9.88

TABLE 4 — EFFECT OF AMOUNT OF S. *Thermophilus* ADDED ON REDUCTION TIME IN HOURS; AVERAGE OF 12 TRIALS (AFTER COMPLETING METHYLENE BLUE TEST FOR GRADE)

Amount added	Time to reduce (hours)		
	0.0 Unit[a]	0.05 Unit[a]	0.10 Unit[a]
1 drop	3.96	9.25	8.58
0.5 ml	3.69	7.00	6.67

[a]Units of Penicillin G added per ml

The extended methylene blue test as described will detect 0.05 unit Penicillin G per ml of milk and will detect many samples containing as little as 0.02 unit per ml. Aureomycin and terramycin may be detected at levels of 0.5 to 1 microgram per ml. Streptomycin may be detected at levels of 3 to 5 micrograms per ml. As a confirmatory test, after the methylene blue has reduced, all tubes may be held for a period up to 10 hours and observed for curd formation. Samples containing no antibiotic set up a firm curd well ahead of those samples which contain at least 0.05 unit of Penicillin G per ml. of milk.

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The helpful suggestions of Dr. J. C. Flake and the assistance of Mr. Ben Coble and members of his staff in performing a large number of tests is greatly appreciated. Thanks are also due to Mr. Neil Angevine for supplying several dried cultures of *S. thermophilus*.

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THE "PROTECTIVE SCREEN" PROGRAM FOR CANNED FOODS[1]

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The canning industry has long been aware of the fact that in the maintenance of consumer confidence in canned foods, each member of the industry is "his brother's keeper." One of the principal reasons for organizing the National Canners Association some fifty years ago was to insure the safety and wholesomeness of canned foods. Perhaps some can remember the botulism scare in connection with canned ripe olives in the early 1920's. This hurt canners of every product, and although no deaths from botulinus poisoning in commercially canned foods have occurred within the past twenty-five years, it took a long time to rebuild consumer confidence in canned food.

The cranberry episode last November was another dramatic demonstration of how all the members of the cranberry industry could be injured by the acts of a few; and some Wisconsin cranberry canners were among those injured.

Before the 1960 canning season got under way, the canning industry laid plans to prevent the occurrence of a similar situation occurring in connection with any other canned food. For want of a better name, we have called this program "The Protective Screen Program for Canned Foods." It amounts to a series of defenses to protect canned foods against chemical contamination.

The basic program was developed by the National Canners Association and is being carried out in co-operation with state canners' associations. Of course, the success of the program depends primarily on the care and intelligence with which the individual canner utilizes the program.

The protective screen program is directed to the problem of food additives as well as to pesticide residues and is broken down into three phases:

I.To prevent contamination of our raw product.

II. To prevent the processing of any contaminated raw product.

III. To prevent the addition of illegal chemicals during processing.

The features of each of these are as follows:

I. *To prevent the contamination of our raw product.*

This is the most important part of the program and involves six steps:

A. All canners, not only the members of the National Canners Association, are furnished by that association complete and current information on what agricultural chemicals have been accepted for registration by the U. S. Department of Agriculture under the Federal Insecticide, Fungicide and Rodenticide Act. Lists of these pesticides were distributed early this year and are kept up to date by means of a special Pesticide News Letter. These lists, of course, include not only insecticides, fungicides and rodenticides, but also herbicides, fumigants, defoliants, dessicants, and plant growth regulators.

B. All canners were urged to furnish each of his growers a list of pesticides to be used on the specific crop or crops to be produced by the grower, together with directions and limitations as to the use of such pesticides. A few canners prepared such lists of their

[1]Presented at the annual meeting of the Wisconsin Association of Milk and Food Sanitarians, at Elkhart Lake, Wisconsin, September 13, 1960.

own but most of them relied entirely on the recommendations of the state agricultural experiment station. We obtained from the University of Wisconsin and sent to canners for such distribution to their growers over 9,000 copies of bulletins containing the Wisconsin recommendations for insect control and weed control of field crops, vegetable crops and fruits.

C. All canners were urged to make periodic checks with their growers throughout the year to make certain that only approved chemicals were being used properly. This is the job of the cannery fieldman whose job it is to supervise the growing of the crop and to determine when it will be ready for harvest.

D. All canners were urged to maintain detailed records of any pesticide usage on each crop. Forms for such record-keeping were made available by state canners' associations. The records were maintained at the cannery office from information supplied by the fieldman or by the grower. A separate record sheet was set up for each field consisting of a single planting.

E. All canners were urged to obtain written guaranties from their growers that the crop had not been treated with any pesticide except as approved. On acreage contracted for at planting time, this guaranty was incorporated in the grower contract, but on open market acreage, this guaranty is required with the first delivery of a particular crop bought from a grower. On open-market purchases, the grower is also required by most canners to attach a crop history record to the guaranty.

F. State canners' associations have been carrying on educational campaigns to enlist the support of canners and growers in the foregoing steps of this program. This has been done through canner and grower meetings and through newspaper publicity.

II. *To prevent the processing of any contaminated raw product.*

This phase of the program relates particularly to open market purchases where the canner, despite written guaranties from the grower, cannot be absolutely sure that the raw product is not contaminated. To check on possible contamination, some canners run analyses in their own laboratories, but most will use commercial testing laboratories such as the Wisconsin Alumni Research Foundation.

The canning plant is able to remove some pesticide residues adhering to the surface of raw vegetables and fruits by washing and peeling. Another defensive procedure is to segregate production into small lots, for instance, by changing code marks on cans each hour or half hour, so that if contamination does occur, relatively small lots can be isolated.

III. *To prevent the addition of illegal chemicals during processing.*

This phase of the program is largely in the hands of the canner himself. The National Canners Association undertakes to keep the industry informed of the substances which may be added to foods, that is, the substances which the Food & Drug Administration classifies as "generally recognized as safe," and the substances it has specifically approved with or without tolerances for residues. Some special problems that arise relate to detergents, germicides, antibiotics and container coatings. Other additives that concern canners are condiments, thickeners, emulsifiers, flavorings and colorings.

A special problem of pea and corn canners, but of particular interest to the dairy industry, is the contamination of pea and sweet corn silage with pesticide residues. Actually no problem exists on pea silage because none of the pesticides used, including parathion for aphid control, leave any residues on the vines. The problem then comes down to sweet corn silage where the crop has been treated with DDT.

The recent registration of Sevin will minimize the sweet corn silage problem, but where DDT is still being used, the canner should carry out the program we have recommended for the past three years, i.e.,

1. Completely segregate the husk and cob silage from any fields treated with DDT.

2. Obtain a written acknowledgement from the grower or other purchaser of the treated silage that he understands the silage is not to be fed to dairy animals, and is not to be fed to meat animals within ninety days of slaughter.

The Wisconsin canning industry is sincerely interested in the well-being of the Wisconsin dairy industry because practically all of our growers are dairy farmers. If any better ways to protect Wisconsin milk from possible contamination can be found, Wisconsin canners will be glad to cooperate.

THE REDUCTION OF THE MICROFLORA OF MILKING MACHINE INFLATIONS BY TEAT DIPPING AND TEAT CUP PASTEURIZATION[1]

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Teats were dipped immediately after milking in (a) an iodophor diluted to contain 1.0 per cent available iodine; (b) P.V.P.—Hibitane, containing 1.6 per cent Hibitane (Chlorhexidine); and (c) P.V.P.—Hibitane containing 0.5 per cent Hibitane. After each cow was milked the teat cups were rinsed briefly and "pasteurized" at 165—170°F for 15 seconds.

Teat-dipping alone reduced dramatically the number of micrococci on the inflations but was only partially effective in reducing the percentage of inflations carrying haemolytic staphylococci, except when the 1.6 per cent P.V.P.—Hibitane was used. This material was, however, somewhat irritating to the teats. Teat cup pasteurizing alone partially reduced the percentage of teat cups carrying haemolytic staphylococci, but had little effect on the number of micrococci initially present on the inflations. It appears that the combination of these simple practices will go far towards eliminating the teat-skin and milking machine inflations as reservoirs of haemolytic staphylococci.

It has been shown (*2*) that it is possible to reduce significantly the number of micrococci present on the rubber inflations of milking machine teat cups by dipping cows' teats in a suitable disinfectant immediately after milking. Dipping teats in warm water was shown to increase the numbers. Tincture of iodine was the most promising disinfectant but because of its effect on the skin of the teats it was not considered to be practically useful and a search for other, less irritating products was instituted.

The present report shows the results of a study of dipping teats immediately after milking in an iodophor, and in a specially devised material containing P.V.P. and Hibitane. Also reported here are results showing the effect of "Pasteurizing"[2] teat cups between cows. These results are the most significant of those obtained during nearly 18 months of trials, and preliminary experiments which paved the way for this work are not reported.

Materials and Methods

The cows used in these experiments were in a small barn at the college research station. They were milked with a suspended-type milker and the teat cup inflations were stored in a 5 per cent lye solution between milkings. Two sets of inflations were used in alternate weeks and treated as described previously (*3*). The 5 per cent lye was changed every three weeks. Prior to milking, each cow's udder was washed with warm water, using one or more clean paper towels. Where stated, between each two cows, the teat cups, after a clean water rinse, were "Pasteurized" by immersing for 15 seconds in a pail of water maintained thermostatically at 165°-170°F. During those periods where teat-dipping was carried on, immediately after the cups were removed from each cow, each teat was dipped to the base in a jar of disinfectant.

On Monday and Thursday of each week, at the afternoon milking, the teat cup inflations were swabbed immediately after they were removed from each cow and before pasteurizing them, and the micrococci enumerated as described previously (*1*). In addition, 0.01 ml. of buffer from each swab was spread over one-quarter of a sheep blood agar plate to determine the presence or absence of staphylococci. All colonies of staphylococci showing any degree of alpha or beta haemolysis were counted as haemolytic staphylococci. Each Tuesday, at the afternoon milking, individual quarter milk samples were taken aseptically and submitted to the mastitis diagnostic laboratory.

Treatment changes were always made on a Saturday beginning with the morning milking.

The two disinfectants were formulated as follows:

1. *P.V.P.Hibitane*[3]—
   this material contained:

Polyvinylpyrrolidone	2.0 per cent
Triton X100	1.5 per cent
Hibitane (Chlorhexidine)	0.5 or 1.6 per cent
Water	to volume

2. *Iodophor*

Polyethoxy-polypropoxy-Polyethoxy-ethanol-iodine complex	9.10 per cent
Nonyl-phenoxy-polyethoxy-Ethanol-iodine complex	8.74 per cent
Hydrogen Chloride	.11 per cent
Inert ingredients	82.05 per cent
(Minimum available iodine	2.0 per cent)

[1]Presented in part before the North Eastern Mastitis Conference Annual Meeting, Dover, Delaware, October 14th and 15th, 1959.

[2]The term "Pasteurization" has been applied to the heat treatment of milking machine teat cups by F. H. Dodd and F. K. Neave at the N.I.R.D., Shinfield, England.

[3]Hibitane is a registered brand name of Imperial Chemical Industries Ltd., England.

TABLE 1 — THE EFFECT OF DIPPING COWS' TEATS IN AN IODOPHOR (1% AVAILABLE IODINE) AND PASTEURIZING TEAT CUPS BETWEEN COWS

Week	Treatment	Mean count per inflation	% of inflations carrying haemolytic staphylococci	% of quarters shedding haemolytic staphylococci
1	Teats not dipped Teat cups pasteurized	25,700	21.45	7.7
2		28,100	21.40	7.7
3		35,200	12.5	3.8
4	Teats dipped Teat cups pasteurized	8,800	7.2	—
5		3,200	8.9	10.7
6		1,060	8.9	0
7		1,020	6.25	0
8		216	0	0
9		106	7.2	3.1
10	Teats dipped Teat cups not pasteurized	1,546	43.75	6.24
11		493	40.6	3.1
12		2,077	28.1	12.5
13		596	29.7	9.4
14		358	28.1	13.9
15	Teats not dipped Teat cups not pasteurized	11,554	56.3	15.6
16		37,520	90.8	22.2
17		24,162	73.4	16.6
18		34,695	98.2	7.15

RESULTS

The counts shown in the tables are the mean counts from all inflations swabbed on two afternoons each week. The term 'mean count per inflation' includes all colonies growing on mannitol-salt agar (Difco) except colonies of spore forming rods which are easily distinguished. Any teat cup inflation from which one or more colonies of haemolytic staphylococci (as defined above) grew on one-quarter of a blood agar plate was counted in determining the percentage of teat cups from which these organisms were obtained. The percentages of quarters shedding haemolytic staphylococci are included only to show that, with very few exceptions, these organisms were constantly being shed.

In Table 1 are shown the results obtained where the iodophor, diluted 1:1 with distilled water (to give 1.0 per cent available iodine) was used as the teat dip. During the first three weeks when teat cups were pasteurized but teats not dipped the mean counts were high, and the percentage of teat cups from which haemolytic staphylococci were isolated was also fairly high. During the next six weeks when teats were dipped and teat cups pasteurized a dramatic reduction in the number of micrococci on the inflations occurred, and the percentage of inflations carrying haemolytic staphylococci was reduced. In the following five weeks when teats were dipped but teat cups were not pasteurized between cows there appeared to be a moderate but probably insignificant increase in mean count per inflation with a marked increase in the percentage of inflations carrying haemolytic staphylococci. For the last four weeks teats were not dipped nor were the teat cups pasteurized, and it will be seen that there was a very marked increase in the mean count per inflation, and the percentage of teat cups carrying haemolytic staphylococci increased to the point where virtually all cups were contaminated. Not shown in the figures is the fact that whereas during the period of teat-dipping the number of haemolytic staphylococci from each inflation was of the order of one to five on a quarter of a blood agar plate, during those periods when no teat-dipping was done they increased to the order of 50 to 100, and sometimes too many to count.

The continued use of this material as a teat dip appeared to have no ill effect on the teat skin, although some chafing occurred when the cows were let out before the teats were dry on two nights in the fall on which near freezing temperatures were recorded.

In Table 2 are shown the results obtained from the use of P.V.P. Hibitane (1.6 per cent) as a teat-dip. The first period in this series of experiments is the same as the last shown in Table 1, and the same observations apply. During the next four weeks teats were dipped and teat cups pasteurized, and during this time an even more dramatic reduction in mean

TABLE 2 — THE EFFECT OF DIPPING COWS' TEATS IN P.V.P. HIBITANE (1.6%) AND PASTEURIZING TEAT CUPS BETWEEN COWS

Week	Treatment	Mean count per inflation	% of inflations carrying haemolytic staphylococci	% of quarters shedding haemolytic staphylococci
1	Teats not dipped Teat cups not pasteurized	11,554	56.3	15.6
2		37,520	90.8	22.2
3		24,162	73.4	16.6
4		34,695	98.2	7.15
5	Teats dipped Teat cups pasteurized	602	7.1	10.7
6		64	1.8	7.2
7		31	0	7.2
8		59	3.6	3.6
9	Teats dipped Teat cups not pasteurized	31	3.6	8.3
10		12	3.6	4.2
11		8	3.6	0
12		153	1.8	5.0

TABLE 3 — THE EFFECT OF DIPPING COWS' TEATS IN P.V.P. HIBITANE (0.5%) AND PASTEURIZING TEAT CUPS BETWEEN COWS

Week	Treatment	Mean count per inflation	% Teat Cups with haemolytic staphylococci	% of quarters shedding haemolytic staphylococci
1	Teats not dipped Teat cups not pasteurized	14,900	73.4	15.0
2		33,160	82.5	10.0
3	Teats dipped Teat cups pasteurized	3,305	15.0	10.0
4		595	12.5	10.0
5		1,137	15.0	10.0
6		875	15.0	10.0
7		920	10.0	10.0
8	Teats dipped Teat cups not pasteurized	2,200	15.0	10.0
9		2,875	20.0	15.0
10		5,350	32.5	10.0
11	Teats not dipped Teat cups not pasteurized	20,690	62.5	30.0
12		22,490	75.0	20.0

count per inflation occurred, with a pronounced decrease in percentage of teat cups carrying haemolytic staphylococci. In the last four weeks teats were dipped, but teat cups not pasteurized, and it can be seen that both mean counts and percentage of teat cups carrying haemolytic staphylococci remained at the previous levels. During both these periods, from a majority of the inflations no micrococci were obtained by swabbing immediately after they were removed from the teats.

During the eight weeks in which teats were dipped twice daily with this preparation a cracking and scaling of the skin was noticed, particularly at the base of the teats where the teat cups did not reach. It was therefore decided to carry out a further experiment with a preparation containing 0.5 per cent Hibitane to see if this skin irritation could be reduced. Results of this experiment are shown in Table 3.

In the two weeks during which neither teat-dipping nor teat cup pasteurization was carried on, the usual quick build-up both in mean count and percentage of teat cups carrying haemolytic staphylococci occurred. Immediately after teat dipping and teat cup pasteurization were started the mean count dropped to much lower levels, and the percentage of teat cups carrying haemolytic staphylococci was reduced to the same order as the quarters shedding. After teat cup pasteurization was discontinued there was a marked increase in the mean count and the percentage of inflations carrying haemolytic staphylococci. At the end of this experiment the teat skin of all cows was quite normal.

DISCUSSION AND CONCLUSIONS

The results presented here show that the two simple procedures of dipping teats immediately after milking the cow and "pasteurizing" teat cups before putting them on each cow very significantly reduced not only the numbers of micrococci on the inflations but, what is probably of more importance, the number of inflations from which haemolytic staphylococci could be isolated. Emphasis can be put on the fact that these reductions were not after pasteurization, but at the time the teat cups were removed from each cow. In other words the organisms were not present, or but in greatly reduced numbers, on the teat skin, from which most of the organisms on clean inflations originate. While teat-dipping alone controls the total numbers it is necessary to pasteurize the teat cups to prevent the spread of haemolytic staphylococci from cow to cow, as shown by the increase in the percentage of teat cups carrying haemolytic staphylococci when pasteurizing was stopped in two experiments. While results using 1.6 per cent P.V.P. Hibitane as a teat dip indicate that pasteurization is not as necessary with this material, it must be remembered that it was somewhat irritating to the teat skin. Spencer and Lasmanis (*4*) observed that the principal extramammary reservoirs of coagulase-producing haemolytic staphylococci were the skin of teats and the teat cups of milking machines. The procedures outlined here will go a long way toward eliminating such organisms from these areas.

ACKNOWLEDGEMENTS

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RELATIVE CLEANABILITY OF VARIOUS FINISHES OF STAINLESS STEEL IN A FARM BULK TANK[1, 2]

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No significant difference was found in the relative cleanability of Nos. 2B, 3, 4, and 7 stainless steel finishes as measured by bacteriological tests. Therefore, it can be concluded that from a bacteriological cleanability standpoint, based on the conditions of this study, the selection of a stainless steel finish from among those used in these studies for a farm bulk tank or any comparable piece of equipment should be based on factors other than bacteriological cleanability.

The relative cleanability of the stainless steel used in sanitary equipment is of great importance to sanitarians, food processors and equipment manufacturers. Hays *et al.* (*4*) and Kaufmann *et al.* (*5*) studied the removal of air-dried films of milk inoculated with bacteria under laboratory conditions. Hays *et al.* (*4*) observed from 99.99 to 100% removal of *E. coli* from 18-8 stainless steel having 2B, 7 mill, 80, 100, and 120 grit surfaces after manual scrubbing for 15 seconds with an alkaline cleaner at room temperature. Kaufmann *et al.* (*5*) used the Direct Surface Agar Plate test (*2*) to detect spores of *B. globigii* which remained on the surface after washing; no significant difference in bacterial cleanability at the 5% level was noted after a minimum spray-washing for 2 seconds with an alkaline detergent at 161±3°F. The present study was undertaken under controlled field conditions of soiling and cleaning using a farm bulk tank fabricated from Type 302 stainless steel having Nos. 2B, 3, 4, and 7 finishes.

Materials and Methods

Description of Tank

A 200-gallon round-bottom farm bulk tank of standard basic design was constructed with a lining of Type 302 stainless steel having Nos. 2B (bright, cold-rolled), 3 (80-100 grit), 4 (120-150 grit), and 7 (325 grit plus buffing) finishes. The tank was constructed in such a manner that each side-wall contained a section of each finish 13.75 in. wide. End-walls were fabricated so that one contained a 2B and 3 finish and the other a 4 and 7 finish (Fig. 1). The welded areas joining the individual sections had a polish equivalent to a No. 4 finish.

Soiling and Cleaning

Soiling and cleaning conditions were designed to approximate those used in actual practice and controlled so the results could be interpreted statistically.

In the initial series of tests, plant water having a hardness of 200 p.p.m. was used for all cleaning procedures; in the second series a water with a synthetic hardness of 370 p.p.m. was employed (*3*). Attempts to increase the hardness beyond this level resulted in the precipitation of the salts from solution. A commercial chlorinated alkaline detergent was used at the recommended level in the initial series. In the second series of tests using a synthetic water of 370 p.p.m. hardness, the same cleaning compound was used at 1/3 the level. Reducing the detergent level might encourage relative differences in cleanability to appear.

The farm bulk tank was filled with cold, raw milk to within 1.5 in. of the top. After standing for 30-36 hours at 36°F. to simulate actual farm holding practices, the tank was emptied. Within 1/2 hour after draining the tank, all interior surfaces were rinsed with water at 125°F. A spray-arm consisting of a 12-inch section of 1.5-inch stainless steel tube with

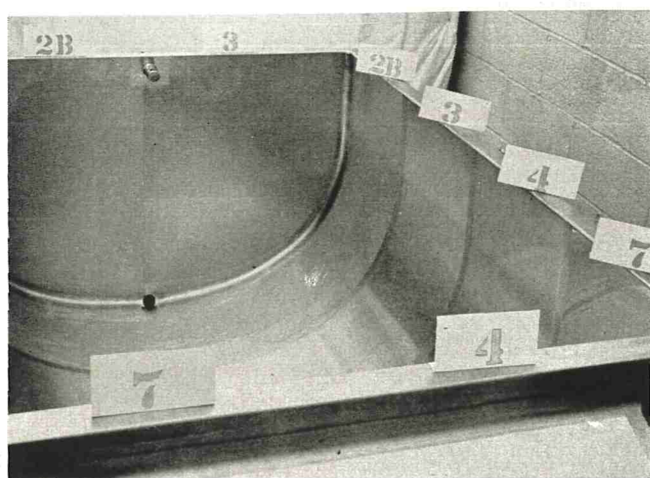

Figure 1. View of farm bulk tank showing finishes on side and end walls.

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[1]Contribution of the Michigan Agricultural Experiment Station No. 2647

[2]Aided in part by the Committee of Stainless Steel Producers, American Iron and Steel Institute, and the National Association of Dairy Equipment Manufacturers.

two lines of staggered holes, 1/16 in. in diameter and 1/4 in. on center, was used to deliver an evenly dispersed, non-turbulent stream of water at a rate of 2 gal. per minute. Rinsing was carried out by holding the unit 2 in. from the wall of the tank at a point just above the cream line and allowing the water to flow over each section for 15 seconds. This rinse removed all of the visible milk soil except the cream line.

After rinsing, the tank was brushed with a nylon-bristle, can-washing brush. The handle of the brush was removed to enable the operator to grasp the brush with the palm of the hand and thereby exert a uniform pressure on the soiled surface of the tank. A cleaning pattern using one stroke (across and back) adjusted to include the width of two panels, constituted the brushing procedure. The brush was immersed in detergent at 125°F. after each stroke. A final flushing similar to the initial rinsing operation was used to remove residual detergent.

To encourage soil build-up the end-walls of the tank were rinsed and sanitized but not brushed with detergent after soiling. After 12 soilings, each end was examined using bacterial and visual techniques. The end-walls were then scrubbed with detergent to remove the nutrient broth which remained after bacteriological testing.

To equalize the exposure to the sanitizing agent, each test surface was fogged with 200 p.p.m. of chlorine solution; after one minute the residual chlorine was inactivated by a one-minute fog-rinse with sterile 10% sodium thiosulfate solution. The surface was bacteriologically tested immediately following this procedure.

Testing

A standard swab contact test (*1*) using a 40-square inch area and a large swab test based on a 120-square inch area were used to determine the residual bacteria. Tests were undertaken immediately after rinsing (T-1); rinsing, washing-flushing (T-2); and rinsing, washing-flushing, and sanitizing (T-3). After each treatment (T-1, T-2, T-3) the tank was completely covered with four individual sections of sterile cloth to eliminate air-borne contamination of the interior. All surfaces except the particular area under examination remained covered prior to testing. During the actual test period the immediate area was covered with a sterile rubber template to eliminate air-borne contamination and to clearly locate the specific area. After T-1, from 1 to 3 hours elapsed before bacteriological testing was undertaken. After T-2 and T-3, no time elapsed before testing.

The test pattern used on each finish is shown in Fig. 2. The standard swab test (SS) was made after rinsing (T-1) and after sanitizing (T-3) on the areas

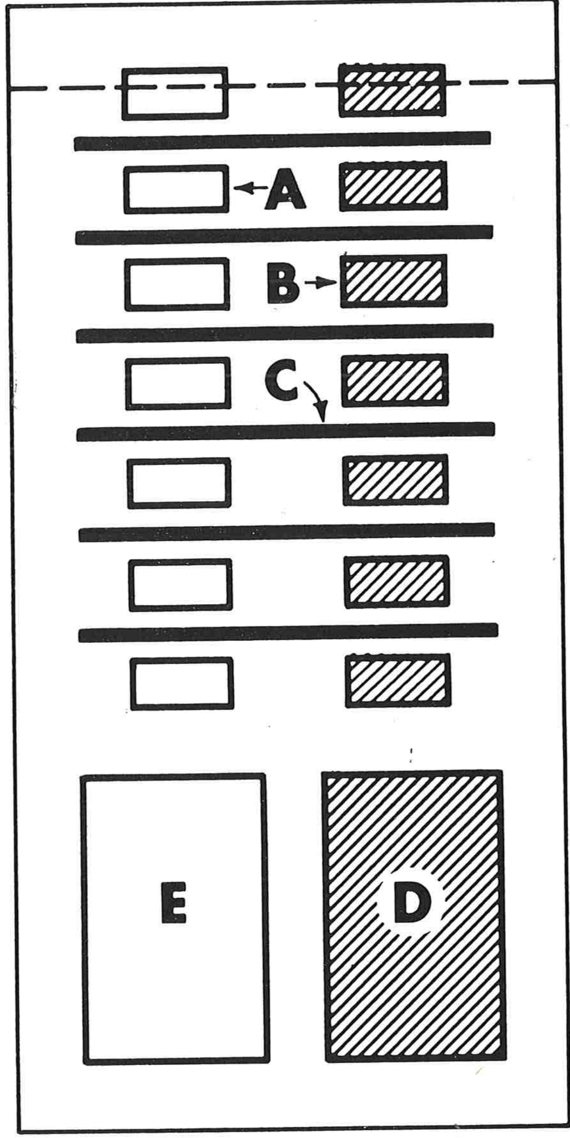

Figure 2. Schematic diagram showing the layout of the test areas examined on each sidewall section. (A) SS after rinsing, (B) SS after sanitizing, (C) SS after washing, (D) LS after sanitizing (E) LS after rinsing. Dotted line represents cream line.

indicated by the small rectangular outlines. Seven of the small rectangular areas provided 40 sq. in. A sterile removable flap covered each individual rectangular area while it was not actually being examined. After detergent washing (T-2), the standard swab test was made on another 40-square inch area as outlined by the long, thin rectangles in Fig. 2. To study a greater area, the large swab test (LS), utilizing 120 sq. in., was made after T-1 and T-3. The arrangement of the test areas was designed to insure that each area was swabbed only once in any single trial.

The large swab was rolled on a 6-inch, round applicator stick. The swab, *per se,* was 140 mm. long and

TABLE 1 — BACTERIA COUNTS PER 40 SQUARE INCHES OF SURFACE AFTER VARIOUS CLEANING TREATMENTS USING THE STANDARD SWAB TEST

Trial No.	SPC[a] (per ml. x 100)	After rinsing[b] (T-1) Finish No.				After washing (T-2) Finish No.				After sanitizing (T-3) Finish No.			
		2B	3	4	7	2B	3	4	7	2B	3	4	7
1	100	42[c]	9	14	13	14	20	73	1	0	3	5	0
2	23,000	78	79	65	232	8	16	28	19	2	6	3	3
3	11,000	84	2678	146	170	19	7	78	41	2	22	6	1
4	590	30	22	22	22	16	6	12	19	6	106	4	6
5	5500	60	70	251	138	11	35	26	6	10	2	7	4
6	260	59	82	71	201	80	26	12	26	3	4	2	1
7	140	954	165	57	45	102	28	9	1	0	1	0	16
8	5700	31	22	19	171	15	44	4	16	0	2	1	0
9	31	181	156	256	95	28	65	149	133	1	3	2	4
10	—	166	29	13	109	58	12	16	37	2	3	3	1
11	54	34	91	32	130	344	418	305	186	10	0	15	233
12	—	55	38	52	271	18	10	3	8	1	0	0	0
Av.	—	148	287	83	129	59	57	68	41	3	17	4	22

[a]SPC of milk in the tank just prior to draining.

[b]The hardness of the water was approximately 370 p.p.m. in all treatments.

[c]Average of two replications.

approximately 21 mm. in diameter. Sterilization was accomplished by autoclaving in a 6-inch test tube containing 10 ml. of distilled water to moisten the cotton for proper swabbing. The swab stick was removed from the tube and grasped along the entire length of the swab with large sterile flat-faced forceps; by grasping in this manner it was possible to exert a uniform pressure over the entire length of the swab while testing the area. The portion of the stick handled in transfer was removed with sterile clippers. The swab was drawn over the test area three times and placed in a 500 ml. prescription bottle containing 50 ml. of nutrient broth. The bottles were shaken 20 times, and 10-, 5-, and 1-ml. volumes were plated in duplicate using standard plate count agar. All counts were made after incubation at 95°F. for 48 hours. The data were tested using an analysis of variance.

RESULTS AND DISCUSSION

The bacteriological results obtained with the standard swab contact test and the large swab test are given in Tables 1 and 2, respectively. The analysis of variance of these data indicates no significant difference at the 5% level in bacteriological cleanability of the 2B, 3, 4, and 7 finishes after rinsing, regardless of the hardness of the water, the level of detergent or the test employed.

Analysis of variance of the bacteriological results after rinsing, washing-flushing of the 2B, 3, 4, and 7 finishes indicated no significant difference at the 5% level in bacterial cleanability among these surfaces.

After rinsing, washing-flushing, and sanitizing, no significant difference in bacterial cleanability was noted at the 5% level among 2B, 3, 4, and 7 finishes with the standard or large swab test. The sanitizing process reduced the number of residual bacteria to approximately the same level on all finishes within any one testing procedure.

The standard swab contact test was compared with the large swab test, corrected to a 40-square inch basis, using an analysis of variance. No significant difference between these two test procedures was observed based on the data obtained after rinsing. After sanitizing, a significant difference was observed when these two testing procedures were compared. The lack of correlation between these procedures under the conditions prevailing after sanitizing is due to the fact that more bacteria are present after rinsing than after sanitizing. With the former treatment each 40-square inch area is representative of the total contamination; swabbing a large area, therefore, does

not alter the results. Under the latter treatment, the bacterial level is greatly reduced, and each 40-square inch area is not representative of the overall surface contamination. In this instance the larger area covered by the large swab test provided a more satisfactory indication of the actual surface contamination. The total area examined by both tests comprised 70% of the total soiled area available (standard swab 23%, large swab 47%).

The bacteriological findings were compared with the recommended maximum standard as described in *Standard Methods for the Examination of Dairy Products* (*1*). After rinsing, results obtained with the standard swab test compiled 96, 96, 100 and 96% of the time with the 2B, 3, 4, and 7 finishes, respectively. In the previous laboratory study (5), compliance was observed 56, 63, 53, and 38% of the time with the four finishes. The deliberate attempt to minimize the removal of bacteria under laboratory conditions is undoubtedly responsible for the difference. After T-2, in the bulk tank study, compliance was obtained 96, 96, 96, and 100% of the time with the 2B, 3, 4, and 7 surfaces, respectively. Compliance under the conditions of the laboratory trials (5) was observed 100% of the time. Compliance was also obtained 100% of the time following a complete cleaning cycle of rinsing, washing-flushing and sanitizing. Similar findings were noted in the laboratory study.

A decrease in bacteria count was observed in all cases as the cleaning cycle progressed from treatments T-1 to T-3. Based on grand average values, detergent washing decreased the bacteria count from that obtained after rinsing by 65%. Sanitization reduced the count obtained after washing by 80%. These data indicate the desirability and need for adherence to the complete cleaning cycle to achieve maximum bacterial destruction.

From the results of the bacteriological studies, it is apparent that the Nos. 2B, 3, 4, and 7 finishes can be cleaned equally well with respect to bacterial removal. These findings are in agreement with earlier studies (5) carried out using a laboratory spray-washing device.

The experimental design which permitted improper cleaning (never brushed with detergent) of the end-walls of the tank made visual observation of build-up possible. To demonstrate the presence of the film on the unwashed end-walls, a strip on each end panel was treated with a slurry of a chlorinated alkaline cleaner; the contrast between the area where the film was removed and the uncleaned surface is shown in Figure 3. This film, produced after only rinsing and sanitizing twelve times in a period of 24 days, was not readily detected prior to cleaning the

TABLE 2 — BACTERIAL COUNTS PER 120 SQUARE INCHES OF SURFACE AFTER VARIOUS CLEANING TREATMENTS USING THE LARGE SWAB TEST

Trial No.	SPC[a] of milk (per ml. x 100)	After rinsing[b] (T-1) Finish No.				After sanitizing (T-3) Finish No.			
		2B	3	4	7	2B	3	4	7
1	100	1508[c]	653	95	113	227	8	19	17
2	23,000	933	315	565	2035	11	21	77	56
3	11,000	900	783	923	1265	35	12	27	105
4	590	185	255	318	413	97	76	18	266
5	5500	783	645	328	228	847	334	8	37
6	260	1200	150	633	1573	80	340	42	33
7	140	351	111	267	602	449	85	0	64
8	5700	1188	1170	230	493	47	17	158	474
9	31	428	838	1520	665	50	38	22	22
10	—	105	578	135	370	215	94	50	213
11	54	830	203	303	320	43	253	638	1474
12	—	225	948	353	505	83	49	31	489
Av.	—	837	563	472	715	182	110	92	270

[a]SPC of milk in the tank just prior to draining.

[b]The hardness of the water was approximately 370 p.p.m. in all treatments.

[c]These values are the average of two replications.

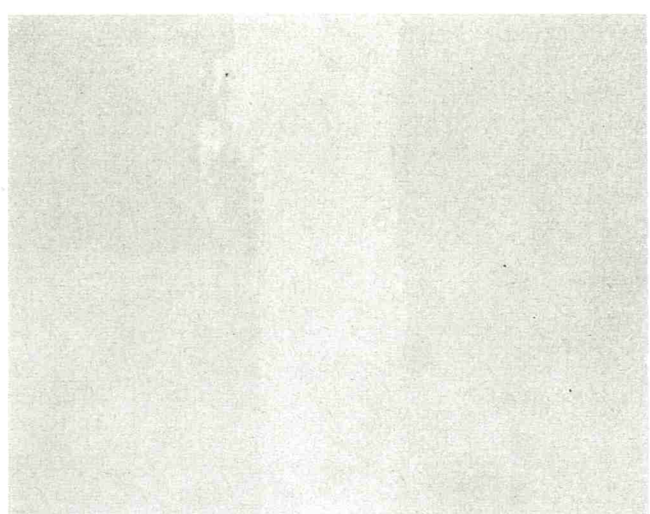

Figure 3. The film of soil shown on this finish is typical of that observed on all finishes after only rinsing and sanitizing for 12 trials. The film of soil is clearly visible in contrast with the cleaned strip in the center.

strip with detergent. It is significant that all finishes of the improperly cleaned end panels showed visual soil when cleaning was limited entirely to rinsing and sanitizing, whereas no build-up was observed on the various surfaces which were brushed with a detergent solution. The film, which showed slight fluorescence when examined with ultraviolet light, may be the start of milkstone formation (*6*). In these studies as in previous work (*6*), an organic acid cleaner failed to remove the film from the finishes after it had formed.

There was no significant difference in the bacterial count on the finishes incorporated in the end-walls even though there was soil build-up. In considering the relative cleanability of stainless steel finishes, the authors theorize that once the stainless steel surface has been covered with a layer of soil, the original surface can no longer affect the rate of build-up which, under identical conditions, should be equal for all dirty surfaces.

A quantitative comparison of the amount of film on each finish was not possible as suitable instruments are not available for objectively measuring the thickness of these films. Visual subjective measurements require careful interpretation because of the difference in the basic reflectance of the various finishes and because soil changes the relative reflectance of the finishes. Preliminary studies on the visual estimation of soil indicate that stainless steel with 2B, 3, 4, and 7 finishes with equal amounts of soil will not appear to be equally soiled when subjectively evaluated. Consequently, the authors believe that the evaluation of the sanitary condition of food handling equipment on the basis of visual appearance is subject to question, especially when the film of soil is very thin and uniformly deposited.

Acknowledgements

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NEWS AND EVENTS

QUESTIONS AND ANSWERS

QUESTION:

Why do dishwashing machines with proper rinse water temperatures frequently not rinse dishes thoroughly even though the rinse jets are unobstructed?

ANSWER:

The problem is most likely due to the pressure of the rinse water at the rinse manifold of the machine. National Sanitation Foundation Standards No. 3 and 5 recommended 15 to 30 pounds flow pressure on the final rinse line of dishwashing machines with about 20 pounds of flow pressure as ideal. Flow pressures below 15 pounds do not furnish adequate rinse water to remove detergents and loose soils. Flow pressures above 30 pounds may cause misting of the hot (180°F) water with excess vapor and inadequate rinse. It is suggested that a pressure gauge be installed in the hot water line to the dishwashing machine. If flow pressures fall below 15 psi, then a booster device is needed. If they are above 30 psi then a pressure reducing valve should be installed in the hot water supply line.

QUESTION:

Why should there be a problem of iron deposits on glasses and other utensils in a mechanical dishwasher when the iron and manganese complex concentrations are 0.0 ppm in the water supply?

ANSWER:

Problems of iron depositions are not frequently encountered when the concentrations of iron and manganese are below the 0.20 ppm limit. Many waters, however, become very unstable at temperatures necessary for the proper operation of mechanical dishwashing machines. At temperatures of 170 to 180°F the unstable water will be very aggressive toward some metal-

lic components of the plumbing system which transports the water to the dishwasher. Therefore, if any ferrous metals are contained in the hot water heater or booster heater or the supply lines to the dishwasher these ferrous metals can be put into solution by the unstable aggressive water. The permanent cure is usually the removal of the ferrous materials from the system in favor of non-ferrous pipes, tanks, valves, etc. Temporary relief may also be obtained in some instances by the injection of stabilizing chemicals into the system. This last solution is a necessity if continuous operation for control is to be effective.

UNENDING BATTLE WITH INSECTS FOR THE WORLD'S FOOD

The statement that the insects will someday take over the world may not be too far from wrong. This startling suggestion is contained in a paper by Dr. George C. Decker of the Illinois Agricultural Experiment Station.

Here in America, Dr. Decker reports, we annually lose about $4 billion of crops to insects. Putting the problem in another perspective, shortly after the war, when mankind developed a perhaps temporary advantage over the insects thanks to DDT, U. S. potato production zoomed up 150%. For the same reason, cauliflower production jumped 120% onions 140%, sweet corn 160%, celery 140% and beet seed 180%. Even advances in milk production per animal was attributed in part to the introduction of DDT.

Although DDT, and successor insecticides, remain effective, Dr. Decker warns against any false optimism that society's tiny antagonists are permanently on the run. Even now – post-DDT – the insect population is almost inconceivably huge. Dr. Decker estimates that the total mass of protoplasm produced by the insects each year exceeds that produced by all other terrestrial animal life put together. If we keep in mind, he observes, that a great part of this insect "protoplasm represents lost plant and animal production that might have been more profitably converted into products for human consumpition, we can arrive at only one conclusion: insect losses are of enormous proportions."

One effective way to meet the problem is to entlist nature's support. Dr. Decker points out that most pests, whether they be weeds, plant diseases, insects, or even rodents, have tremendous reproductive powers. Despite that, "for each species, nature has arrayed against it a variety of dynamic forces . . . to inhibit or nullify these fantastic reproductive powers. Thus we have a sort of natural balance wherein natural forces tend to keep plant and animal populations in a state of near equilibrium."

Too often, however, human progress has undercut nature's assistance. Many of the insect scourges that have been most destructive in America during the last 100 years were actually inadvertent imports from abroad. Unchecked by any natural enemies, armies of grasshoppers, army worms, potato beetles have again and again devastated American farms – sometimes causing widespread abandonment of otherwise valuable agricultural properties.

And farming, itself, is, of course, something of a departure from "nature." Farms certainly provide, Dr. Decker notes, an abundant and highly convenient food supply to rampaging insect hordes.

Obviously, therefore, man must reinforce whatever natural forces he can mobilize to fight insects with an effective battery of chemical insect killers. "At any rate," the Illinois entomologist suggests, "the use of insecticides is the only established protective pratice available for combatting the majority of our injurious insect species and, like matrimony, it is here to stay.

That is not to say that the role of insecticides, any more than that of matrimony, has been exposed to some criticism. There is always the worry, for instance, that insecticides may produce a deleterious effect upon human consumers. This danger is more potential than real, Dr. Decker emphasizes. He notes that assurances on this score have been issued by the U. S. Department of Agriculture, the Food and Drug Administration, the U. S. Public Health Service and the National Research Council.

Still so, the scientist observes, "a few ill-advised critics go so far as to say that all use of chemicals is wrong and that we should let nature take its course. The American Indian followed such a course for centuries, and found that under this policy the North American continent supported a population of about one million souls. We now have a population close to 180 million in the U. S. alone."

Dr. Decker concludes that the "insects will continue to demand tribute of enormous proportions. As highly versatile living organisms, insects are constantly changing to meet each variation in the environment, whether it be biological, physical or chemical." There are, therefore, two alternative battle plans for man to follow: "to hold our own . . . research must continue undiminished . . . to make progress, research must be expanded."

CERTIFIED MILK RATING OFFICERS LISTED BY PHS

A total of 115 State employees in 42 State Departments of Health or Agriculture have been certified as rating officers whose ratings of milk pasteurization plants and their producing farms are acceptable, the Public Health Service announced.

Ratings made by these officers are eligible for inclusion in "Sanitation Compliance Ratings of Interstate Milk Shippers" and/or "Milk Sanitation Honor Roll" published periodically by the Public Health Service.

Initial inclusion of each officer on the list, as well as his continuation on it, is predicated on standardization and evaluation of his inspections by representatives of the PHS Milk and Food Program. The evaluation assesses the rating officers' competency in applying standards and procedures of the Milk Ordinance and Code — 1953 Recommendations of the Public Health Service.

Names of the rating officers are:

State	State Rating Officers	Location	Agency
Alabama	R. C. Burkhardt	Gadsden	SHD*
	Joseph F. Fail	Montgomery	"
	U. D. Franklin	Birmingham	"
	E. E. Herrmann	"	"
	G. R. Wright	"	"
Arizona	O. V. Cooper	Phoenix	SHD
Arkansas	Joe Hall	Jonesboro	SHD
	W. D. Hanns	Little Rock	"
California	Lee Biggs	San Diego	SDA
	H. C. McCausland	Los Angeles	"
	D. J. Radmacher	Tulare	"
	H. J. Sartori	Merced	"
	Wendell C. Weaver	Fresno	"
	O. M. Williams	San Leandro	"
Colorado	Eugene A. TeSelle	Denver	SHD
	Fred L. Vogt	Fort Collins	"
Delaware	Ward H. Meredith	Dover	SHD
Florida	Samuel O. Noles	Jacksonville	SHD
	Lewis W. Willis	"	"
Georgia	Joel H. Adkins	Athens	SHD
	J. R. Culp	Atlanta	"
	Garnett H. DeHart	"	"
Idaho	Charles J. Hammond	Boise	SHD
	Kenneth L. Pool	"	"
Illinois	Howard McGuire	Chicago	SHD
	P. E. Riley	"	"
Indiana	Verne Cavanaugh	Indianapolis	SHD
	Wilbur G. Stevens	"	"
	Herbert H. Vaux	"	"
Iowa	Harold A. Bayes	Des Moines	SHD
	Ray A. Belknap	" "	"
	Richard E. Stedman	" "	"
Kansas	O. L. Honomichl	Wichita	SHD
	Frank L. Kelley	Lawrence	"
Kentucky	Joseph W. Durbin	Louisville	SHD
	Louis E. Smith	"	"
Louisiana	Jack Blanks	New Orleans	SHD
	Charles F. Miller	Shreveport	"
	B. C. Pardue	New Orleans	"
	R. J. Richards	Lafayette	"
Maryland	Alexander A. Pais	Baltimore	SHD
Michigan	Robert R. Dalton	Lansing	SHD
	Mason I. Smith	"	SDA
	Kenneth Van Patten	"	"
	Frederick J. Wesg	"	"
Minnesota	Orlowe M. Osten	St. Paul.	SDA
	Leonard J. Waldock	" "	"
Mississippi	P. L. Bradshaw	Jackson	SHD
	A. R. Russell	Tupelo	"
	Clinton Van Devender	Jackson	"
	Olin Mays	"	"

*State Health Department or State Department of Agriculture

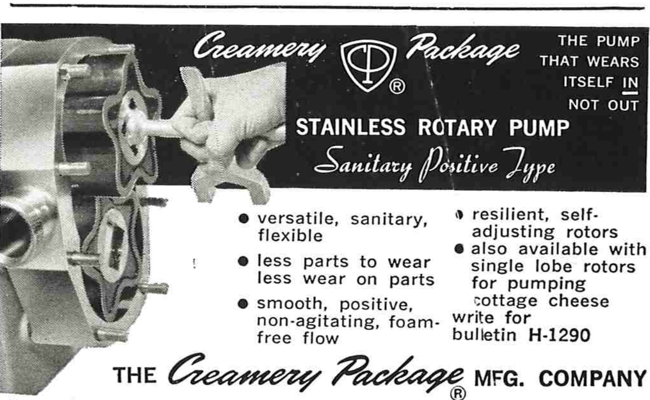
State	State Rating Officers	Location	Agency
Missouri	Erwin P. Gadd	Jefferson City	SHD
Nebraska	Charles W. Fahrenbach	Lincoln	SHD
Nevada	W. B. Hunter	Reno	SHD
	S. D. Mastroianni	"	"
	Sigvard J. Nielsen	"	"
New Hampshire	Richard A. Copson	Concord	SHD
	W. F. Oakman	"	"
New Jersey	Robert Inglis	Trenton	SHD
	Joseph Prince	"	"
New Mexico	Grant R. Jones	Santa Fe	SHD
	Tom W. Proctor	Clovis	"
New York	Nelson J. Hohl	Rensselaer	SHD
North Carolina	Ford P. Brendle	Winston-Salem	SHD
	Carson C. Foard	Ashville	"
	E. E. King	Wrightsville Beach	"
North Dakota	Everett Lobb	Bismarck	SHD
	Alfred B. Johnsgard	Wahpeton	"
Ohio	Willis R. Aukland	Columbus	SHD
	Ivan R. Baker	"	"
	Ned Baker	"	"
	Max L. Bunce	"	"
	Thos. W. Gabele	"	"
	Bernard M. Hull	"	"
	Jon E. Malamatinis	"	"
	Richard M. Martin	"	"
	James E. Warfield	"	"
	Ray B. Watts	"	"
Oklahoma	Glen W. Earley	Stillwater	SHD
	Berl I. Poe	Oklahoma City	"
	L. F. Pummill	" "	"
	Hardy Watson	Lawton	"
Oregon	Joseph A. Gray	Salem	SDA
	Vergil N. Simmons	"	"
	Alvin E. Tesdal	"	"
Pennsylvania	John A. Ginck	Paxonis	SDA
	Albert Dougherty	State College	"
South Carolina	John D. Cagle	Columbia	SHD
	E. M. Causey, Jr.	"	"
	Hart B. Hiers	"	"
	W. W. Weston	"	"
South Dakota	Charles Halloran	Pierre	SHD
Tennessee	Frank L. Cheney	Nashville	SHD
	Glenn C. Fulkerson	"	"
	Clifford Gulley	Knoxville	"
	R. E. Maxwell	Nashville	"
	M. R. Winfrey	Jackson	"
Texas	Floyd N. Cobb	Austin	SHD
	J. M. Doughty, Jr.	"	"
	W. W. Greer	Stephenville	"
	L. D. Kenney	Sulfur Springs	"
	D. H. Price	Stephenville	"
Utah	Edgar M. Hayes	Salt Lake City	SHD
	Guy P. Stevens	" " "	SDA
Virginia	G. S. Kennedy	Richmond	SHD
	C. B. Neblett	"	"
Washington	L. O. Tucker	Seattle	SHD
West Virginia	O. R. Lyons	Charleston	SHD
	Richard A. Moats	"	SHD
Wisconsin	Glen C. Drake	Madison	SHD
	C. K. Luchterhand	"	"
	C. O. Widder	"	"
Wyoming	W. H. Tiberend	Cheyenne	SDA

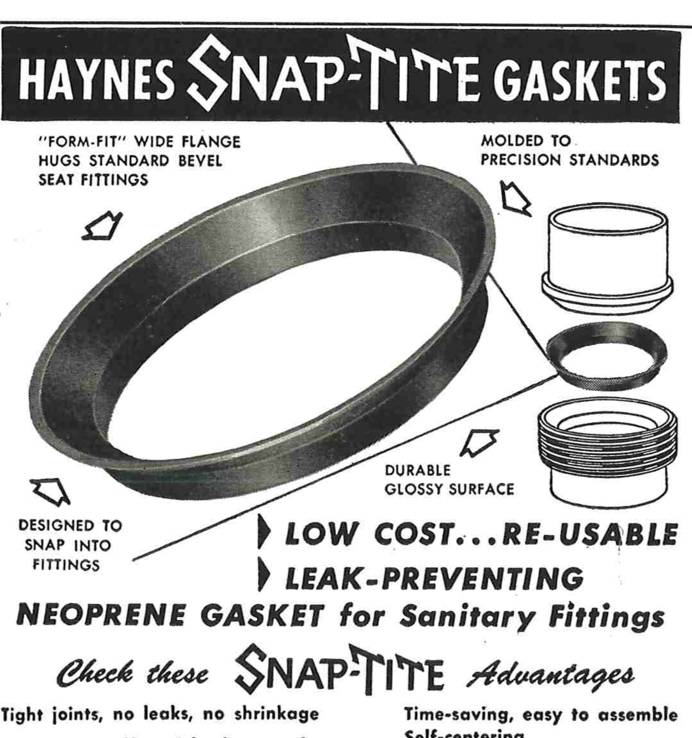
MAN-MADE RADIOACTIVITY: A FOOD ADDITIVE PROBLEM?

The results of extensive investigations on the intensity and distribution of man-made radioactive elements in the biosphere have received wide public attention although their true significance is little understood by the layman. At present, practically all of the artificial radioactivity occurring in foods is due to fallout from nuclear weapons testing. Authoritative judgment based on current knowledge is that present levels are well below safe tolerances.

For example, the maximum safe cumulative dose of radiation from man-made isotopes is estimated to be 10 rad over a 70-year life span (a rad is the amount of ionizing radiation which results in the dissipation of 100 ergs of energy per gram of tissue). Recent studies have shown that strontium-90 is the element likely to be of greatest concern since it is metabolized like calcium and stored in bones and teeth and it possesses a relatively long half-life (about 28 years). The present levels of strontium-90 in the soil and atmosphere (hence available to all food sources) is not sufficient to permit the accumulation of more than 0.2-0.4 rad in the human skeleton within a 70-year period.

Unless the rate and intensity of weapons testing increases greatly, this source of radioactive contamination can probably be held to safe levels. A major concern, however, is the problem presented by the safe disposal of highly radioactive wastes which will accumulate as the level of industrial use of atomic





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energy increases over the next decades. All storage schemes proposed so far present a potential ultimate source of contamination to the biosphere in the event of their release from depots as a result of either natural or man-made catastrophies. This is a serious problem in the design and operation of atomic reactors for power purposes. Continuous vigilance, is a necessity to check future hazards.

Reprinted from Sept. 1960 Food and Drug Research.

FOOD LAW INSTITUTE PRESENTS ANNUAL DISTINGUISHED SERVICE AWARD

Dr. William J. Darby of Vanderbilt University's School of Medicine and chairman of the Food Protection Committee of the National Research Council recently accepted on behalf of his committee The Food Law Institute's annual Award for Distinguished Food Law Services to the American People. Presentation of the award was made at The Food Law Institute dinner, held at Washington, D. C., in conjunction with the fourth annual conference of the Food and Drug Administration and The Food Law Institute.

The Food Protection Committee was created in 1950 to promote, among other objectives, closer and more intensive work between industry and agencies of the public to assure wholesomeness and safety of the nation's food supply. The group was chosen for this year's Food Law Institute award "in recognition of its significant contributions to a better understanding of Food Law by stimulating research to determine the *safety of food additives,* by publishing authoritative scientific reports and by fostering cooperation between industry and public agencies."

In accepting the Institute's award conferred on his committee, Dr. Darby called for more attention by the scientific community to the basic problems relating to assessment of food additives as well as further evolution in thinking aimed at the removal of the last possibility that additives might be harmful to the consumer.

Pointing to the need for further research on methodology, Dr. Darby also urged a more realistic and scientifically unprejudiced approach to interpretation of data and particularly in projection of these results from the laboratory to their significance in the human. He also cited the need to provide guidance for those responsible for the formulation of laws and regulations in order that they may formulate protective measures which are not unduly restrictive.

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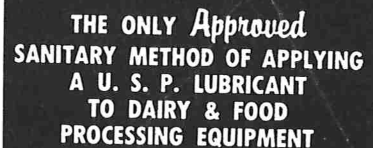

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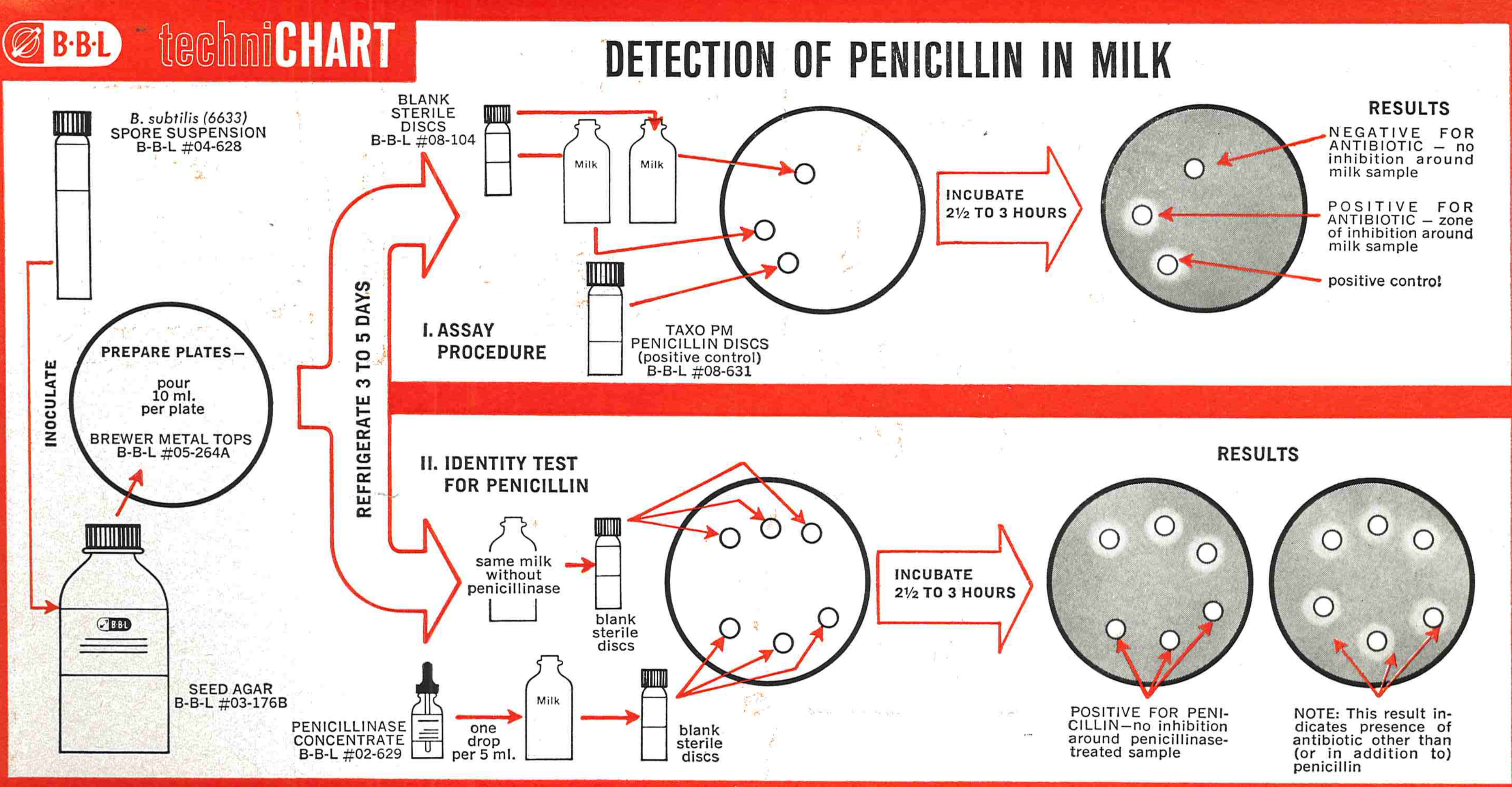

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*Arret, B., and Kirshbaum, A.: J. Milk and Food Technol. **22**:329, 1959.

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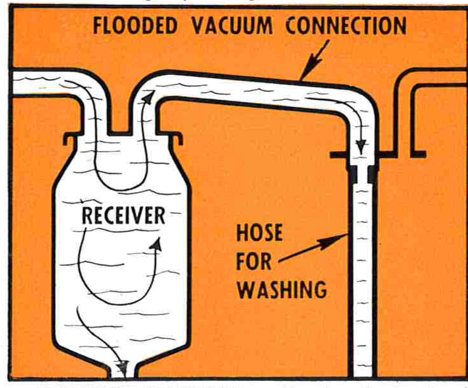

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