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MILK and FOOD TECHNOLOGY

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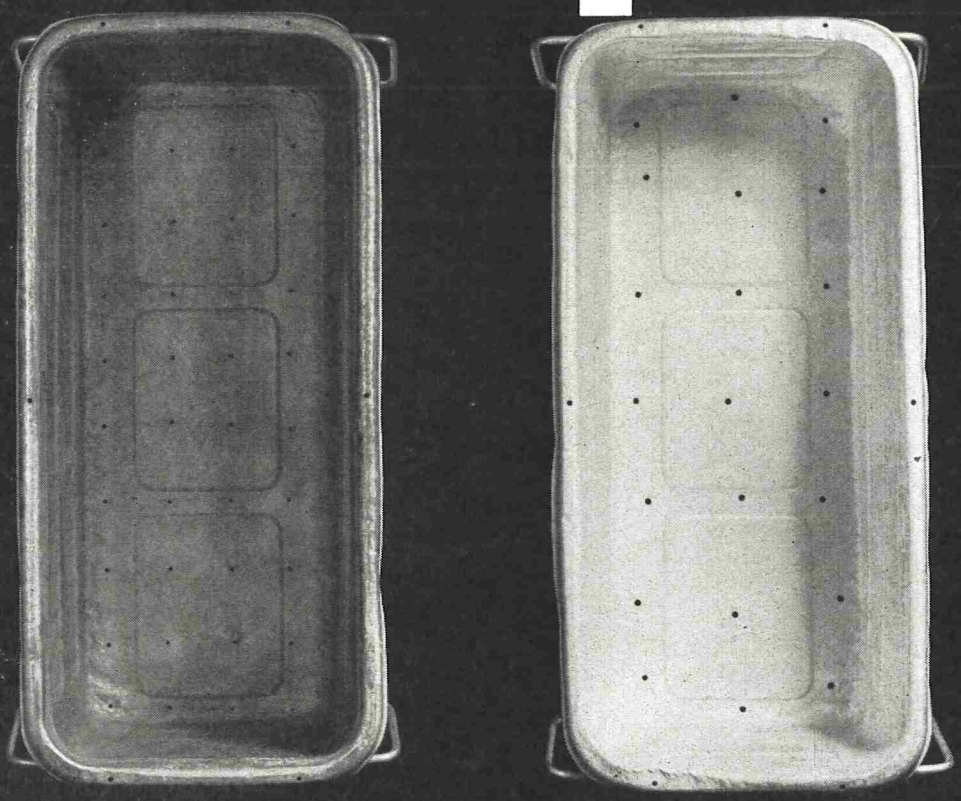

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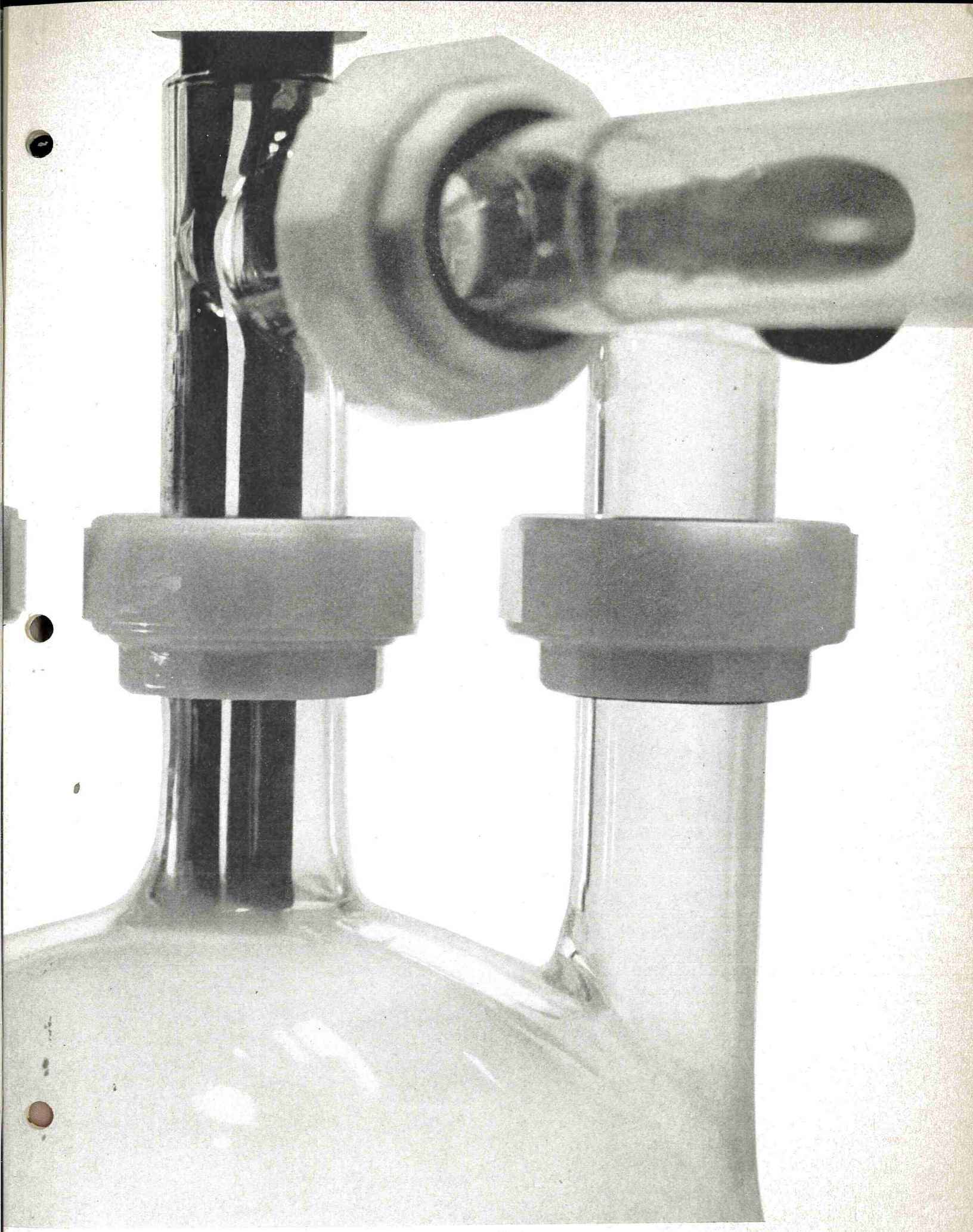

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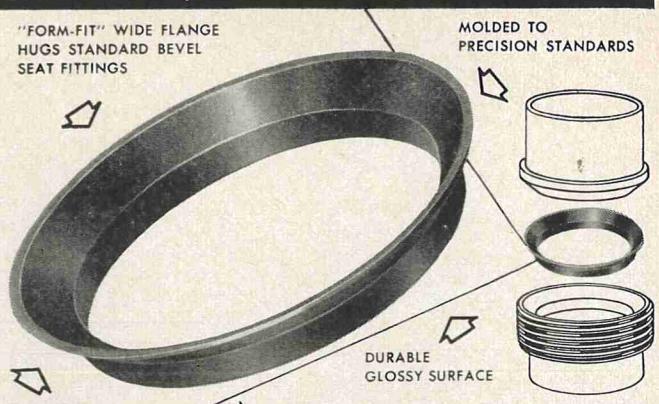

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EFFECT OF STORAGE TEMPERATURE ON THE MICROFLORA OF IRRADIATED AND NONIRRADIATED VACUUM-PACKAGED PETRALE SOLE FILLETS

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ABSTRACT

Petrale sole fillets that were vacuum packaged in mylar-polyethylene bags were irradiated at 0.0, 0.1, 0.2, and 0.3 megarad and stored at 0.5, 3.3, 5.6, 7.8, 10.0, 15.6, and 22.2 C. The fish were monitored throughout storage for spoilage, total bacterial count, coliform count, enterococcus count, and the presence of coagulase-positive *Staphylococcus*. Generic changes in the aerobic flora were determined by the identification of nearly 14,000 microbial isolates. The predominant spoilage flora of the irradiated fish stored at all the temperatures were lactic acid bacteria. The predominant flora at the time of spoilage of the nonirradiated fish stored at 5.6 C and below was *Pseudomonas*. When the nonirradiated fish was stored above 5.6 C, the predominant spoilage flora was lactic acid bacteria. Coliforms and enterococci showed growth at the higher storage temperatures but were suppressed by the radiation treatment. No coagulase-positive *Staphylococcus* were found in any of the irradiated samples.

The spoilage flora of irradiated fishery products stored at refrigeration temperatures has been shown to be significantly different from that of nonirradiated seafoods *(3, 4, 5, 6, 8, 9)*. Because radiation-pasteurized seafoods, like other perishable foods, can be mishandled by exposure to high temperatures during shipment and storage, it is important to determine what effect this might have on the microbial population.

The purposes of this study were to determine the effect of various elevated storage temperatures on the composition of the microflora of irradiated and nonirradiated petrale sole throughout storage to the point of sensory spoilage and to determine the sanitary quality of the fish as indicated by the outgrowth of coliforms, enterococci, and coagulase-positive *Staphylococcus*.

MATERIALS AND METHODS

Sample preparation and radiation. Samples were prepared *(8) from* petrale sole fillets purchased from a local processor. They were vacuum sealed in mylar-polyethylene bags and irradiated in a Cobalt-60 gamma irradiator *(7)* at 0.0, 0.1, 0.2, and 0.3 Mrad.

Storage and evaluation of samples. After irradiation, the packages were placed in low-temperature incubators with temperatures controlled to ± 1 C (1.8 F). The storage temperatures used were 22.2 C (72 F), 15.6 C (60 F), 10.0 C (50 F), 7.8 C (46 F), 5.6 C (42 F), 3.3 C (38 F), and 0.5 C (33 F). Triplicate samples were removed from storage periodically for evaluation. A 45 g portion of each sample was used for bacteriological analysis and the remainder of the 3 samples were then presented to an experienced panel of up to 20 judges for evaluation of odor and appearance. The methods used for the total bacterial plate counts *(8)* and the detection of coagulase-positive *Staphylococcus (10)* have been described. The total coliform count was determined using Desoxycholate Lactose Agar (Baltimore Biological Laboratory) and the total enterococcus count was determined using Enterococcus Agar (Difco). The spoilage end-point was based on the rejection of all samples by all of the judges.

Isolation and identification of microorganisms. Bacterial isolates were collected from the countable pour plates made for the total bacterial count. Whenever possible, all of the colonies from a given plate were picked. The identification scheme has been described *(8)*. The coliform isolates were tested using the indole, methyl red, Voges-Proskauer, and citrate reactions (IMViC), and selected sugar fermentation tests. Transfer of the cultures to the various solid and semi-solid agars and broth was facilitated by the use of a replicating device and special tube racks *(11)*.

RESULTS AND DISCUSSION

Storage life. The initial bacterial counts on the fillets used in this study approximated 10^5 organisms per g. The total number of bacteria was reduced, as expected, approximately 1 log cycle by each 0.1 megarad increment of radiation applied.

The maximum storage life of the irradiated and nonirradiated petrale sole stored at the various temperatures may be seen in Table 2. The total bacterial counts were usually in the range of 10^7 to 10^8 organisms per g at spoilage regardless of the radiation dose and the storage temperature used. The maximum storage life of the samples, on the other hand, was strongly influenced by the storage temperature and the radiation dose. Differences between temperatures were more pronounced than between radiation dosages.

Changes in the incidence of sanitary indicator organisms. The data presented in Table 1 show the initial effect of irradiation on the enterococcus counts, coliform counts, and presence of coagulase-positive *Staphylococcus* in petrale sole fillets. The coliform organisms, which were not present in significant levels before irradiation, were detected only in the 0.1 megarad samples after irradiation. From Table 1, it would appear that the coliform count after 0.1

TABLE 1. EFFECT OF IRRADIATION ON THE ENTEROCOCCUS COUNT, COLIFORM COUNT, AND PRESENCE OF COAGULASE-POSITIVE *Staphylococcus* IN PETRALE SOLE FILLETS

Megarad of radiation	Coliform per gram[a]		Enterococcus per gram[b]		Coagulase-positive *Staphylococcus*	
	Before irrad.	After irrad.	Before irrad.	After irrad.	Before irrad.	After irrad.
0.0	6.5×10^2	———	3.5×10^3	———	+	———
	8.5×10^2		2.0×10^3		−	
	1.1×10^3		3.5×10^3		+	
0.1		1.3×10^2		4.4×10^2	−	−
	$<5.0\times10^1$	2.0×10^2	3.3×10^2	6.2×10^2	−	−
	$<5.0\times10^1$	2.2×10^2	1.1×10^3	7.3×10^2	−	−
0.2		<5		3.5×10^1	−	−
	$<5.0\times10^1$	<5	3.3×10^2	4.0×10^1	−	−
	$<5.0\times10^1$	<5	1.1×10^3	6.0×10^1	−	−
0.3	8.5×10^2	<5	4.0×10^2	<5	+	−
	3.0×10^2	<5	7.5×10^2	<5	+	−
	3.5×10^2	<5	7.0×10^2	<5	−	−

[a]Typical colonies on desoxycholate lactose agar.
[b]Typical colonies on enterococcus agar.

megarad treatment was higher than before irradiation. This can only be explained as sample-to-sample variation since different pieces of fish were used for each determination. The enterococcus counts were insignificant both before and immediately after irradiation. Coagulase-positive *Staphylococcus* were detected initially in the lots of fish used for the nonirradiated and 0.3 megarad samples; however, no *Staphylococcus* were found after irradiation.

The data presented in Table 2 show the total enterococcus counts, coliform counts, and presence of coagulase-positive *Staphylococcus* in the irradiated and nonirradiated petrale sole stored at various temperatures at the time of spoilage. Significant increases in the coliform counts were found in the nonirradiated and the 0.1 megarad samples that were stored above 3.3 C (38 F), in the 0.2 megarad samples that were stored at 10.0 C (50 F) and above, and in the 0.3 megarad samples that were stored at 22.2 C (72 F). No coliforms were detected in the 0.2 megarad samples stored at 3.3 C (38 F) and below or in the 0.3 megarad samples stored at 15.6 C (60 F) and below. The enterococcus counts of the nonirradiated and 0.1 megarad samples increased when the samples were stored at 5.6 C (42 F) and above. The enterococcus counts of the 0.2 megarad samples increased when stored at 7.8 C (46 F) and above. No significant changes occurred in the enterococcus counts of the 0.3 megarad samples stored at any of the temperatures tested. Coagulase-positive *Staphylococcus* were found at the time of spoilage in the nonirradiated fish that was stored at 22.2 C (72 F) and 15.6 C (60 F). They were not found in any of the irradiated fish.

Irradiation is effective in suppressing the growth of coliforms and coagulase-positive *Staphylococcus*. Although the higher storage temperatures supported the growth of coliforms, their levels were always lower in the irradiated than in the nonirradiated fish. The results indicate, however, that, if the product were to be contaminated *after* irradiation and then held at temperatures in the range of 7.8 C (46 F) and above, significant coliform growth could occur.

Since staphylococci were not detected in any of the irradiated fish held at any temperature, it is difficult to speculate what their growth pattern might be. It is possible that petrale sole is not a good substrate for S. *aureus*. It would be necessary to inoculate fish samples with S. *aureus* to determine growth under various storage conditions.

In this study, the enterococci must be defined only as the organisms showing characteristic growth on the m-Enterococcus medium. Many of the catalase-negative, gram-positive rods (lactic acid bacteria) isolated in this study were also able to produce typical colonies on this medium. In general, the growth of the enterococcus group was suppressed by irradiation and the lower storage temperatures (Table 2), whereas the growth of the lactic acid bacteria (Tables 3 through 5) was enhanced by the same conditions.

Changes in the spoilage microflora. In the nonirradiated fish (Table 3), the predominant spoilage

organism at the lower temperatures of 0.5 C (33 F) and 3.3 C (38 F) was *Pseudomonas*. When the storage temperature was increased, the proportion of *Pseudomonas* decreased, and the coliforms were able to grow. In the petrale sole stored at 22.2 C (72 F), as much as 49% of the spoilage flora was found to be coliforms. *Achromobacter* accounted for very little of the flora.

Although over 60% of the initial microflora of this particular lot of fish was gram-positive, the only group that showed significant growth was the lactic acid bacteria. The lactic acid bacteria showed the most increase in the fish stored at the higher temperatures and comprised 46% of the spoilage flora of the samples stored at 22.2 (72. F). Little or no growth was observed in the *Micrococcus* and coryneform groups.

In the 0.1 megarad irradiated petrale sole (Table 4), *Pseudomonas* were not found immediately after irradiation, but they were isolated during the storage period. Significant *Pseudomonas* growth occurred in the samples stored at 0.5 C (33 F) and 3.3 C (38 F), but they did not become the predominant flora. Coliforms were not found immediately after irradiation, but some growth was found after storage at temperatures of 10.0 C (50 F) and above. The *Achromobacter* appeared to be relatively resistant to radiation (38% surviving), but they showed no significant growth at any of the storage temperatures. The predominant gram-positive flora surviving at 0.1 megarad were *Micrococcus* (42%) and coryneforms (14%). These organisms did not grow out at any of the storage temperatures. The lactic acid bac-

TABLE 2. EFFECT OF STORAGE TEMPERATURE ON THE MAXIMUM SHELF LIFE, COLIFORM COUNT, ENTEROCOCCUS COUNT, AND PRESENCE OF *Staphylococcus aureus* IN IRRADIATED AND NONIRRADIATED PETRALE SOLE FILLETS

Storage temp.	Radiation dose	Maximum storage life	Coliform count	Enterococcus count	*Staphylococcus aureus*
° C	Megarad	Days	Coliform/gm	Enterococcus/gm	
22.2	0.0	2	6.9×10^{7}	2.3×10^{7}	+
	0.1	2	2.6×10^{7}	3.9×10^{5}	−
	0.2	2	2.5×10^{5}	5.1×10^{5}	−
	0.3	4	2.6×10^{4}	5.0×10^{1}	−
15.6	0.0	3	2.7×10^{7}	5.7×10^{7}	+
	0.1	3	1.2×10^{6}	1.3×10^{5}	−
	0.2	4	7.5×10^{5}	9.6×10^{6}	−
	0.3	7	<5	3.7×10^{2}	−
10.0	0.0	6	1.8×10^{4}	3.0×10^{3}	−
	0.1	7	1.6×10^{5}	3.2×10^{5}	−
	0.2	9	2.6×10^{4}	1.0×10^{5}	−
	0.3	16	<5	1.0×10^{1}	−
7.8	0.0	7	1.9×10^{6}	5.6×10^{5}	−
	0.1	8	5.1×10^{3}	3.3×10^{4}	−
	0.2	12	4.0×10^{3}	1.6×10^{5}	−
	0.3	23	<5	<5	−
5.6	0.0	10	1.5×10^{5}	6.5×10^{4}	−
	0.1	12	1.6×10^{4}	1.8×10^{5}	−
	0.2	15	4.3×10^{2}	2.7×10^{3}	−
	0.3	26	<5	6.2×10^{2}	−
3.3	0.0	12	3.5×10^{3}	3.5×10^{3}	−
	0.1	21	3.3×10^{3}	1.6×10^{4}	−
	0.2	34	<5	2.5×10^{3}	−
	0.3	34	<5	<5	−
0.5	0.0	14	1.9×10^{3}	1.9×10^{3}	−
	0.1	33	1.8×10^{1}	7.8×10^{2}	−
	0.2	36	<5	2.8×10^{4}	−
	0.3	42	<5	<5	−

TABLE 3. CHANGES IN THE MICROFLORA OF NONIRRADIATED, VACUUM-PACKAGED PETRALE SOLE FILLETS THROUGHOUT STORAGE AT VARIOUS TEMPERATURES FROM 0.5 C TO 22.2 C

Storage temp. ° C	Days of storage	Number of isolates	Percentage of isolates								
			Not identified	*Pseudomonas*	*Achromobacter*	Coliform	*Micrococcus*	Coryneforms	Lactic acid bacteria	*Bacillus*	Other
0.5	0	304	22	4	13	0	4	46	9	1	1
	4	136	25	62	1	1	1	8	1	1	0
	12	55	2	71	7	2	0	4	14	0	0
3.3	0	304	22	4	13	0	4	46	9	1	1
	7	254	3	77	1	2	1	7	9	0	0
	11	49	2	78	0	0	0	4	16	0	0
5.6	0	304	22	4	13	0	4	46	9	1	1
	3	222	6	55	3	6	0	8	22	0	0
	6	66	1	73	6	9	0	0	11	0	0
	8	59	5	41	0	10	0	10	34	0	0
7.8	0	304	22	4	13	0	4	46	9	1	1
	3	153	3	65	0	8	0	2	21	<1	0
	4	85	1	59	1	5	1	4	29	0	0
	6	82	8	10	0	23	0	0	59	0	0
10.0	0	304	22	4	13	0	4	46	9	1	1
	3	95	4	63	0	17	0	1	15	0	0
	4	75	0	33	0	24	0	1	42	0	0
	6	60	0	82	2	5	0	6	5	0	0
15.6	0	304	22	4	13	0	4	46	9	1	1
	1	134	4	28	9	8	3	18	28	2	0
	2	249	1	11	1	29	1	1	55	<1	<1
	3	148	0	16	0	29	0	0	54	1	0
22.2	0	304	22	4	13	0	4	46	9	1	1
	1	122	2	16	2	63	2	1	14	0	0
	3	321	1	2	<1	49	<1	<1	46	<1	0

teria, however, which constituted only 4% of the flora immediately after irradiation, became the dominant spoilage organism at all of the storage temperatures.

Pseudomonas were not isolated at any time from the 0.2 megarad irradiated fish (Table 5). Of the other gram-negative organisms, a few coliforms were found to survive the irradiation treatment, but they showed no growth even at room temperature. The *Achromobacter* comprised 12% of the flora immediately after irradiation but showed no growth at any of the storage temperatures.

The dominant genus, immediately after 0.2 megarad irradiation, was the gram-positive *Micrococcus* which comprised 76% of the survivors. As storage progressed, however, the percentage of *Micrococcus* decreased until none were found at the time of spoilage. Very few coryneforms and *Bacillus* were found and these organisms showed no significant growth at any of the storage temperatures. The predominant organisms at the time of spoilage of the fish stored at all temperatures were lactic acid bacteria.

The microfloral patterns found in the 0.3 megarad petrale sole were nearly identical to the 0.2 megarad irradiated fish. In the 0.3 megarad irradiated fish, however, no coliform organisms were found.

This work is an attempt to elucidate the role of temperature in the microfloral changes. Definite growth patterns were observed for most of the major constituents of the microflora.

In this study, lactic acid bacteria were the predominant organisms at the time of spoilage of vacuum-packaged petrale sole irradiated at 0.1, 0.2, and 0.3 megarad and stored in the temperature range of 0.5 C (33 F) and 22.2 C (72 F). Even in the nonirradiated fish, lactic acid bacteria showed considerable growth in the vacuum-packaged samples stored at 5.6 C (42 F) and above and accounted for up to 50% of the flora at the time of spoilage. The group designation, lactic acid bacteria, is used because a number of catalase-negative organisms with streptococcal morphology were isolated from the fish stored at the higher temperatures, even though the majority of the isolates were indeed *Lactobacillus*. From these results and from studies on other lots of petrale sole and other fish species, it is clear that vacuum packaging favors the growth of *Lactobacillus*

(8). It has been shown that lactobacilli cause the spoilage of nonirradiated, vacuum-packaged products such as sliced, cold meats *(1, 2)*.

Pseudomonas were not found immediately after irradiation at any of the dose levels used. They did show significant growth in the 0.1 megarad irradiated fish that was stored at the lower temperatures of 0.5 C (33 F) and 3.3 C (38 F) but they did not become the predominant flora. No *Pseudomonas* were found in any of the 0.2 and 0.3 megarad irradiated samples stored at any temperature. This unusual sensitivity of the psychrophilic *Pseudomonas* to radiation has been well documented *(12, 13)*.

Previous work has shown that the predominant spoilage flora of nonirradiated petrale sole stored at 0.5 C (33 F) consists of psychrophilic *Pseudomonas* *(8)*. Similarly, in this study the *Pseudomonas* were the predominant spoilage organism at 0.5 C (33 F) and 3.3 C (38 F). Temperature may be a factor in the control of *Pseudomonas* growth because, as the storage temperature increased, the proportion of *Pseudomonas* decreased and they were replaced by coliform organisms.

Of the gram-positive organisms, the *Micrococcus* were the most radiation resistant. As the radiation dose increased, the *Micrococcus* made up a greater portion of the surviving flora. This had been observed in previous studies *(8, 9)* where it had been speculated that the reason these organisms showed no substantial growth in spite of their high level of survival was that their growth was inhibited by the low storage temperature of 0.6 C (33 F). Surprisingly, in this study no increase in *Micrococcus* occurred at the higher temperatures which should have allowed them to grow readily. The only exceptions were the 0.3 megarad irradiated fish in which the *Micrococcus* persisted through mid-storage in the samples stored at 5.6 C (42 F) and above. It is noteworthy that the *Pseudomonas* and coliforms were absent in these samples. The growth of these organisms might be controlled not only by storage temperature but also by competition with or inhibition by the gram-negative rods.

The coryneforms and *Bacillus* isolations were few The *Bacillus* occurrence was sporadic and not significant. The majority of the coryneform isolations were made from the initial samplings either just before or just after irradiation indicating that they might have been inhibited by the conditions of vacuum packaging or that the petrale sole was deficient as a substrate for their growth.

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TABLE 4. CHANGES IN THE MICROFLORA OF 0.1-MEGARAD IRRADIATED, VACUUM-PACKAGED PETRALE SOLE FILLETS THROUGHOUT STORAGE AT VARIOUS TEMPERATURES FROM 0.5 C TO 22.2 C

Storage temp. ° C	Days of storage	Number of isolates	Percentage of isolates								
			Not identified	*Pseudomonas*	*Achromobacter*	Coliform	*Micrococcus*	Coryneforms	Lactic acid bacteria	*Bacillus*	Other
0.5	0	196	0	0	38	0	42	14	4	2	0
	12	226	0	58	1	0	1	0	40	0	0
	26	312	0	14	0	0	2	1	83	0	0
3.3	0	196	0	0	38	0	42	14	4	2	0
	9	230	2	20	28	1	2	3	44	0	0
	19	300	0	0	0	0	0	0	100	0	0
5.6	0	196	0	0	38	0	42	14	4	2	0
	9	340	1	1	5	0	2	1	90	0	0
	12	260	<1	0	0	0	<1	0	97	0	2
7.8	0	196	0	0	38	0	42	14	4	2	0
	8	378	<1	<1	<1	1	3	0	94	0	0
10.0	0	196	0	0	38	0	42	14	4	2	0
	5	493	6	1	3	5	8	0	77	0	0
	7	334	4	2	2	8	2	1	81	0	0
15.6	0	196	0	0	38	0	42	14	4	2	0
	2	368	4	1	2	13	7	1	72	0	0
	3	229	20	2	3	2	1	2	68	2	0
22.2	0	196	0	0	38	0	42	14	4	2	0
	2	194	13	1	0	2	1	0	83	0	0

TABLE 5. CHANGES IN THE MICROFLORA OF 0.2-MEGARAD IRRADIATED, VACUUM-PACKAGED PETRALE SOLE FILLETS THROUGHOUT STORAGE AT VARIOUS TEMPERATURES FROM 0.5 C TO 22.2 C

Storage temp. ° C	Days of storage	Number of isolates	Percentage of isolates								
			Not identified	*Pseudomonas*	*Achromobacter*	Coliform	*Micrococcus*	Coryneforms	Lactic acid bacteria	*Bacillus*	Other
0.5	0	174	6	0	12	1	76	3	1	1	0
	13	209	1	0	1	0	6	0	91	1	0
	36	335	1	0	0	0	0	0	99	0	0
3.3	0	174	6	0	12	1	76	3	1	1	0
	12	203	0	0	0	1	0	0	99	0	0
	34	297	0	0	0	0	0	0	100	0	0
5.6	0	174	6	0	12	1	76	3	1	1	0
	9	255	0	0	1	0	6	0	93	0	0
	15	204	1	0	0	0	0	0	99	0	0
7.8	0	174	6	0	12	1	76	3	1	1	1
	8	188	0	0	12	0	4	0	82	2	0
	12	103	0	0	0	0	0	0	100	0	0
10.0	0	174	6	0	12	1	76	3	1	1	0
	7	277	1	0	1	0	1	0	96	1	0
	9	203	2	0	0	0	0	1	97	0	0
15.6	0	174	6	0	12	1	76	3	1	1	0
	2	330	2	0	7	0	28	1	61	1	0
	4	273	11	0	0	0	0	1	88	0	0
22.2	0	174	6	0	12	1	76	3	1	1	0
	2	331	9	0	0	1	0	0	90	0	0

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WHAT DAIRYMEN SHOULD KNOW ABOUT MASTITIS

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Editors Note. Material for "What Dairymen Should Know About Mastitis" has been abstracted by the NMC Education Committee from its earlier publication "Current Concepts of Bovine Mastitis." This Journal article is based on this recently released material.

Mastitis is the reaction of the mammary gland to injury. The term mastitis comes from the Greek word *mastos* for breast and *itis* which means inflammation of. Inflammation is characterized by heat, swelling, pain and redness, and in mastitis there is additional evidence in the appearance or other characteristics of the milk.

Certain terms are used to describe mastitis. Generally speaking "Udder infection is the invasion of the mammary gland by organisms. They may multiply within the gland and cause inflammation. "Non-clinical (sub-clinical mastitis)" is the form of mastitis in which there are none of the recognizable signs of inflammation or visible abnormality of the milk. There are milk changes and signs of udder inflammation which are detectable only by special tests. "Clinical mastitis" is the form in which the mammary gland shows obvious signs of inflamation and the milk contains clots, flakes, watery or other unusual appearances. Severe acute mastitis may produce systemic reaction such as: fever, rapid pulse, weakness and loss of appetite. When only the udder shows inflammation, the condition is called "acute local mastitis." When the cow becomes sick from mastitis, it is called "acute systemic mastitis". "Chronic mastitis" is caused by persistent udder infection which can flare up into the active or clinical form. The udder may return to the non-clinical form, but progressive destruction of milk secreting tissue results from each attack.

It is important to bear in mind that mastitis is a complex problem in which microorganisms may live in a host-parasite relationship in the udder without causing recognizable disease. Environmental factors which injure the cow's udder or lower her resistance enable the microorganisms to overcome the cow's resistance and produce clinical signs of the disease. It is, therefore, important for dairymen to understand that eradicating organisms from the udders of herds will not necessarily eliminate clinical mastitis. Clinical mastitis can occur in udders free from infection as a result of irritation or injury which may in turn predispose the udder to infection.

Cost and Public Health Significance

Estimates of annual losses of milk resulting from mastitis amount to between $225,000,000 and $500,000,000 in the United States. Add to this the shorter productive life of affected cows. In many herds, losses experienced from culling mastitic cows are great. Often all female animals born into the herd must be reared to replace cows culled for mastitis.

Pasteurization of milk removes the danger of transmission of organisms commonly found in milk to humans. Some members of the staphylococcus group of organisms are capable of producing enterotoxins which are not destroyed by pasteurization. These poisonous materials are capable of producing vomiting, diarrhea and other toxic manifestations in humans. The presence of sufficient enterotoxin in milk to produce such reactions is, fortunately, quite rare. The most important problem involving human health is the presence in the milk supply of residues of antibiotics and other drugs used for mastitis treatment.

During the period between 1953 and 1958 penicillin residues were found in a large number of bulk milk supplies. Reactions to penicillin in milk were reported in persons who had become hypersensitive to the antibiotic. Prompt action by the industry, governmental agencies and producers working together has greatly reduced the danger since that time.

Factors Influencing the Susceptibility of Cows to Mastitis

There are certain physiological and environmental factors which may affect the development of mastitis.

Anatomy of the Udder and Teats. — Cows with pendulous, poorly attached udders are more likely to have mastitis. Where the floor of the udder lies below the level of the hocks there is greater likelihood of udder and teat injury. Excessively long teats are more prone to injury by tramping. Easy milkers may be more prone to mastitis, but it is not clear that certain characteristics of the teat duct are responsible. Injuries and local inflammation at the end of the teat apparently prevent adequate closure of the teat sphincter and allow entrance of bacteria.

Age. — It is generally true that as cows advance in age, they are more likely to become infected with mastitis bacteria and experience clinical mastitis. Old cows which have sound udders should be recognized

for their genetic worth when saving replacement heifers.

Milk Production. — It is a fact that well-managed, high-producing cows have less mastitis. Herds which have high production year after year are not the herds with mastitis problems. Herds with the ability for high production can achieve this goal with adequate management; herds with the genetic ability for high production may suffer from mastitis and other problems when dairymen fail to pay attention to important management practices.

Stage of Lactation. — Cows which carry infection through the dry period frequently suffer clinical mastitis at freshening time. Mastitis is sometimes observed at breeding time. Although it has been shown that mastitis organisms may enter the udder at any time, some studies show that up to one-third of all infections occur during the dry period.

Hormones. — Some research workers suspect that certain estrogenic hormones, originating in plants or in the animals themselves, may increase susceptibility to mastitis, but nobody has yet been able to demonstrate that any specific hormone is involved.

Heredity. — Although there is insufficient evidence at present to indicate that selective breeding for mastitis resistance can be a practical accomplishment, it is wise to select animals with well-attached udders, good milking characteristics and a clinical mastitis free history as breeding stock to provide herd replacements.

Ninety-five per cent of all clinical mastitis cases are caused by streptococci and staphylococci. Many other organisms may be involved in the remaining five per cent of infections. Following invasion, their establishment depends upon their ability to survive defensive mechanisms of the cow. Laboratory culture tests of quarter milk samples are necessary to identify the organisms causing infection.

Anything in the cow's routine or environment which can serve as a stress or can affect resistance to mastitis. More often than not, it is a combination of factors which may together affect the cow's resistance. Sudden changes in feed, deficiency or excess of protein or energy in feed, possible hormonal effects of certain legume pastures such as ladino clover or alfalfa have been suspected, but not proven, to be causative factors in outbreaks.

Housing may be an indirect cause of mastitis. Too small stalls result in teat and udder injuries. Tiestalls which are adequate in length and width, provide adequate comfort and space and reduce teat and udder injury. Free-stall loose housing appears to be the best way to handle cows which are not tied. These stalls, when adequately bedded, keep cows clean, comfortable and relatively free from injury.

Lack of good ventilation can have a very bad effect on disease resistance, although this has not been proven for mastitis. Dairymen should recognize the fact that milk production is hard work for cows; and, regardless of the kind of housing or handling, attention to comfort and cleanliness of the cows will pay off in less clinical mastitis.

MILKING AND MILKING MACHINES—THE MILKING ACT

The udder contains more milk than is removed at a single milking. In order that milk can be removed by the nursing calf, by hand milking or by machine milking, it is necessary that a physiological process occurs in the cow called "milk-let-down." This is a reflex mechanism whereby stimuli, such as nuzzling of the udder by the calf, washing and massaging the teats, the sound of the milking machine, the sight of the person who does the milking or other stimuli cause the brain to stimulate the posterior pituitary gland to release oxytocin into the blood stream.

Oxytocin travels via the blood to the alveoli (tiny milk sacs) in the gland which produce the milk. Small musclelike fibers surrounding the alveoli contract and literally squeeze the milk out of the alveoli. Milk let-down takes place in about thirty seconds following the beginning of stimulation and persists for about six minutes. The milk is forced under pressure from the contraction of millions of tiny musclelike fibers surrounding the alveoli into the teat cistern. It is during this period that milk removal should take place.

There is another physiological process which can almost immediately stop milk let-down. If the cow is hurt, frightened or angered, the adrenal gland secretes adrenalin into the bloodstream. This defense mechanism stops the action of oxytocin and milk let-down ceases. From this it can be seen that milking should be a regular act that is best performed in a tranquil atmosphere. Condition the cow to let down her milk by washing and massage. Attach the milking machine when let-down has begun and remove it before the milk flow ceases. Make every effort to eliminate injury or fright or any other disturbance during the time milk let-down is taking place.

MECHANICAL MILKING

The milking machine employs differential pressure between the inside and outside of the teat. When air is removed from the chamber between the inflation and the teat cup shell, the milk under pressure expands the teats, opens the teat canal and moves into the inflation. When air is allowed to flow back into the teat cup chamber, the teat is allowed to return to its normal shape and the teat sphincter is closed. This then allows the teat cavity to refill with

milk and allows the blood to circulate in the teat walls. As long as milk is forced into the teat cavity as the inflation collapses, there is relief from vacuum around the walls and at the end of the teat. When the teat is empty this does not occur and vacuum may actually be present in the teat cavity and the teat cup may crawl toward the udder. This usually pulls udder tissue into the teat cup and prevents further entrance of milk into the teat cavity. For this reason, pull teat cups downward toward the end of the milking process to prevent teat cup crawl and insure the presence of milk in the teats. Overmilking can cause injury to the teats.

Large-bore inflations tend to overstretch small teats, and when they collapse, they tend to flatten the middle area of the teat while the teat end remains ballooned under vacuum. Narrow-bore inflations under tension open and close the teats with the least amount of distortion and exposure of the smallest amount of teat surface to constant vacuum of the interior of the teat cup. Excessive vacuum levels may cause erosions and edema at the teat ends and severely injure cows which are overmilked. Inadequate vacuum levels may slow milking beyond the physiological let-down time. When insufficient claw capacity or some other machanical factor allows flooding, vacuum fluctuations occur. This slows milking and increases the incidence of mastitis. Pulsation rates should agree with manufacturers recommendations. All pulsators functioning properly should regularly expand and collapse the teats at the right speed to prevent congestion and injury to the teat walls. Too fast pulsations may actually slow milk removal.

Criteria for Good Pipeline Milking

In a good pipeline milking operation the following points are important:

1. Milk should move toward the pipeline in one direction—never falling backward toward the claw.
2. Milk entry valves should allow milk to enter above the level of milk moving in the milk line so that there is no interference with air movement.
3. Milk in the line should flow rapidly by gravity and the level of milk in the line should not exceed half its capacity.
4. Regardless of the kind of pulsator used, all should function the same way—regularly opening the teats with the same level of vacuum and closing the teats by allowing air into the cavity around the inflations in the teat cup. Leaking or overloaded pulsators (as sometimes seen with master pulsators) fail to open and close the teat properly and result in injury.
5. Filters should not in any way interfere with passage of air or milk through them. In a properly functioning pipeline system there is an unbroken column of air extending from the end of the teat to the vacuum source. When a vacuum gauge is applied into the teat cup of a milking unit, there should be a minimum of fluctuation.

For bucket or suspended milkers where milk must be carried to the milkhouse, it is rare that one man can handle two units continuously and milk the cows correctly. For pipeline milking in a barn using moveable units, two units per man is the maximum. In the most efficient milking parlors a maximum of four units per man is the rule. Actually, in good systems which remove milk rapidly it is difficult to handle more than three units without overmilking the cows.

A good milking system maintains a stable vacuum adequate to milk most cows within three to five minutes. It opens and closes the teats in the same way regularly without causing injury. It moves milk continually toward the vacuum source with no flooding or blockages. It is designed so that it can be cleaned and sanitized efficiently and satisfactorily. It uses sanitary methods to keep inflations clean.

Steps to Good Milking

There are certain practices that are essential to good milking.

1. Adequate Preparation. — Allow at least thirty seconds to adequately clean and dry off the teats.
2. Applying the Teat Cups. — Admit a minimum amount of air into the milking system and position the cups as low on the teats as possible.
3. Milk Removal Time. — This varies with individual cows, but average milk removal time for the herd should not exceed six minutes per cow. At the end of milking, apply downward pressure to the claws to prevent teat cups crawling upward and shutting off milk flow into the teats.
4. Stripping. — Machine stripping should never exceed twenty seconds. Strip no longer than necessary to remove milk from full teats. Do not attempt to get the last few ounces of milk which remain.
5. Removal of the Teat Cups. — Break the vacuum first by admitting a small amount of air before removing teat cups. Remove teat cups gently.
6. Prevent Overmilking. — Use the correct number of units for your system. Do no other chores during milking. Concentrate on being at the right place at the right time when you milk cows.

Measuring Your Efficiency of Milking

If milking time per cow (the number of units times the number of minutes required to milk the herd, divided by the number of cows) exceeds five minutes, there is room for improvement in your procedure or in the milking system you use. To illustrate: U = Units; M = Minutes; C = Number of Cows

$$\frac{U \times M}{C} = \frac{2 \times 60}{25} = \frac{120}{25} = 4.8 \text{ min. per cow}$$

This formula is influenced by idle time between cows and the extra time cows may be allowed to consume grain in milking parlors.

THE UDDER'S REACTION TO INFECTION OR INJURY

This is called the inflammatory reaction. First, the blood vessels dilate and carry much more blood to the affected area than normal. The microscopic blood vessels become more porous and blood fluid escapes from them. Blood flow slows down and blood fluids coagulate in the tissues and milk spaces. Milk is trapped in the smaller ducts and it becomes mixed with blood fluids, or whole blood and it may coagulate. Milk-collecting-duct walls become roughened and thickened; this interferes with normal milk drainage. After all but the very mildest inflammatory reactions, permanent damage results in the udder. The amount of damage depends upon the severity of the inflammation and the length of time over which it occurs.

In response to injury and/or infection enormous numbers of leukocytes move from the blood stream into the affected area. These cells are part of the body's main line of defense. In normal milk, their numbers in milk may range upward to approximately 500,000 per milliliter (about 15 drops of milk). In sub-clinical mastitis quarters milk leukocyte numbers increase and may exceed one million per milliliter (ml). Where the milk becomes abnormal in gross appearance (clinical mastitis), leukocyte numbers may exceed five million per ml. The number of leukocytes per ml in a milk supply is thus a good measure of the degree of mastitis in the herd. Herds producing bulk milk in excess of 1,000,000 leukocytes per ml may have a mastitis problem severe enough to depress milk production and the quality of the milk.

DIAGNOSIS OF MASTITIS

Gross changes in the milk or udder, fever, pain and lack of appetite are characteristic of clinical mastitis. A competent veterinarian can often identify chronic non-clinical mastitis quarters by careful manual examination, but some infections may escape detection by this method. Quarter-sampling and identification of organisms by laboratory culture is the best method for determining what organisms are present.

Several screening tests have been developed and are in popular usage throughout the country. Following is a brief description of the more commonly employed tests.

The Strip Cup. — Use of a strip cup or plate in good light is an excellent means of identifying grossly abnormal milk. There is also an additional advantage in using a strip cup: milking several streams of milk from each teat stimulates milk let-down and keeps milk which usually contains relatively large numbers of bacteria and leukocytes out of the supply.

The California Mastitis Test. — (or two similar tests: The Milk Quality Test and the Michigan Mastitis Test) — This is a simple test that can be used at the side of the cow to determine the degree of mastitis present. Depending upon the number of leukocytes present, the CMT reagent and milk mixture increases in viscosity. Normal milk when mixed with CMT reagent shows no change in viscosity. Mastitis milk may form a heavy viscid gel.

The Modified Whiteside Test. — This simple test using a 4% solution of sodium hydroxide (lye) and cold milk indicates by degree of reaction (like the CMT) the approximate number of leukocytes present. This test is usually done in the milkhouse, receiving platform or the laboratory.

The Wisconsin Mastitis Test. — This test uses a reagent similar to that used in the CMT. It may be used in the milkhouse or laboratory. The increase in viscosity of the reagent milk mixture is measurable by its rate of flow through a standard-sized hole in the cap of a special tube. By reading a scale on the side of the tube, the approximate content of the milk can be determined.

The Catalase Test. — The amount of the enzyme, catalase, in milk is broadly related to the leukocyte count. By mixing a given amount of milk and hydrogen peroxide solution, the amount of catalase present releases a measurable amount of oxygen proportional to the severity of mastitis present.

The Direct Microscopic Somatic Cell Count. — (formerly called the Direct Microscopic Leukocyte Count). Stained films of milk on glass slides are examined using a microscope and the types and numbers of leukocytes and other tissue cells are observed and counted. This time-consuming technique requires an expert technician. It was recently developed by the Research Committee of the National Mastitis Council to serve as a standard through which all other screening tests will be evaluated.

WHAT SCREENING TESTS MEAN

Elevated leukocyte counts, as revealed by screening test reaction, are caused primarily by milk from cows with mastitis; however, in some instances they also result when a relatively large number of cows in the herd are recently fresh or are producing small amounts of milk (less than 20 pounds) at the end of excessively long lactations (over 320 days). When bulk milk produces a screening test reaction, it indicates more than 500,000 leukocytes per ml and strongly suggests a significant incidence of mastitis in the herd. Interstate regulations and many state regulations require that all milk offered for sale must contain less than 1,500,000 leukocytes per ml.

It pays to produce milk which is below 1,000,000 leukocytes per ml and negative to screening tests. Excessive leukocyte levels in milk indicate up to 25% loss of production potential for the herd. The cow's productive life is longer in the absence of udder inflammation. Less herd replacements are necessary. The quality, flavor and wholesomeness of the herd's milk will be improved. Dairymen will have a part in increasing milk consumption and their sales potential by improving the quality of the product. Good milk cannot originate in the dairy plant; it must originate in the cows which produce it.

Dairymen can check their herds for abnormal milk by regularly using a simple screening test on samples

of bulk milk or pooled can samples at two week or monthly intervals. Dairymen can estimate the number of leukocytes which may indicate whether milk production is being impaired by subclinical mastitis. A test of such a sample showing more than a negative or trace test indicates that mastitis or udder injury may be present. Using a screening test to check cows in late lactation will help dairymen to judge when such animals should be dried off. Cows milking less than 20 pounds of milk 320 or more days following freshening may show strongly positive test. Testing occasional quarters which may be suspected of having mastitis will reveal whether or not they should be treated. Routine checking of cows soon to be dried off may reveal quarters for which treatment during the dry period may be indicated.

When screening tests show that milk is abnormal ask your dairy fieldman, veterinarian, milking machine serviceman or your county extension agent to check for defects in your milking and management which are contributing to mastitis. Be sure that you are doing a good job of milking and caring for your cows before you embark on a treatment program.

Preventing the Spread of Mastitis Infection in a Herd

Certain recommended practices must be followed to insure against the spread of infection.

Calves. — Feed calves milk in such a manner that they will not suckle each other. Infections which may produce "blind quarters" may be introduced in this way.

Milking Order. — Milk first calf heifers first. Milk older cows and cows which have had mastitis last. In large herds several units of milking size may be possible. If such groups can be started as first calf heifers and milked together without mixing them with older animals, the spread of many mastitis organisms can be slowed.

Sanitary Procedures. — Since mastitis is caused primarily by infection which spreads during the milking period, sanitizing udders, milkers' hands and equipment will help to lessen the possibility of spread. New procedures for sanitizing or pasteurizing teat cups may be helpful. Use individual paper towels and a non-irritant sanitizer for preparing cows for milking. Washing hands in a sanitizer between milking and dipping teats in an efficient non-irritant disinfectant after milking has been widely recommended.

Culling the herd. — Cull mastitis infected cows which do not respond to treatment to help reduce sources of infection in the herd.

Treating dry quarters. — Treat dry quarters which have had clinical mastitis or other evidence of infection during the previous lactation.

Dairymen should concentrate on good management and good milking which includes the hygiene practices necessary for producing good, clean milk and preventing the spread of mastitis organisms. The answer to herd mastitis problems does not lie in using antibiotics. When the dairyman does a good job, treatment of occasional mastitis cases (which are inevitable in the best managed or controlled herds) is quite effective; when the dairyman does a poor job, tremendous effort and expense for treatment has little value.

RAPID REMOVAL OF PESTICIDES REPORTED BY MSU SCIENTISTS

Progress was reported recently in Michigan State University's effort to accelerate removal of pesticide residues from animal systems.

Dairy scientists D. G. Braund, L. D. Brown and J. T. Huber contaminated a group of rats with dieldrin and fed half of them the drug heptabarbital. At the end of just 14 days, residues stored in body fat of treated rats were reduced by 75%.

Heptabarbital also proved effective in treating animals already contaminated with dieldrin. Rats were fed the drug during a 6 week decontamination period. A 96% reduction in stored dieldrin was found. Ordinarily, it would take a year to decontaminate an animal.

Next step was finding out how drugs work on metabolism and removal of pesticides. This research was reported by graduate student Barbara Zook and Dr. R. M. Cook.

Chlorinated hydrocarbons, like dieldrin, are not water soluble. This means it would take a long time for them to be broken down and excreted by the animals, the researchers reported.

"Current work is aimed at drug metabolism in the liver," Dr. Cook said. Treatments stimulate secretion of enzymes which make pesticides water soluble. Pesticides then can be excreted in the urine.

An overall goal of the MSU research is to clear an animal's system of pesticides as quickly as possible. Previous research showed that rate of pesticide removal could be doubled when animals were fed small amounts of charcoal causing them to pass residues in the feces.

FOOD AND FEED TOLERANCES FOR PESTICIDES[1]

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You are all perhaps familiar with U.S. Food and Drug Administration (FDA) laws that regulate the use of pesticides on agricultural commodities. The purpose of these laws is to protect the public's health which may be endangered by pesticide residues that remain on food and feeds. Pesticide residues in milk are particularly noticed, because milk is one of the first foods a person receives in his life and it continues to be an important food in the form of butter fat throughout his life. There is the danger that the constant intake of pesticide residues through milk and other products could eventually accumulate to levels in the body that are deleterious to health. Just in what way certain small residues would affect health has not been established definitely, but the FDA would rather be safe than sorry in its interest of safe guarding health.

The type of insecticides that are of primary interest to the dairy industry on this regard are the long lasting insecticides, particularly the group known as the chlorinated hydrocarbons. Examples of these are: aldrin, BHC, DDT, lindane, heptachlor, dieldrin, endrin, toxaphene and many others. One of the other main problems with these insecticides is that they are not readily eliminated from the body, but accumulate in the fat. In dairy animals this includes the butter fat.

Back in the 1950's when the danger from these insecticides was suspected, their registered use on forage was withdrawn. A zero residue tolerance on forage and in milk was established for these pesticides. Since that time much of the milk sold in the United States has been illegal.

The widespread illegality of milk sales is not a result of dairymen flagrantly ignoring the laws, but the result of the history of pesticide use, and the advancement of residue testing technology. To be sure, there are perhaps cases of willful misuse of pesticides.

Because certain pesticides are so persistent in the soil, they can still contaminate forage and hence milk years after they had been applied to ground now used for forage production. Most of these insecticides are not systemic in the plants, but harvest operations kick up enough soil to contaminate the forage to a degree that is detectable by modern techniques. As small as these residues may be, they are still not zero. Therefore, they are illegal.

The FDR soon realized the meaninglesssness of the zero tolerance on certain commodities, but the situation was not immediately correctable. Before finite neglible residue tolerances could be established, it was necessary to make a study of what amount of residue could be expected in milk when illegal pesticide use is not involved. This year the FDA has been able to temporarily establish pesticide residue action level guides for certain pesticides in milk and other products. These negligible tolerances are subject to re-evaluation and changes as more information becomes available. If a sample of milk contains residue in excess of the neglible tolerance, action will be taken against the persons involved. Action will also be taken even if the tolerance is not exceeded, but it can be shown that there was a misuse of a pesticide.

Another piece of information that you may be aware of is that the USDA cancelled Dec. 31, 1967, registrations of pesticides for use on food or feed that were registered on a "no residue" or "zero tolerance" basis unless: (1) finite tolerances or exemptions from the requirement of tolerances have subsequently been established, or (2) progress reports were submitted showing that studies are being conducted to obtain data to support finite tolerances.

A hasty look at these two pieces of information may seem to be from a topsy-turvy world. A particular insecticide may be illegal to use on forage although there is a residue allowed, but the same insecticide may be legal to use on a different crop although no residue is allowed. Part of this contradiction can be explained by the fact that the legal tolerance level is really zero in both cases, but in some cases a limited excess is allowed, for certain reasons. This is somewhat analagous to driving 61 mph down a hill in a 60 mph zone. The excess of 1 mph over the limit is hardly speeding especially when you take into consideration the adjustment necessary to compensate for the acceleration brought about by the down slope.

My concern is that the two statements about residues may be confused. Some persons coming aware of

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[1]Presented at the 1968 Kentucky Fieldmen and Sanitarians Conference, Mammoth Cave, Kentucky, February 27 and 28, 1968.

the action level guide for the residue of a certain insecticide on particular agricultural produce may interpret this as permission to use this insecticide on this produce. Many of you who do not grow all your forage are exposed to the danger of possibly buying hay that is contaminated because of such a misinterpretation. My advice to you is to know the source of your hay so that should you become involved in a residue problem you have some recourse.

The best protection you have is to use only those pesticides that are recommended for a specific purpose as given in the University of Kentucky recommendation literature; or at least as stated on the pesticide label.

ECONOMIC FACILITIES FOR MILK PRODUCTION[1]

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The total production system controlled by each individual producer of milk must be efficient in the realm of today's economy, or he faces the drastic fact of being forced out of business. The physical facilities are a part of the total production system. These facilities usually represent 25% of the total capital outlay. A list of the components that comprise the physical facilities of a modern dairy system is as follows:

1. Milking parlor and holding area.
2. Milk handling room.
3. Hay storage and feeding.
4. Silage storage and feeding.
5. Grain and supplement storage and feeding.
6. Resting area.
7. Maternity, nursery and medical.
8. Drinking water.
9. Exercise.
10. Manure and waste handling.

It is impossible to say which of these components is the most important, therefore, it should not be construed that this listing is in order of importance.

In general, the dairy equipment manufacturers have designed and are marketing very workable milking parlors and milk handling room. Likewise, the industry has done an excellent job designing vertical-type silos. The major problem comes upon the owner and operator in trying to arrange all ten of these components into an efficient operating system. This is where the extension agricultural engineers, dairy specialists, and area specialists can be of greatest help to the producers as far as the physical facilities are concerned. Since this is quite a complex problem, the producer should be encouraged to seek the advice of these trained persons.

One of the components that is of tremendous importance and can usually be obtained economically, is providing high quality drinking water in the correct amount. When one stops to realize the amount of time, effort, and expense that goes into the production, storage, and handling of hay, grain, and silage, and also stops to realize that drinking water is of equal importance, we can understand the meaning of economy as applied here. For a fraction of the cost of feed production, drinking water can be supplied at the feedlot so that the milk cows can always have sufficient quantity of high quality water available. Many of our producers could provide this component which they are not now adequately doing.

UNIVERSITY PROVIDES PLANS

Another component that seems to be generally ignored by our producers is the maternity, nursery and medical facilities. In general, I would say that the nursery and medical units are the most neglected of these three. Since replacements are the backbone of a continuing herd, the producers could well afford to invest in proper facilities for young calves. There is always need for medication and special care in a herd of milk cows. Providing good facilities for this type of work is a sound investment. Agricultural engineers in cooperation with the dairy specialists of the University, have recently developed a Calf Nursery Plan No. 8839-3. It may be obtained from Plan Service, Agricultural Engineering Department, University of Kentucky, Lexington, Kentucky for 75 cents.

One particular inovation that has apparently been earning its way the past few years, is the free stall

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[1]Presented at the 1968 Kentucky Fieldmen and Sanitarians Conference, Mammoth Cave, Kentucky, February 27 and 28, 1968.

resting area. Rather than have the milk cows lying down in filthy and unsanitary areas where the possibility of udder infection is increased, as well as increased clean up time in the parlor, and a higher possibility of milk contamination, the free stall barns provide clean, dry, draft-free areas. The free stall barn undoubtedly is a wise investment for the producer. The University of Kentucky Extension Plan Service has three different plans for building free stalls. They are as follows:

1. No. 723-28, Double Aisle—Cows Face Out, @ 75c per set.
2. No. 723-29, Single Aisle—Cows Face Out, @ 25c per set.
3. No. 723-30, Side-Entering, @ 50c per set.

These plans may be obtained from the Plan Service, Agricultural Engineering Department, University of Kentucky, or from the area dairy extension specialists.

IMPORTANCE OF FEED STORAGE LOCATION

The components that appear to present some difficulty so far as the location or arrangement with the other components are the silos. One main thing to plan for is the very heavy loads of silage that will be brought to the structure, so silos must be located so that these vehicles can unload and return to the field without difficult maneuvering, or be in danger of overturning. Secondly, they must be located so that the stored material can be removed and taken to the mouth of the cow with the least amount of difficulty and feed wastage . It appears that utilization of the horizontal-type silo has been slightly neglected. It is quite possible that today's milk producer is missing a good opportunity for an economical silo structure by overlooking the possible use of a horizontal-type silo. It is a well-established fact that silage may be stored for 1/4 to 1/2 the capital cost in horizontal structures. In general, it takes a little more effort and management time to handle the horizontal silo compared to the vertical, but that in many cases the producer can provide this extra time and effort where he might not be able to supply the extra capital for the vertical type.

One thing should be said about hay feeding. If it is at all possible, the hay should be stored where it is to be fed. This eliminates extra chore time and labor in having to load baled hay at feeding time. One inovation that has been in use for several years in many cattle feeding systems is the slanted-slat head gate. These have been primarily designed for self-feeding into horizontal silos, but the principle can very well be applied to hay feeding as well as to silage feeding. The general idea is that the animal has to turn its head to enter the head gate, since the slats are sloping approximately 60°, and are about 10" to 12" apart. Animals feeding through head gates of this sort usually remain much quieter with less pulling in and out and disturbing the animals on either side, thus there is an apparent saving of feed being dragged out and wasted on the ground.

One last item that is of tremendous importance today is the manure waste handling. Laws are very strict about drainage from any animal feedlot today, and will be even more strict in the future. In many cases there is no simple answer to the problem, and the cost of correcting it might be so great as to be the "straw that breaks the camel's back" and force the producer out of business. Generally, however, if this problem is faced intelligently and planned for, manure can at least be properly handled so that it can defray its own costs of handling. Most important is not to violate the sanitation laws and allow the producer to continue in business.

CHANCES OF FOOD INFECTION INCREASES IN SUMMER

Summer picnics, with traditional potato salad and cold chicken, increase the chances of occasional food infections. This is often caused by *Salmonella* organisms, which food scientists are only beginning to understand.

The effect of acidity and temperature of food on the growth of one species of *Salmonella, Salmonella typhimurium,* was recently reported by E. H. Marth, University of Wisconsin food bacteriologist.

Marth and C. S. Subramanian added 3 common food acids —lactic, citric, and hydrochloric—to skimmilk that contained *Salmonella* organisms to see how acid affected the growth of the harmful bacteria. They held one batch of skimmilk at the temperature used in making cultured dairy products, (72 F) and another batch at human body temperature (98 F). The various acids were added up to 16 hr, and then the milk was held at the test temperatures for a longer time.

The *Salmonella* bacteria continued to multiply in all the acid conditions, but they were slowed down at lower temperatures. They reached peak populations in 12 hr at 98 F but didn't reach peak until 16 hr at 72 F.

Marth concluded from his experiments that acid will not prevent the growth of bacteria in *Salmonella*-contaminated milk.

SANITATION PROBLEMS IN THE PRODUCTION OF FROZEN CITRUS CONCENTRATE[1]

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Abstract

Extensive repairs are made during the off season in food plants operating on a seasonal basis. Precautions taken to protect equipment during down periods are discussed.

Microorganisms causing food poisoning do not grow, but die readily in citrus juices and concentrates. Coliform bacteria are of no apparent public health significance in frozen citrus concentrates, partially concentrated or single strength citrus juices. Lactic acid bacteria, which constitute the most important index of processing sanitation, are held in check by constant sanitation efforts.

Soundness of incoming fruit and efficiency of grading are important factors in final product quality. Chlorinated water sprays are used to sanitize fruit handling equipment. A chlorine concentration of 15 ppm was found to be effective in controlling conveyor belt contamination at one plant.

The TASTE evaporator (thermal accelerated short time evaporator), now used almost universally in the citrus industry, is not a source of microbial contamination. Data indicate that a loss of diacetyl occurs when it is used for processing.

In distributing finished product from processor to consumer, an occasional can may infrequently be exposed to conditions conducive to the development of spoilage. Tests results indicate that for a 6 oz can of frozen concentrated orange juice to swell or burst, 3 or more days are required at room temperature, and 5 or more wk at 40 F.

Microbial contamination is controlled in the citrus industry by strict adherence to fruit quality and by maintaining an efficient sanitation program. The diacetyl test is used as a quality control tool to detect microbial activity in processing orange and grapefruit concentrates.

Good housekeeping is an important adjunct to sanitation. One company employs a good housekeeping/safety contest as a method of maintaining a safe and neat-appearing plant. The contest has resulted in improved morale of employees, along with better over-all plant sanitation and efficiency.

Webster defines sanitation as the application of measures to make environmental conditions available to health. Modern usage does not restrict the term to conditions affecting health. According to the Food and Drug Administration, the term must be interpreted broadly encompassing the field of food plant sanitation including conditions that not only lead to contamination of food with microorganisms or other elements dangerous to health, but also filth and other extraneous matter that have no place in food. Sanitation, an integral part of plant operation, is of utmost importance in the production of high quality frozen food products with wide consumer acceptance. It is for this reason that the citrus industry emphasizes sanitation so strongly in its plants. The industry's policy is to give the consumer not just a good product, but the best and finest attainable. At no time does it want the consumer to open a can of citrus concentrate which is "off-flavored" or contains foreign matter. The citrus industry has one of the highest sanitary codes in the frozen food field.

The Florida citrus industry is big business. Last season (1965-66) the on-tree-dollar value was $227,952,000, with 72% of the oranges in the United States produced in Florida, 26% in California, and the remainder in Texas, Arizona and other states *(3)*. This season (1966-67) an estimated 147,000,000 boxes of oranges will be produced in the state of Florida. Over 50% of the orange crop annually is used for the production of frozen concentrated orange juice. Processing this tremendous volume has led to the development of the most modern equipment and processing technique.

Processing Frozen Orange Concentrate

The processing of frozen orange concentrate is briefly reviewed below. At most plants fruit is received by truck, dumped onto a conveyor system, graded for maturity and soundness, stored in bins, washed, regraded, and sanitized prior to entering the extractors. Juice leaving the extractors passes through a series of finishers which remove the seeds and pulp. Product, prior to entering the evaporators, is pumped to large storage tanks which are either held under atmospheric pressure or vacuum. In the evaporators juice is concentrated to the desired solids content measured as degrees Brix. It is flash-heated to reduce enzyme activity, and thus retard separation and gelation. The concentrate then enters the blending tanks where it is mixed with fresh juice to replace some of the volatile constituents which were lost during evaporation. In some plants volatile essence is recovered and restored to the product along with cutback juice. The blended (45 ° Brix) product is either pumped through votators where it is slush-frozen or to cold wall tanks prior to filling into cans. The finished canned concentrate is quick-frozen in a blast or alcohol freezer, cased, and stored in a cold

[1]Presented at the 54th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Miami Beach, Florida, August 14-17, 1967.

storage warehouse at 0 to –10 F until shipped through commercial channels to the market.

The frozen citrus concentrate season in Florida usually starts in December and extends into June of the following year. Operation during this period is usually 7 days a wk and 24 hr a day. At the end of the season's operation all equipment is given a thorough renovation. Most plants, during the summer months, make necessary equipment changes to eliminate processing "bottlenecks" which have shown up the previous season. Occasionally certain phases of the processing operation are completely modified to improve manufacturing efficiency. An extensive painting program is usually carried out. Buildings are painted both inside and out where needed. Equipment is given a thorough overhaul and defective parts replaced. Floors, both concrete and tile, are inspected and repaired as required. Since the citrus industry in Florida is located in a semitropical area, problems associated with high humidity are of concern. Consequently, steps are taken to minimize rust formation by use of rust inhibitors, grease, and by use of paint on equipment where needed.

Prior to the start of seasonal operation all equipment is reassembled and checked to make sure it is in running order. Each plant is inspected to insure that: (*a*) motor guards removed during the summer have been replaced, (*b*) windows are installed where broken or absent, (*c*) doors or windows that require rescreening have been rescreened, and (*d*) plant appearance and housekeeping are satisfactory.

SANITATION PROBLEMS ENCOUNTERED DURING PROCESSING SEASON

Up to this point, the operations that are generally followed by the citrus industry during their off-season have been briefly discussed. Now, some of the sanitary problems encountered during the processing season will be mentioned. However, before proceeding, mention should be made of the microflora encountered in processing frozen concentrated orange juice.

Significance of pH

The pH of citrus concentrate, excluding lemon and lime, which averages from 3.4 to 4.0, makes this product unique in comparison with other food products. Citrus juices, therefore, act similar to a differential plating medium in that they restrict the growth to only those organisms capable of tolerating this acid environment. Consequently, enteric organisms such as *Salmonella* and *Shigella* types cannot survive for long periods in citrus juices or concentrates *(1, 5)*. Furthermore, the spores of *Clostridium botulinum*, Types A and B, apparently cannot germinate even though they may be present *(18)*. In other words, microorganisms causing food poisoning do not grow, and often die readily in citrus juices and concentrates.

Coliform bacteria have been reported to be present from time to time in frozen citrus concentrates by various public health agencies. In this regard, there are no data to indicate that these organisms actually grow in citrus juices. On the other hand, there is considerable evidence to show that coliform bacteria can retain their viability for extended periods in frozen orange concentrate, but die off rapidly in fresh or reconstituted juice *(2, 5, 19)*. It is the opinion of Dack *(2)*, and others *(7, 8)* that the coliform index of frozen citrus products is of no public health significance. Dack *(2)* also states, "Millions of cans of frozen concentrated orange juice have been consumed without causing any known cases of enteric infections."

Microorganisms capable of growing in citrus products

Up to this point, microorganisms which fail to grow in citrus products have been discussed. Now those capable of tolerating this acid medium will be considered. Organisms known to grow in single strength juices of these acid foods (not including lemon or lime juice) are lactic and acetic acid bacteria, yeasts and molds. Of this group, organisms belonging to the genera *Lactobacillus* and *Leuconostoc* are of prime concern. Lactic acid bacteria are organisms of sanitary significance in processing frozen concentrated orange juice. They impart flavors and odors which have been characterized as similar to "buttermilk" *(6, 7, 15)*.

Fruit handling

One of the most important factors in the production of high grade product is the quality of the incoming fruit. It must be carefully graded prior to juice extraction. If defective fruit entering the extractors is not removed, it will affect the microbial load of the expressed juice (Table 1) and may produce "stale" and "old" fruit flavors in the finished product.

In some plants, fruit is washed prior to bin storage and again before juice extraction. The effect of pre-bin washing was investigated *(16)* and results indicate a decrease in fruit surface contamination occurred immediately after the initial fruit wash. The overall effect of pre-washing was not statistically significant. However, fruit handling equipment (particularly the storage bins) remained in a more sanitary condition, and the washed fruit was cleaner from the standpoint of surface soil up to the point of final brush washing. Graders preferred handling washed fruit and culled more oranges entering bins when they were unwashed. Pre-bin washing did not affect the performance of the final graders (Table 2).

One of the most effective means of removing soil

TABLE 1. RELATIONSHIP BETWEEN QUALITY OF FRUIT ENTERING EXTRACTORS AND CONTAMINATION OF EXTRACTED JUICE[a]

Defects[b]	Frequency of occurrence	Juice sampled before finishers Microorganisms per ml		
(%)		(Min.)	(Max.)	(Avg.)
0	10	1,000	21,000	8,835
4	1	37,000	98,000	67,000
6	1	90,000	120,000	105,000
8	2	47,000	320,000	176,000

[a]Period covered—3 days. Total samples examined—14.
[b]Per cent defects based on examination of 50 oranges collected at random from belt feeding one line of extractors.

from fruit surfaces is the brush washer. It consists of a detergent applicator and a set of rotating brushes. The fruit is thoroughly rinsed prior to leaving the unit. The brush washer is an essential piece of equipment used in all citrus plants, and is generally placed in the line prior to the final graders.

Fruit from the bins to the extractors is transported by a series of conveyor belts and elevators. It is important that this equipment not only be cleaned at periodic intervals, but also kept properly sanitized. This is usually accomplished by placing chlorinated water sprays at strategic locations on the conveyor belts and elevators. The sprays must completely cover the entire width of the belt. Otherwise, dark areas at the edges of the belt consisting of mold and bacterial slime will accumulate (Figure 1). When sprays are positioned to adequately cover the entire belt surface, top as well as the underside, microbial contamination will be kept to a minimum. Likewise, the elevators must be effectively sprayed.

The relationship of chlorine concentration on a conveyor belt feeding a line of extractors and the bacterial counts of expressed juice is shown in Table 3. Data show a 15 ppm chlorine residual held expressed juice microbial population to an acceptable level. Although this concentration of chlorine proved to be effective in the present study *(4)*, it could vary from one installation to another. Chlorine concentration is dependent upon the degree of contamination; length and speed of the conveyor belt; and the number, location and volume of the sprays.

Preparation of juice for concentrate

Up to this point the need of proper grading to insure that only sound fruit enters the extractors, and the importance of maintaining the fruit handling system in a sanitary condition have been discussed. An efficient sanitation program is also needed in processing the juice from the extractors to the finished product.

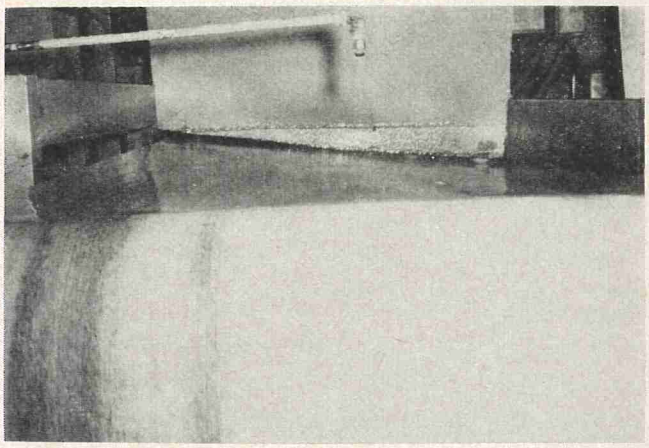

Figure 1. Inadequate coverage of conveyor belt with chlorinated water spray. Dark edges of belt indicate presence of mold and bacterial slime.

The juice extractors, of which there are 2 principal types, Brown (Automatic Machinery Corp.) and the FMC In-line (FMC Corp.), must be flushed with chlorinated water and cleaned with detergent solution at regular intervals. This also applies to the finishers which are used to remove seeds and pulp from the juice. The usual practice at Minute Maid is to flush all juice handling equipment, prior to the evaporators, at 4 hr intervals with water containing between 50 and 100 ppm chlorine. This is a very effective method of controlling microbial buildup.

Evaporators and finished product

Generally speaking, there are two types of evaporators used in the citrus industry, low temperature (approximately 65 to 80 F) and high temperature

TABLE 2. FRUIT CULLED BY GRADERS (WASHED VERSUS UNWASHED FRUIT)

	Unwashed			Washed		
	Total			Total		
	Boxes received	Boxes culled	Per cent culled	Boxes received	Boxes culled	Per cent culled
Fruit to bins	199,031	982	0.493	201,142	749	0.372
Fruit to process	198,049	956	0.483	200,393	1,028	0.513

TABLE 3. GEOMETRIC MEAN BACTERIAL COUNTS OF EXPRESSED JUICE DURING CHLORINATION OF BELTS

Chlorine dosage	No. tests	Count per ml
(ppm)		
5	10	114,000
10	11	105,000
15	14	19,000
20	4	16,000

TABLE 4. AVERAGE DIACETYL VALUES OBTAINED WHEN PROCESSING WASH PULP CONCENTRATE (60° BRIX)

		Avg. ppm of diacetyl		
Evaporator	No. tests	Evaporator feed juice	Pump-out concentrate	Diacetyl % change
Low Temp.	44	0.282	0.323	15 (+)
TASTE	35	0.265	0.171	36 (−)

short holding time units (195 to 200 F). The latter are generally referred to as TASTE evaporators (thermal accelerated short time evaporator). Within the last year or two, the citrus industry has replaced nearly all of their low temperature units with the TASTE evaporator. Product leaving the TASTE evaporator is, for all practical purposes, free from microorganisms *(11)*. On the other hand, an increase in contamination usually occurs in a low temperature evaporator. Table 4 shows a comparison of diacetyl values between juice entering and product leaving a TASTE evaporator in comparison with a low temperature unit when wash pulp concentrate was being processed. Note a 36% decrease in diacetyl occurred in the TASTE evaporator which compares with a 15% increase in the low temperature unit. A similar reduction in diacetyl occurred when the TASTE evaporator was used to process orange concentrate.

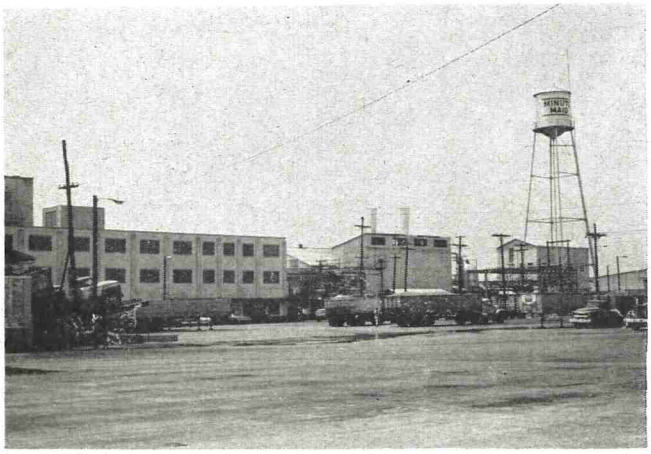

Figure 2. Partial view of a citrus concentrate plant.

Subsequent processing equipment consisting of blending tanks, votators and filler bowls are not a source of contamination during operating periods since concentrate in these units is usually in the temperature range of 25 to 30 F.

Up to this point, sanitation problems encountered from the time the fruit enters the plant to the point where concentrate is placed into the can have been discussed. One would think that there are no more problems after the product has been canned, frozen, cased and placed in primary storage at 0 to −10 F. This is not true. It is entirely possible along the distribution route, between the processor and consuming public, that an occasional can of frozen concentrated citrus juice may be exposed to conditions conducive to the development of spoilage. For example, the consumer may place it in a refrigerator (40 F) or even on the kitchen shelf or in the pantry where the can may explode. Fortunately, these complaints have been exceedingly low, averaging less than 1.5 per 10,000,000 units of 6 and 12 oz cans of frozen concentrated orange juice sold *(10)*.

Lorant *(9)*, in his study on distribution and handling of frozen fruits, vegetables, and juices, states that the major sources of adverse exposure for frozen concentrated orange juice are: (*a*) transport, (*b*) break-up operation, (*c*) retail store, and (*d*) home storage. Of the 4 categories mentioned, the greatest abuse occurs during home storage.

The question is frequently asked, "How long does it take for a 6 oz can of frozen concentrated orange juice to swell or burst when abused?" An investigation *(17)* showed for the cans to swell or burst, 3 days or more were required at room temperature (70-74 F) and 5 wk or more at 40 F. Yeasts were the predominant organisms which grew rapidly in the product stored 5 days at room temperature and were the only ones found capable of growing at 40 F in 42° Brix concentrate (Tables 5 and 6).

Methods used to control microbial contamination

As previously stated, the frozen citrus concentrate industry strives to produce a product that has the appearance and all of the flavor characteristics of freshly squeezed orange juice. How is this possible with large scale production with its inherent sanitation problems? This is resolved by strict adherence to fruit quality and maintenance of an efficient sanitation program. The prerequisites may be briefly stated as follows:

1. Only clean sound fruit must be permitted to enter the extractors.

2. Fruit must be carefully graded before it enters the bins, properly washed, regraded and sanitized prior to juice extraction. If unsound fruit composed of a large percentage of drops, soft deteriorated spots, splits, etc. is permitted to

TABLE 5. SPOILAGE DEVELOPING AT ROOM TEMPERATURE (70-74 F) IN 6 OZ CANS OF ORANGE CONCENTRATE. PRODUCT REPRESENTATIVE OF 2 CITRUS SEASONS

Season	No. cans tested	No. days all cans flat	Days for 1 or more cans to swell		Days for 1 or more cans to burst	
			Days	%	Days	%
1961 Midseason[a]	150	2	3	21	3	2
1961 Valencia	100	2	3	5	3	1
1962 Midseason	100	2	3	1	4	20
1962 Valencia	50	3	4	62	4	16

[a]Samples from 2 plants.

TABLE 6. SPOILAGE DEVELOPING AT 40 F IN 6 OZ CANS OF ORANGE CONCENTRATE. PRODUCT REPRESENTATIVE OF 2 CITRUS SEASONS

Season	No. cans tested	No. weeks all cans flat	Weeks for 1 or more cans to swell		Weeks for 1 or more cans to burst	
			Wk	%	Wk	%
1961 Midseason[a]	150	4	5	10	[b]	[b]
1961 Valencia	100	4	5	3	7	1
1962 Midseason	100	4	5	3	16	2
1962 Valencia	50	5	6	2	8	16

[a]Samples from 2 plants.
[b]Not checked to determine time required to burst.

enter the extractors, it not only contaminates juice room equipment and evaporators, but may also result in stale, old fruit flavors in the finished product.

3. Fruit handling equipment must be kept in a sanitary condition to prevent recontamination of fruit surfaces. Recontamination may result from slimy belts, sizers, elevators, and from the extractors just before the fruit is extracted if they are not cleaned properly. This problem is resolved through the use of chlorinated water which is used as a germicidal rinse to control fruit surface contamination, and as a spray on conveyor belts, elevators, etc. to minimize slime formation.

4. An effective cleaning and sanitizing program must be maintained to prevent contamination by microorganisms during the processing operation. Otherwise microbial growth, if not controlled, may result in yeasty, fermented, and buttermilk-like flavors in the finished product.

DETECTION OF CONTAMINATION BY LABORATORY METHODS

The citrus industry is very fortunate that there is a rapid method, generally referred to as the diacetyl test *(12)*, for the detection of microbial activity in orange and grapefruit concentrates. It is a colorimetric procedure requiring about 30 min for the detection of diacetyl and acetylmethylcarbinol, end products of microbial growth in orange juice principally by those organisms belonging to the genera *Lactobacillus* and *Leuconostoc*. The diacetyl test is used very effectively as a quality control tool during processing operations *(13)*.

Plate counts are also employed by the citrus industry to determine the total number of viable microorganisms in a product. Generally, they are restricted to finished product. However, in some plants juice from various processing operations are plated. These tests are usually referred to by the citrus industry as line checks.

Minute Maid has been able to detect microbial buildup in their processing operations, source of contamination, and determine the efficiency of each clean-up through their biological control program. This is accomplished by making routine diacetyl determinations and line checks. These procedures have also been highly successful in preventing product spoilage.

HOUSEKEEPING—AN ADJUNCT TO SANITATION

The citrus industry has made great strides in improving plant appearance and maintaining good

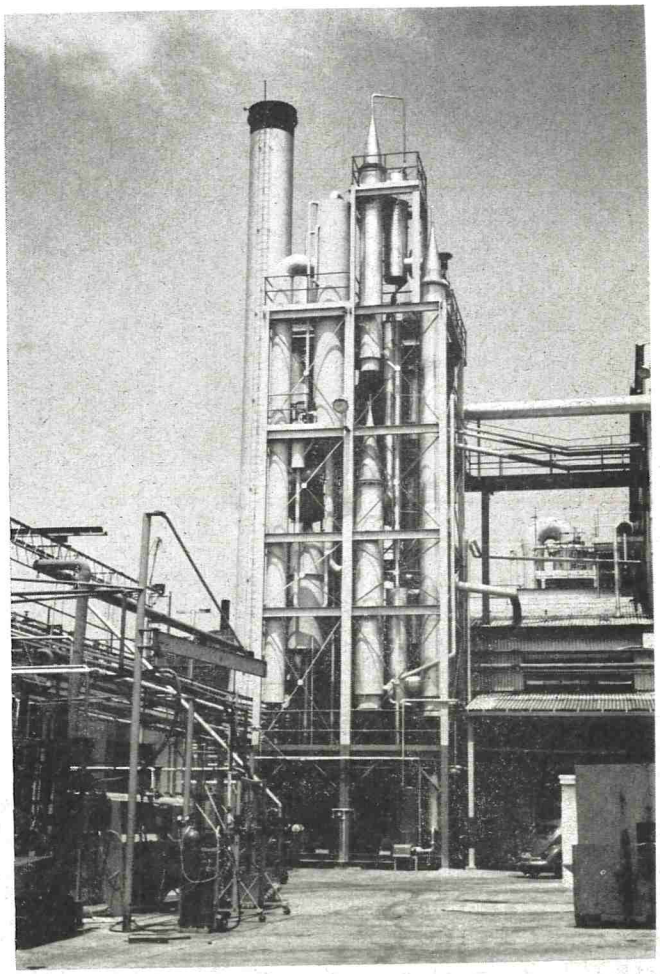

Figure 3. TASTE evaporator typical of the type used in the citrus industry.

housekeeping throughout the processing season. In plants of the Minute Maid Company it was decided this could best be accomplished through a good housekeeping contest *(14)*. Since a clean plant is generally a safe one, a combination was made of both safety and good housekeeping. Posters using a "catchy" slogan announcing the contest are placed in each plant prior to the start of the program. Some examples are: "WANTED — Cleaner and Safer Plants for 1965"; "GET ON TARGET for '–66, Play it Safe, Keep it Clean", and "LET'S ALL PULL TOGETHER for a CLEANER — SAFER 1967." Prizes are awarded as an incentive to keep up interest in the housekeeping program. This year "Safety Sam" was introduced to make employees more safety conscious. A different safety slogan is placed in a plant twice each mo. Employees' names are drawn from a hat, and the first employee to repeat the slogan word for word receives a gift certificate. Since the contest has been in force, a substantial reduction in accident frequency rate has been obtained. For example, during a recent season 1 of our plants received national recognition by working 1,000,000 man-hr without a "lost-time" accident. Morale of employees, over-all sanitation, and plant efficiency have been improved.

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ISU RESEARCH REPORTS ON NEW, PRECISE SUGAR-TESTING PROCEDURE

A highly sensitive method for measuring the content of various sugars in cheese was described recently by an Iowa State University researcher.

A. H. Miah pointed out that even though there are numerous colorimetric methods for determining sugar levels in cheese, they are of limited value because other reducing substances are present.

"It was commonly believed that lactose in cheese disapears within the first 2 weeks after manufacture. However, this new method has been used to find low levels of lactose in cheese several years old," Miah said.

He added that as little as 0.002% of glucose and 0.001% of galactose can be detected by the enzymatic method developed at Iowa State.

THE POTENTIALS OF FREEZE DRYING[1]

WILLIAM FLIEG, JR.

Freeze Dry Products, Inc.
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It is an honor for me to be invited to talk about freeze drying and its potentials. Freeze Dry Products, Inc. has been involved with this industry for five years and has seen it grow from an infant to a young adult. Our young adult has matured quickly during his development. He knew he had potential, but he has gone through some difficult times learning to utilize it. Two directions seem very promising and are paying their own way. There is a third way to go that could utilize the industry's potentials to the fullest.

The first two paths of growth are in the areas of institutional convenience feeding and industrial ingredients. Freeze-dried food offers large institutional feeders quickly prepared foods that handle and store easily as well as assuring uniform quality, flavor and texture each time they are prepared. Dinner entrees, soups, salads and breakfast items are available to the mass feeder now and are doing very well.

The military is an extensive user of freeze-dried foods. In addition to the above advantages they also list ease of shipping and storage as well as making some perishable items available to remote locations. Freeze-dried pouch packed meals for long range patrols are now replacing C-rations. The quality and acceptance has been so good that many soldiers are sending the packets home for their families to try.

By industrial ingredients I am referring to freeze-dried foods which are incorporated with other food products before they are sold to the end user. These ingredients afford the processor a quality dehydrated component that will enhance his final product and is generally easier to store and handle. Freeze-dried chives for dairy products, fruits with cereals, and meats, fishes and poultry for soups and casseroles are some examples.

Before I discuss the industry's third and possibly best area of growth potential, let me quickly explain the process for a fuller understanding of what freeze-dried foods have to offer.

We all know that at sea level water boils at 212°. If we go to Pikes Peak, the boiling temperature is less because there is less pressure. And, if we continue reducing the pressure, the boiling point soon drops to where it is equal to the freezing point of water. At this point, and lower, all water must exist in the form of ice. But, we also have a boiling point at this pressure that causes the ice to change to a vapor of ice crystals without going through the liquid state—a process called sublimation.

The resulting water vapor is collected on refrigerated coils until the product is dry to less than 2% moisture. With proper packaging in a nitrogen atmosphere, and the low moisture content, the final product has a long shelf life.

Because the water leaves the product as a vapor the cell structure is not disturbed and there is no loss of color, flavor, or nutritional values. Also, the vapor leaves so gently that there is no surface hardening or any other objectionable property commonly associated with dehydrated foods. Thus, when you replace the water, the rehydrated product is virtually identical to the original in flavor, texture and appearance.

All of this now brings us to freeze drying's third area of growth potential of offering completely new food products to the market place as well as increasing the availability of foods to new markets. This potential can only be accomplished by close cooperation and great imagination on the part of freeze dryers and the food industry. A number of companies are exploiting this potential right now and it is paying off.

A perishable item as cottage cheese is being sold to Americans living overseas by a meat packing company. They are selling on the average of 7,200 pounds a month and that is in addition to the three million pounds our company sold to the military last year.

Freeze-dried ice cream enrobed in chocolate or other coverings is being used as a candy center. It's crunchy with the definite flavor of ice cream. Freeze-dried ice cream in cereal was also attempted as was the same product in an instant milk shake.

Horseradish kept losing its flavor, even while in a sauce. Now it is freeze dried, milled, and able to be put on the table and dispensed like salt. It releases its flavor when it comes in contact with any moist product.

I could keep citing examples of how a market could be expanded or a new market created by utiliz-

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[1]Presented at the 1968 Kentucky Fieldmen and Sanitarians Conference, Mammoth Cave, Kentucky, February 27 and 28, 1968.

ing freeze drying. It obviously is not the only way, but it is an area to be investigated because of the potential it holds.

We are pleased with the potentials of the freeze-drying industry and with its growth these past years. The direction it will take or the products that will account for the greatest percentage of the business we can only speculate about. In all probability the products that are enjoying success today will be overshadowed by the new ones of tomorrow.

PASTEURIZED MILK BACTERIA SOMETIMES RECOVER

Why does pasteurized milk "sour" after several weeks in the refrigerator?

Scientists have long believed that bacteria somehow entered the milk after pasteurization, but a University of Maryland graduate student has found some bacteria "knocked out" by the heat treatment can and do recover after a period of time. However, he hastened to explain, this does not mean that pasteurization is a poor method of protecting milk.

It simply means that pasteurized milk is not "sterile" milk. Most bacteria are not "harmful"—in fact, some are necessary in the manufacture of butter, cheese and other dairy products.

Mr. Roger Dabbah, working under the supervision of Dr. J. F. Mattick of the University's Dairy Science Department, found that certain kinds of bacteria began multiplying after being totally inactive for 3 days.

Dabbah reported on the work he did in cooperation with Dr. W. A. Moats at the U. S. Department of Agriculture Research Center, Beltsville, Md.

He identified certain psychrophiles in milk. After he heated the bacteria to 55 for 30 min, he transferred them to a series of sealed glass ampules so that no outside bacteria could enter. He opened one of the ampules and found no living bacteria; the other samples were stored for later examination.

Twenty-four hours later he opened one of the ampules and incubated the enclosed material. He continued to do this on a 24 hr period. For the first 2 or 3 days, he found no activity, but then the bacteria began to multiply.

He also observed that the "recovered" bacteria grew as well as similar organisms that had not been heat treated. Dabbah explained, "When bacteria do not multiply, the scientist must assume that there is no life. But, we now have evidence that psychrophilic bacteria do recover after sub-lethal heat treatment."

OFF FLAVORS MAY BE DUE TO AIR POLLUTION

Air in our cities may at times be so polluted that it cannot be used to dry milk without affecting the flavor, a U. S. Department of Agriculture scientist reported recently.

If present indications are borne out in experiments to be conducted this summer, future milk-drying plants may have to be constructed at considerable distances from areas of heavy automobile traffic. Or, milk dryers in such locations will require filters to remove air contaminants.

Scientists of USDA's Agricultural Research Service, doing experimental work on the production of skim-milk powder in Washington, D. C., believe that ozone in the air used for drying is responsible for serious flavor defects they have encountered in making the product during the summer months.

"Consistent appearance of the off-flavors during the hot weather made us suspect that contamination of the air with ozone might be responsible," explained ARS chemist, F. E. Kurtz, of the Eastern utilization research laboratory in Washington. He reasoned that the combined action of sunlight and heat on automobile exhaust fumes can result in the conversion of considerable quantities of these combustion products to ozone.

This seemed a likely source of the off-flavors encountered, since the Washington laboratory is located in a heavy-traffic section of the city. But when the theory was first proposed last fall, the hot weather was over, and satisfactory dried milks were again being produced. To test out the theory, Dr. Kurtz said the scientists intentionally contaminated with ozone the air they were using for drying milk. They found that ozone concentrations as low as 30 to 50 parts per billion—well within the ozone levels that have been reported for polluted city air—were sufficient to produce off-flavors in the dried milks.

Final proof of the theory must await tests to be made this summer when the dryer air will be subjected to analyses for ozone and other contaminants. If, as expected, the levels are high and the same off-flavors reappear, this will establish that dairy products cannot be dried without flavor change where the air pollution is high.

A SANITARY SURVEY OF ICE
I. ICE MANUFACTURE AND VENDING UNITS[1]

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Abstract

A study of the sanitary quality of ice products and manufacturing waters from three Denver plants including coliform, mesophilic and psychrophilic microbial determinations and sediment evaluations was made. Cubed ice from vending units in Fort Collins, Colorado was examined for mesophilic and psychrophilic microorganisms and sediments. Some additional observations are presented.

Generally microorganisms were consistently present in low numbers. The coliform content of ice was extremely low and often they were not present. There were indications that much of the microbial and sediment contamination in ice resulted from environmental or human exposure after manufacture. A variety of foreign particulate matter was observed in both the Denver and Fort Collins ice; however, there appeared to be little correlation between sediment and microbial content. Sanitary control of ice manufacture and dispensing should include sediment testing and microbial determinations to supplement the currently used coliform determinations.

The desire of modern society for chilled foods and beverages, along with vast needs in the preparation, storage, transport, and serving of foods and beverages have created an ever increasing demand for ice. In the past, most of the ice was supplied by commercial plants which produced blocks of ice by mechanical freezing or, to a lesser degree, by cutting natural ice. For several years after the development of the household refrigerator, the ice cubes produced by this appliance seemed to meet family needs. Changing social and recreational habits and increased mobility of the population have created a demand for ice to supplement the household refrigerator supply. To meet these increased needs two major developments have taken place. On-the-premise ice machines are used by most hotels and motels, institutional food services, bars, restaurants and retail food outlets. Also, large number of retail stores, gasoline stations, and roadside vendors have installed ice dispensers (coin-operated or over-the-counter). These units dispense cubed, crushed, chipped or block ice supplied by commercial ice plants or by ice-making machines.

Even though ice is consumed as a food, examination for sanitary quality and the control of manufacture and distribution is often neglected. While freezing is detrimental to large numbers of organisms in a fluid environment, not all bacteria are killed. Also, other foreign matter can be incorporated into ice. The large surface area of crushed or chipped ice makes it particularly vulnerable to environmental contamination. When ice is produced from potable water, the sanitary quality of the product should be superior to that of the water, because freezing inactivates many organisms. In practice, however, the microbial contaminants in ice can approach unsafe levels for human consumption *(3, 6)*. This increase in microbial content was attributed by many investigators to improper and insanitary handling and storage of ice after production *(3, 6, 7)*.

This paper reports the results of a survey of sanitary quality of ice manufacturing of commercial plants in Denver, Colorado and a survey of ice sold at dispensers or storage bins in Fort Collins, Colorado. It also reports sources and types of microbial populations and foreign matter contamination in ice and methods for laboratory testing.

Materials and Methods

The usual laboratory test for sanitary quality of ice is to treat it as a form of water and test for *Escherichia coli* or coliform density. Several investigators have noted that this test may be inadequate because gram-negative bacteria, particularly the coliforms, are more sensitive to freezing than are the gram-positives *(2, 4, 5,* Morrison and McCarron, unpublished data). Therefore in these surveys, in addition to standard coliform testing, total mesophilic (32 C) and psychrophilic (5 C) plate counts (bacteria and yeasts) were performed.

Denver ice plants

Between February 1964 and July 1965, 593 ice and processing water samples were collected in sterile covered glass containers from three ice manufacturing plants in Denver by sanitarians of the Department of Health and Hospitals and transported promptly to the Environmental Health Laboratory where they were analyzed.

The ice samples were placed in a 48-55 C water bath only until they melted. Dilutions of the water and melted ice were plated, in duplicate, using procedures outlined in *Standard Methods for the Examination of Dairy Products (1)*. One

[1]This study was supported by research project EF 00507 of the U. S. Public Health Service.

set of plates was incubated at 32 C for 48 hr before counting and the duplicate plates were incubated at 5 C for 14 days for psychrophiles. Coliform determinations were done by the most probable number method on five 10 ml portions. Counts of viable organisms in ice were reported for 100 ml portions, whereas for processing water, counts per ml were used.

For an approximation of the quantity and type of suspended solids present in ice and processing waters, 500 ml were passed through cotton milk filter pads (0.4 inch) and the resulting sediments compared visually with an arbitrary set of standards established in the laboratory.

Fort Collins vending units

During the period May 1964 to July 1965, 121 samples of ice in the original plastic or paper bags were collected from commercial vending units located in a variety of sites in the Fort Collins area: parking areas, gasoline stations, grocery stores and beverage outlets.

The collection and testing of these samples were done by personnel of the water laboratory of the Department of Microbiology at Colorado State University. In the laboratory, ice was melted in sterile glass containers at 45 C in a water bath. Duplicate 25 and 50 ml samples were passed through filter membranes (Millipore HA, 0.45 μ) and the membranes transferred to absorbent pads, saturated with m-plate count broth (Difco) in petri dishes. One set of plates was incubated at 32 C for 48 hr for mesophilic counts and the duplicates were incubated at 5 C for 14 days. The membrane counts were read under a dissecting microscope *(1)*. Membrane filter detection of coliforms was attempted for approximately the first half of the samples, but the occurrence of coliforms was so infrequent that the method was abandoned.

Sediment detection was carried out as described above.

RESULTS AND DISCUSSION

Denver ice plants

The three Denver ice manufacturing plants (designed A, B, and C) included in this study were quite similar in their basic operational methods. Ice blocks were produced in metal forms which were filled with water and immersed in refrigerated brine. When freezing of the blocks was complete, the metal forms were immersed in a thaw tank to release the ice blocks. The blocks were slid into a cold area for storage or distribution, or were broken up into a variety of smaller units (small blocks, crushed, cubed, chipped or shaved).

The mesophilic and psychrophilic viable microbial (bacteria and yeast) counts found in ice samples from each of the plants are presented in Table 1. Counts were made on samples from the interior of the blocks, on samples composed of a mixture of interior and surface ice and on cubes made by the plant. Mean counts per 100 ml for each group of samples are presented along with the per cent frequency distribution of the counts in arbitrary groups. Although the mesophilic and psychrophilic counts were relatively low in most of the samples, it is interesting to note the infrequency of zero or near zero counts.

At Companies B and C the interior of the ice blocks showed fewer mesophilic and psychrophilic organisms than the block mixtures or the cubes, both by mean count data and per cent frequency distribution of counts. The higher counts of the samples containing surface material and ice that had been through the cutters indicates contamination of the surfaces by the thaw tank, by the slides and floors over which the ice is moved, and by air and human contamination. Thaw tank contamination was observed by Shewan *(7)*. The ice cubes go through the additional exposure of cutting and human handling. The apparent exception to the statements above, seen in Company A, can be explained by the poor quality water this plant was using to fill the metal forms (Table 2).

Consistently the number of ice samples showing coliform organisms was very low. Out of the 250 samples tested, only 10 yielded any coliforms (Table 1), even though 17% of the fill water and 71% of the thaw tank water samples (Table 2) did contain coliforms. Some of these organisms may have been removed from the surfaces of the ice blocks during the brief period of thawing needed to release them from the forms and move them to the storage or process area; however, the greater factor in the low coliforms was probably the sensitivity of these organisms to the temperature of ice.

In the Denver study the numbers of observed psychrophiles and mesophiles were similar. The membrane filter was more efficient than the plate method for detecting psychrophiles. Damage to the psychrophiles by the temperature of melted agar when pouring plates, as reported by Vanderzant and Matthys *(8)* was probably an important contributing factor to depressed psychrophile counts.

Each of the plants accumulated municipal water in tanks to provide the high flow rates needed in production. This storage system appears to be the source of the coliforms that appeared in 17% of the fill water samples (Table 2). Also the table shows that the psychrophile level was similar in samples from each plant and the mesophilic counts were similar in samples from Companies B and C. The high mesophile sample count in A was probably related to the complex processing applied to their water supply; the water was passed through a sand clarifying-charcoal decolorizing-ion exchange system to a storage reservoir.

Two other procedures used by the plants were meant to improve the quality of the ice. Company B scraped and washed the ice block surfaces before cutting; both Company B and C usually removed core water before completion of block freezing and

TABLE 1. FREQUENCY DISTRIBUTION SURVEY OF DENVER PLANT ICE FOR TOTAL COUNTS AND COLIFORMS

Company	Type of ice sample	No. of samples	Total viable counts /100 ml at 32 C: % Frequency distribution 0-9	10-99	100-999	1000-9999	10000+	Mean	No. negative for coliform 0/5	No. of samples	Total viable counts /100 ml at 5 C: % Frequency distribution 0-9	10-99	100-999	1000-9999	10000+	Mean
A	Block interior	28	0	14	64	22	0	710	27	20	5	30	55	10	0	610
	Block mixture	28	0	14	64	22	0	580	27	20	0	45	40	15	0	470
	Cubes	26	0	4	69	27	0	1200	24	19	5	5	58	32	0	900
B	Block interior	29	7	45	48	0	0	190	29	20	25	55	20	0	0	74
	Block mixture	29	0	17	59	21	3	2000	25	19	5	32	32	10	21	6000
	Cubes	27	0	0	63	37	0	1500	25	20	0	10	55	35	0	970
C	Block interior	28	14	18	64	4	0	310	28	19	37	37	26	0	0	82
	Block mixture	28	0	18	75	7	0	860	28	19	16	26	58	0	0	130
	Cubes	27	0	15	70	15	0	530	27	19	5	53	32	10	0	540
Subtotals	Block interior	85	7	26	59	8	0	400	84	59	22	41	34	3	0	260
	Block mixture	85	0	16	66	17	1	1200	80	58	7	34	43	9	7	2200
	Cubes	80	0	6	68	26	0	1100	76	58	4	22	48	26	0	800
Total	All ice	250	2	16	64	17	1	870	240	175	11	32	42	13	2	1100

TABLE 2. FREQUENCY DISTRIBUTION SURVEY OF WATER SAMPLES FROM DENVER ICE PLANTS FOR TOTAL COUNTS AND COLIFORMS

Company	Type of water sample	No. of samples	Total viable counts /ml at 32 C: % Frequency distribution 0-9	10-99	100-999	1000-9999	10000+	Mean	Coliform MPN: % Frequency distribution 0/5	1-3/5	4-5/5	No. of samples	Total viable counts /ml at 5 C: % Frequency distribution 0-9	10-99	100-999	1000-9999	Mean
A	Fill	29	0	0	41	55	4	2500	96	4	0	20	25	30	35	10	440
	Core	29	3	4	69	21	3	1500	96	4	0	20	15	55	15	15	410
	Brine	29	3	66	31	0	0	100	100	0	0	20	5	55	40	0	98
	Thaw	29	0	17	69	14	0	550	24	21	55	20	0	40	55	5	220
B	Fill	29	24	41	28	7	0	330	82	14	4	20	30	40	20	10	300
	Core	28	55	29	11	5	0	76	100	0	0	19	84	11	5	0	51
	Brine	29	76	17	7	0	0	19	100	0	0	20	55	35	10	0	38
	Thaw	29	0	14	55	28	3	1500	3	31	66	20	5	50	35	10	350
C	Fill	28	18	43	25	14	0	280	68	11	21	19	21	32	37	10	350
	Core	28	61	21	18	0	0	67	93	7	0	19	47	27	21	5	130
	Brine	28	46	54	0	0	0	21	100	0	0	19	37	63	0	0	18
	Thaw	28	0	4	93	3	0	460	61	25	14	19	16	68	16	0	40
Subtotals	Fill	86	14	28	31	26	1	1000	83	9	8	59	26	34	30	10	370
	Core	85	40	18	33	8	1	570	96	4	0	58	48	31	14	7	200
	Brine	86	42	45	13	0	0	47	100	0	0	59	32	51	17	0	52
	Thaw	86	0	12	72	15	1	830	29	26	45	59	7	52	36	5	203
Total	All	343	24	26	37	12	1	620	77	10	13	235	28	42	24	6	210

replaced it with fresh water. This core, the last portion of the block to freeze, is cup shaped at the top center of the freezing block. As freezing progresses the ice excludes foreign matter as salts, gases and microorganisms which concentrate in the unfrozen area. The bacteriological data of this study do not show evidence of greatly improved product by either of the above procedures. However, additional more specific studies are needed to evaluate the procedures.

Another variable of operation among the plants for which our data do not provide evidence of preference was the freezing times and temperatures used. Plant A used brine temperature of 8-15 F and a three day period for freezing; Plant B used a temperature near 0 F and a variable freezing cycle of 1-2 days; Plant C used 14-24 F brine temperature and a four day freezing period. As expected, relatively few organisms were detected in the brine waters due to the high salt content.

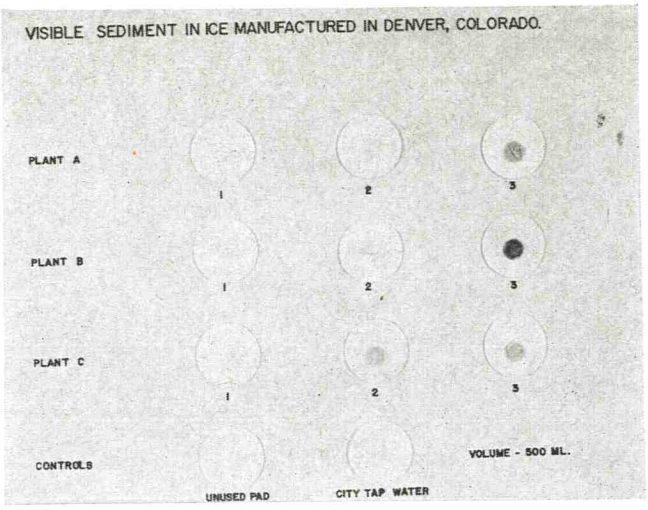

Fig. 1. Typical pads showing sediment from Denver ice samples rated on 0-3 scale.

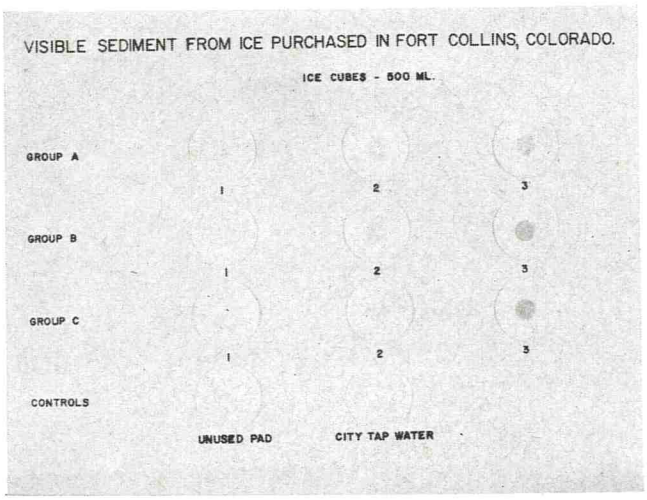

Fig. 2. Typical pads showing sediment from Fort Collins ice samples rated on 0-3 scale.

Table 3. Sediments, rated on 0 to 3 scale, in samples from Denver ice plants and Fort Collins ice dispensers

Company	Type of sample	% Distribution 0	1	2	3	Samples
Denver A	Fill water	50	50	0	0	20
	Ice block interior	10	57	19	14	21
	Ice block mixture	14	45	27	14	22
	Ice cubes	0	10	19	71	21
Denver B	Fill water	78	13	9	0	23
	Ice block interior	23	36	14	27	22
	Ice block mixture	14	50	18	18	22
	Ice cubes	5	5	14	76	21
Denver C	Fill water	60	30	5	5	20
	Ice block interior	0	35	35	30	20
	Ice block mixture	5	53	16	26	19
	Ice cubes	4	14	41	41	22
Subtotals	Fill water	63	30	5	2	63
	Ice block interior	11	43	22	24	63
	Ice block mixture	11	49	21	19	63
	Ice cubes	3	9	25	63	64
Total	All ice	8	34	23	35	190
Denver	City tap water	85	5	10	0	20
Fort Collins A	Ice cubes	0	33	53	14	30
Fort Collins B	Ice cubes	0	10	42	48	52
Fort Collins (C)	Ice cubes	0	56	22	22	27
Total	Ice cubes	0	28	40	32	109

(C) = Sources unknown

Suprisingly, the microbial content of the thaw waters was not unusually high (Table 2). The thaw tanks were large pits below floor level, continuously filled with running water, and emptied weekly. Large amounts of debris were visible in these tanks and high microbial counts were expected.

Table 3 presents the per cent frequency distribution of the sediments in 500 ml samples of the fill water and ice samples from each Denver plant. A pictorial presentation of some typical sediment pads is shown in Fig. 1. While over 90% of the fill water samples showed sediment pads that were rated 0 to 1 (trace), the block ice samples, both interior and mixed, showed a higher number of sediments in cate-

TABLE 4. FREQUENCY DISTRIBUTION SURVEY OF FORT COLLINS ICE TOTAL COUNTS

Origin of ice cubes	Total viable counts /100 ml at 32 C							Total viable counts /100 ml at 5 C						
	No. of samples	% Frequency distribution					Mean	No. of samples	% Frequency distribution					Mean
		1-9	10-99	100-999	1000-9999	10000+			1-9	10-99	100-999	1000-9999	10000+	
Company A	35	14	72	14	0	0	47	44	18	48	32	2	0	140
Company B	54	5	61	30	4	0	150	64	1	20	47	30	2	1000
Unknown (C)	32	0	28	47	22	3	1100	36	11	17	36	25	11	4300
Total	121	7	55	30	7	1	370	144	9	28	40	20	3	1600

gories 2 and 3 with little difference between the interior samples and the samples containing both interior and exterior (mixed) ice. When the ice was cubed, there was a definite increase in foreign matter, almost 90% of the samples rated 2 or 3. This indicates that some of the sediment occurs in the freezing forms, but the bulk of the foreign matter was added during later handling of the ice.

Microscopic study of the sediment pads led to the detection of sand particles, salt crystals, rust, wood slivers, paint flakes and much unidentifiable material. There was no relationship between sediments and microbial content.

Fort Collins vending units

A summary of the results of the microbial content of Fort Collins ice is presented in Table 4; the evaluation of the sediments found in this ice in Table 3. All of the ice samples were either in cubed or cracked form. An attempt to trace the source of the ice was partially successful. Company A used an automatic cube-making machine; Company B made cracked ice by crushing blocks; and C were samples whose source was unknown or were made on the premise. The letter designations are in no way related to the Denver companies.

The mesophilic (32 C) counts of the ice from Companies A and B were somewhat lower than the counts observed in the Denver plants. Although it is impossible to directly compare the water supply or the manufacturing procedures in the manufacture of the Fort Collins and Denver ice, the lower counts were expected because the Fort Collins ice was stored samples, while the Denver ice was fresh. Work in our laboratory has shown the rapid decline of organisms, particularly mesophiles, when stored in ice. Considerably higher mesophilic counts occurred in ice from heterogeneous group C. In this group were liquor stores, gasoline stations and small food stores that filled bags for the purchaser in a very insanitary manner.

In contrast to the Denver study where mesophilic and psychrophilic counts were comparable, the Fort Collins samples yielded higher levels of psychrophiles. The membrane filter determination of psychrophiles was used and yielded higher counts than the pour plate technique. Again the group C samples showed higher counts than those observed for A and B.

The sediments in the Fort Collins samples distributed on our 0-3 evaluation scale similarly to the ice cube samples from Denver. A photograph of some typical pads is presented in Fig. 2. Again no correlation between microbial content and foreign matter was seen.

Microscopic examination showed the same types of foreign matter seen in the Denver ice and also unidentified mucoid slime. To determine if the mesophilic organisms that we were encountering in the counts might be including some potential pathogens such as hemolytic *Staphylococcus* and *Streptococcus* or enterics, duplicate membrane filters were pressed on the surface of blood agar in petri dishes and incubated for 48 hr at 37 C. Colony observation, Gram stains and subcultures, where necessary, were done. No colonies which could be considered pathogenic *Staphylococcus, Streptococcus* or enterics were found in the samples studied. Almost all the mesophilic bacteria observed in ice were gram-positive with rod shaped cells predominating; the psychrophilic organisms were primarily gram-positive bacteria and yeasts.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance and cooperation of the Environmental Health Service of the Denver Department of Health and Hospitals, particularly the field collection and evaluations of Mr. George Barela and the laboratory work by Mrs. Helen Havers.

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ASSOCIATION AFFAIRS

WILLIAM J. DIXON SR.

William J. Dixon, Sr. age 69, Associate Editor of the Journal the past two and one half years and a long time member of International, died Friday, June 14. "Bill" had been in poor health for sometime but his death was unexpected. He was born in Kansas City, Missouri and was Commissioner of Sanitation for the Kansas City Health Department from 1940 until 1948. He resigned in 1948 to become a Vice-President of Klenzade Products, Inc. Beloit, Wisconsin. "Bill" and Alma returned to Kansas City in 1967 after his retirement from Klenzade.

During his tenure with Klenzade he became widely known and liked by everyone who attended the Klenzade Seminars. The work done by "Bill" as Director of the seminars was most outstanding and will always be considered a monumental contribution to the field of sanitation.

He was a member of the American Public Health Association; International Association of Milk, Food and Environmental Sanitarians, Inc.; The Association of Food and Drug Officials of the United States; past president of the Missouri Public Health Association; Mid-Continent Dairy Food & Drug Association and the Dairy Technology of Greater Kansas City.

He will be greatly missed by all his friends in International. Surviving are his wife, Mrs. Alma M. Dixon, 5318 North Virginia Ave., two sons, Robert H. Dixon at home and William J. Dixon, Jr. Claymont, Delaware.

GUY JESSE NAGEOTTE

Guy Jesse Nageotte, Extension Specialist, Dairy Science, at VPI since 1951, died of a heart attack on Wednesday, July 17, 1968, at Radford Community Hospital, Radford, Virginia. He is survived by his wife, Mrs. Eudora D. Nageotte, his father, Mr. Joseph Nageotte, Penn State University, University Park, Pennsylvania, a brother, J. L. Nageotte, Montibello, California and three sisters.

Professor Nageotte served as Dairy Products Specialist at VPI and was very active in many programs relating to quality milk production and processing. He helped conduct annual conferences and training sessions for Dairy Plant Fieldman and Milk Sanitarians. He helped organize and was instrumental in planning outstanding programs for two Dairy Technology Societies in Virginia, as well as serving for many years on the Food Promotion Committee of the American Dairy Association of Virginia. Activities in the latter were centered around plans for the Annual June Dairy Month Program on Milk promotion.

Professor Nageotte prepared a Dairy Herd Management Calendar that received wide acclaim throughout Virginia and many other states as being very useful as a guide on proper milking practices and producing quality milk. The calendar has been used in several states for a period of six years. He was the author of 47 scientific papers dealing with quality milk and milk products. He was a member of the American Dairy Science Association and International Association of Milk, Food and Environmental Sanitarians, Inc.

During the last year he served as staff assistant to the Dairy Task Force Committee of the Commission of the Industry of Agriculture in Virginia. Also he was advisor to the Student Dairy Science Club at VPI.

ABRAHAM W. FUCHS

Abraham W. Fuchs, 76, a retired Sanitary Engineer Director in the United States Public Health Service, who devoted most of his professional life to improving the quality of milk and foods, died on June 25, 1968 in Washington, D. C.

Born in New York City, Mr. Fuchs attended the City grade schools and the Boys' High School in Brooklyn. He was graduated from Cornell University in 1913 with a major in sanitary engineering.

After graduation, he worked for three years as a junior engineer with the Baltimore Sewerage Commission. In 1916 he began a long association with the U. S. Public Health Service—one that was to last until his death.

In the early years of his PHS career, he worked in the area of malaria control in various Southern States. In 1927 he became involved in a specialty that was to become his lifelong concern—milk sanitation. He first conducted milk sanitation surveys in Connecticut and New York for the 1930 White House Conference on Child Health. While working in New York City in 1931 he began laboratory studies for improved bactericidal treatment of milk equipment.

In 1933 he became Assistant Chief of the PHS Office of Milk Investigations in Washington, D. C., and in 1940 was appointed Chief of the Milk and Food Branch of the Sanitary Engineering Division. In this position, Mr. Fuchs helped State and local agencies develop milk and food sanitation ordinances and codes and initiate cooperative programs with industry for a higher quality of milk supplies. During World War II, his attention was directed toward providing adequate milk supplies for critical defense areas and conducting demonstration classes for food handlers. His research focused on sanitary design and adequacy of pasteurization equipment. He developed basic design criteria for leak-protector valves on pasteurizers as well as for milk regenerators. He also developed a plan for the certification of interstate milk shipments to eliminate trade barriers. In 1952 he served as Chief of Health and Sanitation on a special U. S. mission to Israel, and in 1955 served as a Senior Public Health Consultant on a similar mission to Jamaica.

When Abraham Fuchs retired from the Public Health Service in 1956, he had achieved the rank of Sanitary Engineer Director (Captain). In 1963 he received the American Campaign Medal, the World War II Victory Medal, and the National Defense Service Medal.

Mr. Fuchs is the author or co-author of over 80 technical papers on malaria, milk and food sanitation, and health administration. He edited all editions of the PHS Milk Ordinance and Code, Restaurant Ordinance and Code, and Frozen Desserts Ordinance and Code that were issued by the PHS during the years 1933 to 1953. These model ordinances, based on many years of research and field experience, have been widely adopted as State regulations and municipal and country ordinances.

Mr. Fuchs was a member of the American Public Health Association, the Standard Methods Committee for Examination of Dairy Products, the Committee on Food Utensil Sanitation and the International Association of Milk, Food, and Environmental Sanitarians, serving as President in 1949 and as a member of its Executive Board from 1946 to 1952. He was associate editor of the Journal of Milk and Food Technology from 1947 to 1952.

Mr. Fuchs is survived by his wife, Hanna, a son, Richard Fuchs, a daughter, Mrs. Martin Packman, 3 grandchildren, 2 sisters, and one brother.

CHARLES HALLORAN

Charles Halloran passed away in a Sioux Falls, South Dakota hospital Sunday June 30, 1968. Funeral mass was held Tuesday morning at St. Joseph's Cathedral in Sioux Falls. He was graduated from Rock Rapids high school and later from South Dakota State University with a B. S. degree in Dairy Manufacturing and minor in Economics and Bacteriology. He later received a M.S. degree in Dairy Science at Michigan State University in East Lansing.

His research toward the Master's degree was in the field of homogenization of milk under the guidance of Dr. G. Malcolm Trout. Based on his research, several articles on the subject were written and published. He then returned to South Dakota and worked as a creamtester, butter maker, milk inspector, water plant operator and supervisor before starting as an assistant milk specialist with the State Board of Health, being assigned to the Pennington County Health Unit April, 1943.

In September, 1949, he was transferred to Pierre. His duties with the State Department of Health were in the field of Environmental Sanitation. He was the State Milk Survey Sanitation Officer as well as a certified food service sanitation survey officer and has been an invaluable consultant in the entire field of environmental sanitation. Mr. Halloran was a charter member of the South Dakota Association of Sanitarians, and held numerous offices in the organization. He was made an honorary member of the Association upon his retirement in December of 1964. He was, also, a long time member of International Association of Milk, Food and Environmental Sanitarians, Inc. and served on various committees.

Since his retirement, Mr. Halloran has made his home in Sioux Falls, South Dakota, and has spent his winters in St. Petersburg, Florida. Survivors include two sisters, Mrs. Leander Dunker of Sioux Falls, and Mrs. Arthur McKelvey of Aurora; and a brother Martin, of Pipestone.

NEWS AND EVENTS

TRAINING PROGRAM

Training Program, National Communicable Disease Center, Public Health Service, Atlanta, Georgia, would like to announce the presentation of Course 3090-G, "Environmental Control in Health Care Facilities," in Atlanta, Georgia, October 14-18, 1968. This is a course for public health workers and others who are responsible for curbing infection through environmental control activities in hospitals and similar institutions. It will be applicable to those who are assuming these responsibilities for the first time, as well as those with some experience.

The purpose of this course is to provide an opportunity for enrollees to gain an understanding of the hospital administrative structure, and to learn the environmental control activities usually followed for control of infections.

The teaching staff of recognized authorities will be drawn from universities, hospitals, state health departments, private industry, and the Public Health Service.

Anyone interested in attending or in getting further information concerning this course should write to: Chief, Community Services Training Section, Training Program, Room 414, Buckhead, National Communicable Dsease Center, Atlanta, Georgia 30333.

INTERNATIONAL PESTICIDE CONTROVERSY[1]

Current international controversy over pesticide safety could have serious reprecussions for food exporting countries as well as for developing nations.

Dr. Henry Hurtig, pesticide research co-ordinator for the Canada Department of Agriculture, has stated that there was a real danger that the levels for the permissible amounts of pesticides in food may be set so unreasonably low as to jeopardize pest and disease control programs in emerging nations. Dr. Hurtig based his contention on recent experiences at the Food and Agriculture Organization in Rome where he has been chairman of the Working Party on Pesticide Residues since it was established in 1963.

He expressed misgivings "over a conflict of values which appears to be evolving at the international level concerning the safety of some pesticides, particularly the organochlorine insecticides, that is DDT and related compounds". The basic reasons for the controversy appear to be the differences in frequency and scale of need for use of pesticides between food importing and food exporting countries, and differences in the need to use organochlorine and other pesticides in large scale programs for saving lives by controlling disease-carrying insects. Unless the Food and Agriculture Organization and the World Health Organization can resolve this problem through cooperation of member governments, further unnecessary restrictions on the sale and use of pesticides will raise the cost of producing food and create barriers to the export of agricultural products. It could also raise the cost and frequency of control of insects which jeopardize public health in the general environment, including recreational areas.

To be effective, a pesticide must control a pest or disease at a concentration that does not yield a residue in food above the "maximum permissible level" recommended by FAO/WHO experts.

"Acceptable maximum daily human intakes for DDT and all other pesticides are recommended on the assumption that the dose involved will be eaten every day for life and that all food in the diet would contain this maximum permissible level," Dr. Hurtig pointed out. Residue analysis surveys in Canada and the U. S. show that in fact the average residue levels in foods are but a small fraction of the amount provided for by these maximum permissible levels.

If the concentration of a pesticide necessary to control a pest or disease must be at a level that contributes to a residue in human food higher than the maximum permissible level, the pesticide cannot be used as a control agent. Thus, if the legal tolerance of a pesticide in food is established at a level unnecessarily low, the use of such a vitally important pesticide is prevented.

The Canadian expert is also worried that countries will use pesticide regulations in place of tariffs to restrict trade. "Although the values established by these UN agencies' expert committees are ultra-conservative, and in my opinion overly cautious, they are being used in discussions among official delegations of developed countries as a basis for the establishment of even lower values. I am apprehensive that the compromises likely to be negotiated will actually cast doubt on the wisdom of FAO/WHO operational programs involving DDT and other pesticides.

"With these pesticides, WHO is approaching the laudable goal of malaria and yellow fever eradication.

"FAO has similar operational and educational programs for developing countries such as cereal treatment, locust control, and animal insect control to produce and preserve urgently needed food.

"These controversies pose a real threat to solving the immediate problems of food production and disease control. And in the end pesticides will still be the main means for insect control", Dr. Hurtig said.

[1]Reprinted from Food and Drug Research, June 1968, No. 53.

CORNELL RESEARCHERS REPORT NEW FINDINGS AT POULTRY CONCLAVE

At the annual meeting of the Poultry Science Association, July 11, at Texas A&M University, Prof. D. V. Vadehra, poultry scientist from the N.Y. State College of Agriculture, Cornell, said cuticle, which is deposited on the egg shell just before it is laid, plays an important role in preventing bacterial attack.

Eggs with the layer of cuticle can remain fresh as long as 20 days at room temperature, whereas eggs without it spoil within five days.

Even after the cuticle dries out, its protection remains effective for as long as three weeks, contrary to previous belief that the coating material becomes ineffective in its protection after a few days, the Cornell professor said.

Vadehra also reported that eggs from different strains of layers differ considerably in their ability to resist bacterial attack. This finding may serve as a basis for selecting birds that offer better built-in protection.

R. B. Gravani, a graduate student working with Profs. Robert C. Baker, poultry scientist, and Vadehra, told the meeting that the greenish-black discoloration of egg yolk on heating in the presence of albumen (egg white) can be prevented by three different methods, involving uses of various kinds of chemicals in different combinations. These methods, he said, could put an end to the discoloration problem which has become quite serious to the industry because of the greater use of liquid whole eggs.

Another Cornell graduate student, R. J. Hasiak, reported that the egg shell, outer shell membrane, and inner shell membrane together contain 11 different kinds of lipids (fats). It was thought previously that these shell structures had no fats. The finding, he said, is a step toward better understanding of ways in which bacteria infect interior parts of the egg.

VERSATILE DAIRY LABS TEST VARIED PRODUCTS

Wild boar meat in a dairy laboratory? Yes—if the lab is one of those operated by the U. S. Department of Agriculture. Specialty products such as boar meat, dried and frozen eggs, and dehydrated chicken soup are tested by laboratories of the Dairy Division of USDA's Consumer and Marketing Service. The Division has its own laboratories in Chicago and Syracuse. It also employs the lab facilities of the University of Washington under a cooperative agreement and has a contract with a San Francisco commercial lab.

In addition to their regular testing of dairy products in connection with the Dairy Division's grading programs, these labs test both dairy and non-dairy products for industry and other Federal agencies on a fee-for-service basis. One example is blended food product (a mixture of nonfat dry milk, corn meal, soy flour, and vitamins and minerals), which is distributed overseas to help combat malnutrition.

They also test products for other divisions within C&MS as part of the agency's cross-utilization program. This means that Dairy technicians have the training and the equipment to check almost any kind of food product. Often, they may be able to test a certain product more conveniently and economically than the division responsible for the commodity. For example, the Chicago lab has been testing some of the margarine bought by the C&MS Livestock Division because it is near the sites where "samples" of the margarine are taken. The margarine is distributed to the school lunch programs and to needy families.

The range of products tested extends from goose livers, wild boar meat, dehydrated chicken soup, and dried and frozen eggs for the C&MS Poultry Division; mayonnaise and gelatin powders for the C&MS Fruit and Vegetable Division; and margarine for the Livestock Division; to dry cream substitute for the Veterans Administration. For products such as these, the labs can provide a broad range of tests—from routine analysis for fat, moisture, and bacteria content to specialized tests for the presence of pesticides and salmonella. The salmonella bacteria can cause persons to suffer an infection of the digestive tract. The emphasis is on bacteriological testing for the wholesomeness and keeping quality of the product. But in addition, if applicable, checks are also made of such basic factors as the net weight—to make sure the product weighs the amount stated on the label.

The laboratories use standard testing procedures and apply them to the special requirements set up by the agency or firm requesting the service. In testing egg products, for example, the dairy technicians use the requirements set up by the Poultry Division. If requested, though, the Dairy Division can help set up product specifications and test requirements.

Although most of the work is done for government agencies, the labs will, on request, help any plant, industry, or private organization analyze its products. Often, these official tests are used by plant managers as checks on the accuracy of their own plants' tests. This service is also used by firms wishing to check the quality of the products they buy. For example, a large Chicago hotel periodically requests the lab to sample the dairy products it buys and to make a general quality check on them.

The Dairy Division lab technicians are recognized as authorities in the area of quality control of food

products and are frequently asked for their opinions on the effectiveness of certain types of quality control work. This is another way in which they aid industry—and thus ultimately help the consumer to get better products.

ANNUAL ECONOMICS LABORATORY TECHNICAL SYMPOSIUM WATER MANAGEMENT AND WASTE TREATMENT SEPTEMBER 11-12, 1968 M. J. OSBORN RESEARCH CENTER MENDOTA HEIGHTS, MINNESOTA

Again this Fall, Economics Laboratory will conduct a Technical Symposium, and this year the subject will be WATER MANAGEMENT AND WASTE TREATMENT. As in prior years, educators and other technical experts will speak.

The two day program will deal with national and international problems and developments relating to water resources, water reuse, water deionization, advanced waste treatment, eutrophication, bio-degradability, and oil spills, along with new chemical products and processes.

Those invited to attend the Symposium are technical representatives from the following industries:

Meat packing, Canning, Pulp and Paper, Food Service, Appliance Manufacturers, Dairy, Metal Treating and Processing, Refineries and oil companies, Government Agencies, Insurance Underwriters, Oil Shipping Companies and Breweries.

SEMINARS ON AUTOMATED CLEANING AND QUALITY CONTROL TO BE FEATURED AT OCTOBER FOOD AND DAIRY INDUSTRIES EXPOSITION

Sessions to study application of automated cleaning, and quality control techniques for food processing operations will be featured at Food and Dairy Industries Expo in Chicago during the week of October 13-17, 1968.

Announcement of the Food Technology Workshops, which will occur on Tuesday and Wednesday afternoons, October 15 and 16, at the International Amphitheatre, was made by Expo's sponsor, Dairy and Food Industries Supply Association (DFISA). Both sessions begin at 2:00 p.m.

Automated cleaning opportunities in meat processing and marine products processing, and equipment cleanability and design criteria will be discussed at Tuesday's session. The following authorities will speak: Dr. N. B. Webb, professor of food science, North Carolina State University; Dr. Rafael Pedraja, research and development director, Booth Fisheries, Division Consolidated Foods Corp; and Mr. Dick B. Whitehead, chairman, Committee on Sanitary Procedures, International Association of Milk, Food and Environmental Sanitarians, a unit of the 3-A Sanitary Standards Committees.

Flavor evaluation and food quality judging will be covered on Wednesday. The session features three experts: Dr. Amihud Kramer, professor of horticulture, University of Maryland; Dr. Loren B. Sjostrom, vice president, Arthur D. Little, Inc.; and Dr. E. L. Thomas, food science professor, University of Minnesota.

An Exposition "first," Food Technology Workshops are designed to help food processors solve problems arising in their processing operations. The sessions are in addition to the Food Forum, announced earlier and which now is in its third year.

Expo is the largest food show in the U. S. featuring at one time and in one place a total display of items useful to the entire food processing operation. Expected to attract some 20,000 qualified registrants, Expo is held biennially.

UNIVERSITY OF MARYLAND SHORT COURSES

The schedule of dates for the 1968-69 conference season of Dairy Technology short courses and conferences at the University of Maryland are as follows:

24th Annual Dairy Technology Conference, November 13, 1968, Center of Adult Education, University of Maryland.

19th Annual Ice Cream Short Course, January 20-January 29, 1969, Department of Dairy Science, University of Maryland.

19th Annual Ice Cream Conference, January 30, 1969, Center of Adult Education, University of Maryland.

For further information, contact Wendell S. Arbuckle, Department of Dairy Science, University of Maryland, College Park, Md. 20742.

TRAINING PROGRAM

The Training Program of the National Communicable Disease Center would like to announce the headquarters presentation of course number 3240-G, "Administration in Communicable Disease Control," in Atlanta, Georgia, November 18-22, 1968. The course is for persons with administrative responsibility, particularly in the field of environmental health.

The purpose of the course is to provide immediately useful information and practice in administrative functions basic to planning, staffing, managing, and evaluating local health department programs for the environmental control of communicable disease.

The teaching staff will be drawn from the Na-

tional Communicable Disease Center, universities, health departments, and similar organizations.

Anyone who wishes to attend or who would like more information about this course should write to Chief, Teaching Reference Community Unit, Community Services Training Section, Training Program, Room 414 Buckhead, National Communicable Disease Center, Atlanta, Georgia 30333.

SANITARIAN CAREER SERVICE BOARD ESTABLISHED

The Department of Health, Education, and Welfare recently established at the Department level a Sanitarian Career Service Board. Mr. Darold W. Taylor, Sanitarian Director in the Public Health Service, was named Chairman of the Board by Secretary Wilbur J. Cohen on June 20, 1968.

Other members of the Board are as follows: Richard Clapp, Francis J. Goldsmith, John E. LaPlante, Jerrold M. Michael, William C. Miller, Warren V. Powell, George E. Prime, Samuel M. Rogers, Harold Scott, Patrick A. Thibeau, Dale H. Treusdell, all Public Health Service personnel.

The functions of this Board will be to determine the specialities and grade levels which should be included in the Career Service; to establish the Career development plan for the Career Service; and to administer the plan on a continuing basis. The plan would provide for all aspects of personnel management for covered employees, including long-range manpower requirements planning, recruitment and selection, orientation, counseling and career planning, appraisal of employees for career development purposes, placement, training, records and reports, and program evaluation.

OSU DEVELOPS NEW PROGRAM IN PEST CONTROL SCIENCE

An undergraduate program in Pest Control Science has developed at Oregon State University to enhance career opportunities for interested students and to help meet a shortage of trained workers in pest control services and industries. The program will be offered within the general agricultural curriculum, according to Dean of Agriculture Wilbur T. Cooney. Developed in cooperation with the School of Science, the unique program combines work in botany and plant pathology, chemistry, entomology, zoology, crops, soils and horticulture. Depending upon the interest of the student and his career hopes, the core courses can be supplemented with additional specialized preparation in the biological or physical sciences, agricultural economics and business, or in the agricultural commodity sciences. Dr. Robert L. Goulding of the Department of Entomology will be the coordinator of the program and adviser to students who elect to concentrate in the rapidly-expanding field.

The program will be started this fall. Details are available on request from Dr. Goulding, Department of Entomology, OSU, Corvallis, 97330.

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Milk flows straight through the new Jet-Flo inflation smoothly and quickly. No damming up or whirlpooling. No backflooding to cause vacuum fluctuation on the teat.

The Surge Jet-Flo is built to keep its shape longer. It's stronger, it offers much greater protection against pin holes and cracking. It's a totally new formulation . . . another new dimension in better cow milking from Surge, the people who take dairying seriously . . . like you.

Your Surge dealer has special transparent Jet-Flo inflations to let you see the faster milk flow . . . the gentle massaging action of new Surge Jet-Flo inflations. Fill in the coupon or contact your dealer for a Jet-Flo demonstration on your cows.

*Patent applied for.

SURGE

Please have my local Surge dealer give me a "See-through" demonstration of the new Jet-Flo inflations.
Mail to: Babson Bros. Co.
2100 S. York Rd., Oak Brook, Ill. 60521

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