

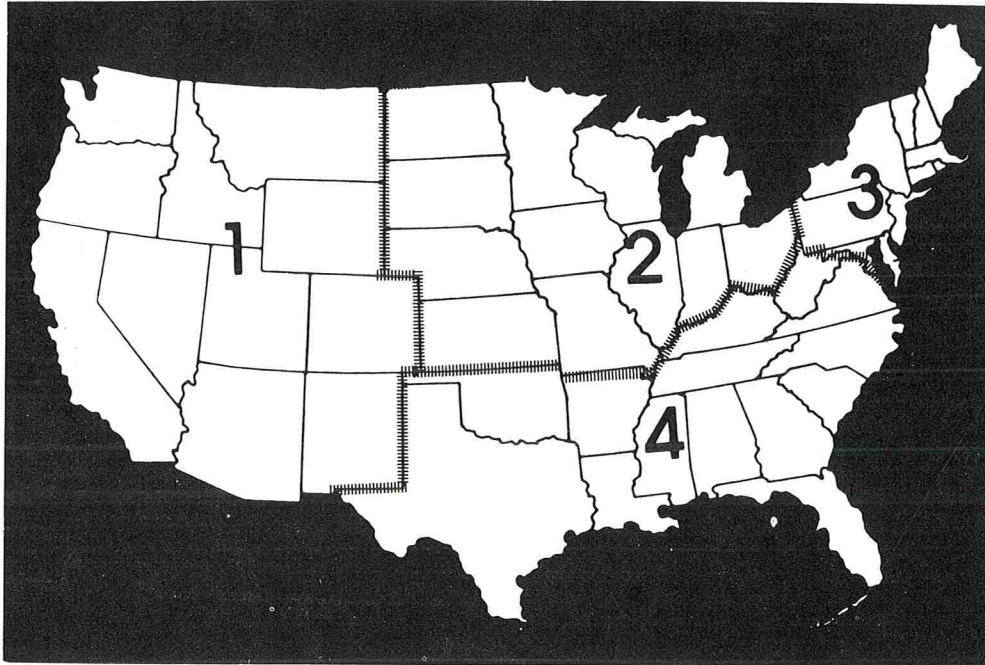
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ROYAL YORK HOTEL
AUGUST 10-13, 1975
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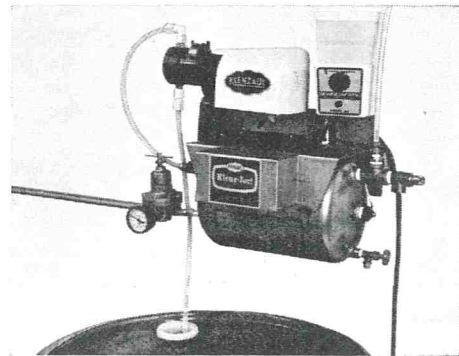
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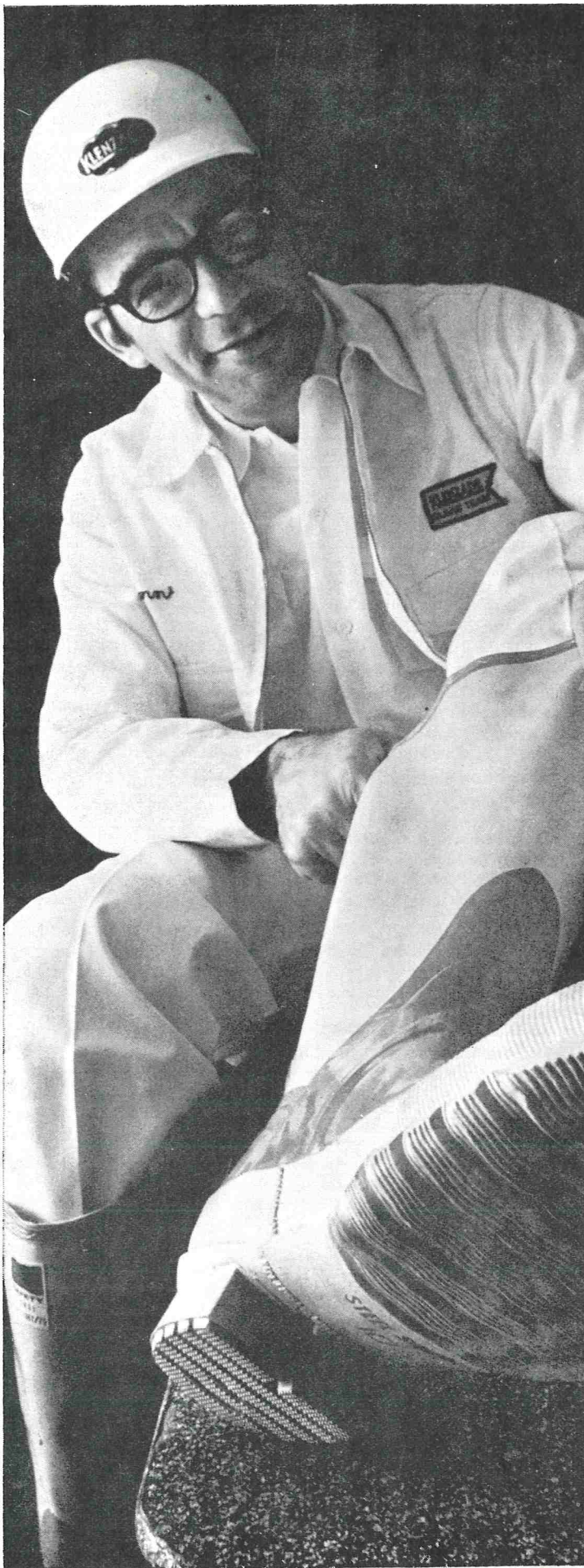
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Chemical Changes in Milk During Exposure to Fluorescent Light

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(Received for publication June 27, 1974)

ABSTRACT

Milk was processed in two commercial plants and packaged in regular paperboard and plastic containers. Gallon containers were held at 40 to 45 F and exposed to 150 foot candles of fluorescent light for (a) 5 h, (b) 10 h plus 14 h in the dark, (c) 24 h plus 9 days in the dark, and (d) 10 days in the dark only. Vitamins A, thiamin, and niacin did not change significantly in milk in paperboard or plastic during storage under the different test conditions. The same was true of 17 amino acids and seven minerals (Fe, Ca, Zn, Mg, Mn, Na, and P). A significant decrease in vitamin C occurred when milk in plastic or paperboard was exposed to fluorescent light for 5, 10, and 24 h. Riboflavin declined in milk in both types of containers when exposed for 10 and 24 h. Vitamin B₆ was significantly less after milk was subjected 24 h to fluorescent light. These decreases were substantially less in milk in paperboard packages than in plastic containers.

With the increasing emphasis on nutritional quality and voluntary labeling, changes in nutrient contents of milk during storage might be a problem. Processors and distributors of milk should be aware of potential decreases of common nutrients after packaging, especially those required on voluntary labeling. Practical means of reducing the losses should be known and precautions taken to minimize them. Consequently, knowledge of the effects and interrelationships of the package and exposure of milk to adverse conditions during distribution, such as fluorescent light in retail stores, is relevant.

The objectives of this investigation were to evaluate changes in certain vitamin, mineral and amino acids in milk under fluorescent light and refrigerated holding conditions that would be indicative of retail distribution in grocery stores. Of interest was the quantitative effects of packaging milk in the regular paperboard and plastic containers on the nutrient decreases in milk.

The adverse effect of light on milk flavor is well known (4, 5, 7, 9, 10, 11, 12, 14). Dimick (6) exposed pasteurized milk to 100 foot candles of fluorescent light for 48 h and examined the milk for off-flavor. There was a detectable off-flavor in milk in blow-molded plastic and clear flint glass containers; however, there was no off-flavor in milk in regular paperboard containers. Other authors (5, 6, 12, 14) have reported more rapid off-flavor changes in milk packaged in plastic and/or clear glass than in paperboard when subjected to sunlight or lights in milk display cases.

After 72 h, the riboflavin loss in paperboard packaged milk was not significant and ranged from 10 to 17% in

milk in plastic or glass (6). Hansen et al. (10) reported that the riboflavin and vitamin C decreased proportionally to the flavor deterioration. Amino acid composition of milk in the three common types of milk containers after light exposure was comparable to the control (6).

EXPERIMENTAL

Milk for the trial was taken at random from two large commercial plants. In one plant milk was standardized to 3.5% milkfat, preheated to 130 F, homogenized at 1300 and 500 psi, pasteurized at 180 F for 17 sec, cooled to 37 F, and simultaneously packaged in regular gallon Pure-Pak containers and blow-molded plastic containers. In the second plant, milk with 3.5% fat was preheated to 125 F, homogenized at 2000 first stage and 500 psi on the second, pasteurized at 172 F for 18 sec, cooled to 36 F, and filled into the gallon paperboard and plastic containers at the same time. Eleven trials were done during November to June.

An attempt was made to simulate average conditions in grocery store display cases for fluorescent light exposure. The gallon containers were placed close together and fluorescent light adjusted to 150 foot candles within 2 inches of the top of the containers. Temperature was 45 F ± 2 for the first two trials and the lowered to 40 F ± 2 for the remaining nine trials. Other samples were held in a dark refrigerated room at same temperature. One set of samples (control) was analyzed at the beginning and another set at the end of the 10-day trial period. After being held overnight at 40 F samples of milk in both types of containers were exposed to the fluorescent light for 5 h (group 1), 10 h (group 2), and 24 h (group 3). Group 2 and group 3 were placed in the dark at 40 F for 14 h and 9 days, respectively.

Vitamin A was determined by the method of Thompson et al. (17). Thiamin and riboflavin were analyzed according to the methods in *Methods of Vitamin Assay* (2). The L-ascorbic acid (vitamin C) procedure was taken from *Methods of Vitamin Assay* (3). The *Official Methods of Analysis* of AOAC, (1), was the reference for the niacin test except the Technicon Auto Analyzer I was used including the automatic dialyzer to remove interfering substances.

Minerals (calcium, iron, sodium, zinc, copper, manganese, magnesium, phosphorus) were determined by the procedure of Kenworthy (13). The cup-plate method of Zoet (18) was used for the vitamin B₆ assay. *Saccharomyces carlsbergensis* was the test microorganism for these trials. The amino acids were determined with a Beckman Sonco Automatic Amino Acid Analyzer Model 120 C, according to the basic procedure of Spackman et al. (16).

Data on analyses for the six vitamins were analyzed statistically. Mean values of samples in paperboard and plastic containers were compared for each storage condition with a one-sided t test. A comparison of the values from control sample with milk in similar containers but held under different conditions was made using Tukey's test and a Studentized range of Rohlf and Sokal (15). Tests for significance were made at the 95% level on the results of the vitamin analyses.

RESULTS AND DISCUSSION

Vitamins

The vitamin A mean values for 11 trials and four treatments dropped slightly when milk was held in both types of containers. The means ranged from 26.7 μg of vitamin A per 100 ml of milk (control) to 23.5 μg in milk packaged in plastic containers and exposed to fluorescent light for 24 h. Statistical analyses indicated no significant difference among the four holding treatments or two types of containers.

The maximum mean decrease of thiamin expressed as μg of thiamin HC1 per 100 ml of milk was 0.8 μg when milk was subjected to any of the four treatments and two types of containers. This change was not statistically significant. Values for controls, among the individual trials during the 8 months, ranged from 48.0 to 41.3 μg per 100 ml of milk.

Vitamin B₆ was expressed as μg of pyridoxine HC1 per 100 ml of milk. No significant differences were found among the control samples and those held 5 to 10 h under fluorescent light. There was a small but significant decrease (32.4 vs 30.5 μg) in milk in plastic containers subjected to 24 h of fluorescent light. Values for milk in the paperboard containers did not decrease significantly (32.6 vs 31.7 μg) under the same three treatments.

Niacin values (μg per 100 ml of milk) varied slightly

among the trials, but the means declined from a maximum of 98.5 μg (control) to 94.9 μg in plastic packaged milk and 99.3 to 95.0 μg in the milk in paperboard containers among the severest of the four storage treatments. These means were not significantly different.

The values for riboflavin are presented in Table 1. Riboflavin in milk packaged in plastic and held 10 h under the fluorescent light declined 7.3% (mean), whereas that in milk in paperboard containers declined 4.0%. When the results from Trial 1 are omitted the means in μg of riboflavin are: control 169.2, for 5 h of light 163.8, 10 h of light 162.6, and 24 h of light 161.6 for milk packaged in the paperboard samples. The mean values of riboflavin in the corresponding samples packaged in plastic were 170.7, 161.7, 158.3 and 153.4 μg , indicating a significant decline as the fluorescent light exposure time increased to 24 h.

Vitamin C is known to be unstable, and results shown in Table 2 confirm the adverse effect of fluorescent light on vitamin C in milk. As the exposure to fluorescent light increased from 5 to 24 h, substantial decreases in vitamin C occurred. Milk in plastic containers in five of the nine trials had 0 μg of vitamin C per 100 ml of milk after the 24 h exposure and 9 days at 40 or 45 F. The mean decrease in vitamin C when milk was held 10 days

TABLE 1. Influence of fluorescent light and storage at 40 or 45 F on the riboflavin in milk¹

Trial No.	Paperboard containers					Plastic containers				
	Control	5 h light	10 h light & 14 h dark	24 h light & 9 days dark	10 days dark	Control	5 h light	10 h light & 14 h dark	24 h light & 9 days dark	10 days dark
1	134.0	128.7	117.0	—	—	125.9	127.7	114.2	—	—
2	144.8	137.7	139.6	132.0	147.5	147.8	138.8	143.3	132.0	148.5
3	172.6	150.8	142.7	134.6	141.8	171.1	144.2	140.2	119.5	141.8
4	191.6	184.2	172.5	171.3	180.3	196.5	182.3	162.7	155.7	180.3
5	168.9	168.9	173.5	169.5	169.5	168.9	166.2	168.4	162.0	169.5
6	169.0	169.0	170.4	170.6	173.6	169.0	166.2	161.9	161.7	172.2
7	175.1	170.2	172.6	168.4	171.0	178.1	170.2	168.1	160.6	169.7
8	158.9	153.5	154.7	163.6	165.1	160.6	151.9	150.0	157.6	165.1
9	177.7	172.5	163.7	175.6	175.6	177.7	168.0	160.9	169.6	178.6
10	164.8	162.8	168.1	161.1	161.1	168.2	162.8	160.8	151.9	159.5
11	168.7	168.2	168.2	168.9	170.3	168.7	166.7	166.7	163.5	167.6
Mean	166.0	160.6	159.4	161.6	165.6	166.6	158.6	154.3	153.4	165.3

¹Expressed as micrograms of riboflavin/100 ml milk

TABLE 2. Influence of fluorescent light and storage at 40 or 45 F on the vitamin C in milk¹

Trial No.	Paperboard containers					Plastic containers				
	Control 0 hours	5 h light	10 h light & 14 h dark	24 h light & 9 days dark	10 days dark	Control	5 h light	10 h light & 14 h dark	24 h light & 9 days dark	10 days dark
3	846	660	515	0	0	856	610	433	0	0
4	939	886	789	650	696	918	546	423	0	567
5	919	908	832	666	744	927	702	373	77	733
6	753	541	427	55	183	718	332	335	0	117
7	738	742	704	298	442	722	550	459	4	33
8	742	705	671	135	181	696	383	202	0	158
9	1199	1176	1135	696	824	1150	858	608	0	570
10	1350	1297	1281	1178	1191	1308	994	973	259	—
11	1282	1244	1138	1041	1114	1255	1116	964	77	1145
Mean	974	907	832	524	597	950	677	530	46	507

¹Expressed as micrograms of L-ascorbic acid/100 ml milk

without light was slightly less than 50% in plastic and 39% in paperboard containers.

Results of the statistical analyses of the means for each of the six vitamins in milk subjected to the four treatments for 11 milk trials are summarized in Table 3.

TABLE 3. Comparison of mean vitamin contents in milk after various treatments when packaged in paperboard and plastic containers

	A	B ₁	B ₂	B ₆	Niacin	C
Control (0 h)	— ¹	—	—	—	—	—
5 h light	—	—	—	—	—	+pb
10 h light & 14 h dark	—	—	+pn ^{2,3}	—	—	+pb
24 h light & 9 days dark	—	—	+pb	+pb	—	+pb
10 days dark	—	—	—	—	—	—

¹—indicates no significant difference between mean of the paperboard and the plastic containers.

²+indicates a significant difference.

³pb indicates less loss in paperboard container.

Mean values for the least stable vitamin, which was C, indicated a significant decrease in the milk with the three fluorescent light exposure periods. Riboflavin decreased significantly in milk held for the two longer exposure times and vitamin B₆ only for the 24 h exposure in plastic packaged milk. The paperboard container appears to provide better protection from the detrimental effects of the fluorescent light. The mean losses were less in the paperboard packaged milk for each vitamin with a significant decrease. These results agree with the trends reported by Barnard (4) who observed that retail milk samples in paperboard had 12.7% with oxidized off-flavor and 86.1% in blow-molded plastic containers.

Minerals and amino acids

Samples in eight trials were analyzed for seven minerals. Mean values for the minerals in all milks packaged in paperboard or plastic revealed no significant change when the samples were subjected to the three treatments. Minerals found in control samples ($\mu\text{g}/100\text{g}$ milk) were: calcium 119-203, ave 161; phosphorus 110-178, ave 128; sodium 39.5-50.4, ave 44.5; magnesium 13-19, ave 16; zinc 0.12-0.38, ave 0.27; manganese 0.012-0.036, ave 0.015; and iron 0.012-0.036, ave 0.015.

Control samples of milk from three trials using paperboard and plastic containers were evaluated for amino acids content. Average values found in g/100g milk protein were: alanine 2.99, arginine 3.56, aspartic 8.00, cysteine 0.19, glycine 1.73, glutamic 20.30, histidine 3.22, isoleucine 5.47, leucine 9.62, lysine 8.40, methionine 1.65, phenylalanine 4.69, proline 9.16, serine 4.99, threonine 4.25, tyrosine 4.87 and valine 6.92. The three treatments did not cause a significant change in the amino acid contents of the milks. Consequently, with the treatments investigated there were no significant differences in protective effects between the milk packaged in paperboard or plastic containers. Dimick (6) reported no effect of light on the amino acid composition. However, Gregory et al. (9) noticed a 14.9%

decrease in tryptophan when milk in plastic containers was subjected to direct sunlight for 120 min. Finley and Shipe (8) noted that losses of arginine, cysteine, lysine, methionine, tryptophan, and tyrosine were caused by fluorescent light.

Several factors influence the decrease in nutrients, especially vitamins, in milk. The principal factors are stability to the various light sources, kind and intensity of light (specific wave length), exposure time, protective effect of the container, surface area of milk in relation to volume in the package (size and shape of package), and temperature. The milk industry and retail groceries should renew efforts to protect milk and thus reduce nutritional deterioration.

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REFERENCES

1. Association of Official Agricultural Chemists. 1970. Official methods of analysis. 11th ed. Washington, D.C. p. 775.
2. Association of Vitamin Chemists, Inc. 1966. Methods of vitamin assay. 3rd ed. Interscience Publishers, New York, N.Y. p. 127, 158.
3. Ibid. p. 299.
4. Barnard, S. E. 1972. Importance of shelf life for consumers of milk. *J. Dairy Sci.* 55:134-136.
5. Bradfield, A., and A. H. Duthie. 1966. Influence of dairy cases on quality of milk sold in retail food stores. *Univ. Vermont Agr. Exp. Sta. Bull. No. 646.*
6. Dimick, P. S. 1973. Effect of fluorescent light on the flavor and selected nutrients of homogenized milk held in conventional containers. *J. Milk Food Technol.* 36:383-387.
7. Dunkley, W. L., J. D. Franklin, and R. M. Pangborn. 1962. Effects of fluorescent light on flavor, ascorbic acid and riboflavin in milk. *Food Technol.* 16:112-118.
8. Finley, J. W., and W. F. Shipe. 1971. Isolation of a flavor producing fraction from light exposed milk. *J. Dairy Sci.* 54:15-20.
9. Gregory, M. E., A. P. Hansen, and L. W. Aurand. 1972. Controlling light-activated flavor in milk. *Amer. Dairy Rev.* 34(4):10,11, 47-50.
10. Hansen, A. P., L. Y. Turner, and L. W. Aurand. 1972. Effect of fluorescent lights on flavor and vitamins of milk packaged in plastic bottles and methods to prevent deterioration. *J. Dairy Sci.* 55: 678. (Abstr.)
11. Hendrick, H., and H. DeMoor. 1962. The effect of light on milk in glass bottles and cardboard and polyethylene containers. *Neth. Milk Dairy J.* 16:418.
12. Jaynes, H. O. 1973. Plastic jugs pose flavor problems. *Southern Dairy Prod. J.* 92(5):26.
13. Kenworthy, A. L. 1960. Photoelectric spectrometer analysis of plant materials. Proc. 36th annu. meeting Council on Fertilizer Application. p. 39
14. Nordlund, J., L. Junkkarinen, and M. Kreula. 1970. The effect of the packaging method on the quality of beverage milk. 18th Intern. Dairy Cong. 1E:167.
15. Rohlf, F. J., and R. R. Sokal. 1969. Statistical tables. Freeman & Co., San Francisco, Cal.
16. Spackman, D. H., W. H. Stein, and S. Moore. 1958. Automatic recording apparatus for us in chromatograph of amino acids. *Anal. Chem.* 30:1190.
17. Thompson, J. N., P. Erdody, W. B. Maxwell, and T. K. Murray. 1972. Fluorometric determination of vitamin A in dairy products. *J. Dairy Sci.* 55:1077.
18. Zoet, A. 1959. Assay of vitamin B₆ in milk products. *Neth. Milk Dairy J.* 13(4):306.

Efficacy of a Commercial Iodine-In-Oil Teat Dip

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ABSTRACT

A nationally marketed product for dipping cows' teats after each milking was tested for efficacy in preventing new intramammary infection. Teats on one side of the udder of 150 Jersey cows were dipped routinely for 3 months in the elemental iodine-in-oil product at 0.5% iodine concentration and then for 3 months in the product at 1.0% iodine. The opposite teats served as undipped controls. Intramammary infection was determined by evaluation of monthly quarter foremilk samples. At the higher iodine concentration, use of the teat dip had no effect on incidence of new infection; at the lower concentration, it was associated with an increase in new infection by *Staphylococcus aureus* ($P < 0.05$).

Consistent dipping of cows' teats after each milking can reduce the incidence of new intramammary infection by staphylococci and streptococci by about one-half. Such efficacy has been demonstrated for the organic iodine complexes known as "iodophors" at 0.5% or 1.0% concentration (3, 7, 12, 18), for chlorhexidine at 0.2% or 0.5% (8, 11), and for sodium hypochlorite at 4.0% (6, 9). Increasing recognition and acceptance of teat dipping as a mastitis control procedure has led to proliferation of commercial teat dip formulations to currently approximately 50 products (10). The active ingredients and added emollients in many of these products differ widely from those formulations whose use has been supported by independent research.

The Teat Dip Committee of the National Mastitis Council has taken the position that efficacy of a teat dip can be established at present only by controlled studies of incidence of new intramammary infection (13). Such evidence has been offered for few if any commercial products. Results of a study of one novel teat dip formulation are here reported.

MATERIAL AND METHODS

The teat dip selected for study consisted of elemental iodine dissolved in a bland unsaponifiable oil. It was accepted by a major manufacturer of milking equipment for national distribution on the basis of considerable indirect evidence of its efficacy supplied by the manufacturer and has enjoyed wide popularity among dairy farmers.

The dip was tested in the dairy herd of the Dairy Experiment Station, University of Tennessee and U.S.D.A., Lewisburg, in which about 150 Jersey cows were milked in two double, in-line, milking parlors. Before the trial was begun, all cows' teats were dipped after each milking in a commercial iodophor-type teat dip. During the trial, the right-front (RF) and right-rear (RR) teats were dipped in the test material and the left-front (LF) and left-rear (LR) teats were not dipped.

Foremilk samples were collected aseptically from all quarters immediately before milking once a month. They were placed in a freezer overnight and then shipped frozen by air freight to the bacteriology laboratory in Beltsville, Md. Normally, milk samples were plated after 1½ days of frozen storage. No attempt was made to increase the new infection rate through artificial exposure of teats to mastitis pathogens.

The original purchase of the teat dip, with a label concentration of 0.5% iodine as active ingredient, was used for 3 months of the experiment. The second batch, ordered to complete the final 3 months of the planned duration, was found after partial use to contain 1.0% active iodine. This study, therefore consisted of application of the iodine-in-oil dip at 0.5% iodine concentration during 3 months, for a total of 486 cows-months followed immediately by application to the same teats of the product at 1.0% iodine concentration during 3 months, for a total of 438 cow months.

RESULTS AND DISCUSSION

Data in Table 1 show the level and distribution of infection among the control and treated udder quarters of the Lewisburg herd at the beginning and after 3 and 6 months of this study. A serious "bounce back" of new infection on abandonment of teat dipping had been thought likely, but the control quarters in this study showed no such effect. Subsequent microbiological

TABLE 1. Level and distribution of intramammary infection among control and treated udder quarters

Infection status of quarters	Intramammary infection											
	Beginning of study				After 3 months				After 6 months			
	Control		Treated		Control		Treated		Control		Treated	
	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
Uninfected	260	85.8	266	88.4	275	87.3	271	86.3	277	86.8	267	84.2
<i>Staphylococcus aureus</i>	10	3.3	10	3.3	10	3.2	12	3.8	5	1.6	11	3.5
<i>Staphylococcus epidermidis</i>	20	6.6	12	4.0	17	5.4	18	5.7	23	7.2	24	7.6
<i>Streptococcus</i> other than <i>agalactiae</i>	8	2.6	6	2.0	12	3.8	10	3.2	13	4.1	13	4.1
Coliform	4	1.3	7	2.3	0	0	1	0.3	0	0	1	0.3
<i>Pseudomonas</i> sp.	0	0	0	0	1	0.3	1	0.3	0	0	1	0.3
Undetermined	1	0.3	0	0	0	0	1	0.3	1	0.3	0	0

TABLE 2. Numbers of new intramammary infections¹ under natural conditions

Pathogen	Concentration of dip	New infection in successive months								
		1	2	3	Total	4	5	6	Total	
	(%I ₂)		—(No.)—				—(No.)—			
<i>Staphylococcus aureus</i>	0.0	4	1	1	6	1	0	1	2	
	0.5	6	4	4	14	0	0	1	1	
	1.0									
<i>Staphylococcus epidermidis</i>	0.0	3	2	1	6	1	9	1	11	
	0.5	5	1	3	9	2	7	3	12	
	1.0									
<i>Streptococcus</i> other than <i>agalactiae</i>	0.0	6	1	3	10	2	2	2	6	
	0.5	0	4	1	5					
	1.0					4	2	4	10	
Miscellaneous ² and undetermined	0.0	3	0	2	5	0	1	0	1	
	0.5	6	4	2	12					
	1.0					1	2	0	3	

¹Quarters available to become infected averaged 274 and 273 in the undipped and dipped groups, respectively.

²Coliform and *Pseudomonas* sp. infections.

TABLE 3. Maximum numbers of new intramammary infections in the Treatment group which would have been significantly lower than the number of new infections observed in the control group ($P < .05$)

Teat dip concentration	Microbial group	Observed new infections in Control group	Observed new infections in Treatment group	Maximum new infections in Treatment group to be significantly lower than Control group
(%I ₂)		(No.)	(No.)	(No.)
0.5	<i>Staphylococcus aureus</i>	6	14	0
	<i>Staphylococcus epidermidis</i>	6	9	0
	<i>Streptococcus</i> other than <i>agalactiae</i>	10	5	2
	Combined staphylococci and streptococci	22	28	10
1.0	<i>Staphylococcus aureus</i>	2	1	<0
	<i>Staphylococcus epidermidis</i>	11	12	3
	<i>Streptococcus</i> other than <i>agalactiae</i>	6	10	0
	Combined staphylococci and streptococci	19	23	8

examinations of this herd showed that the relatively high incidence of coliform infections observed at the start of this trial was not an annual seasonal occurrence. Judicious use of antibiotic therapy, as advised by the local veterinarian, and maintenance of a closed herd may account for absence of *Streptococcus agalactiae* despite no formal attempt at its eradication.

The monthly accretion of new intramammary infection among control and treated quarters is shown in Table 2. As determined by Student's t-test of the difference of paired comparison means the results for control and treated groups are not different, except that the rate of new *Staphylococcus aureus* infections among quarters subjected to the iodine-in-oil dip at 0.5% iodine concentration was higher than the rate among control quarters ($P < 0.05$). Thus, use of the iodine-in-oil teat dip was completely ineffective in preventing new intramammary infection. We are unable to explain at this time the apparent enhancement of intramammary infection by *S. aureus* at the lower iodine concentration. Extrapolating from observations that the actual site of multiplication of micrococci in human skin seems to be sebaceous glands (4, 5) and that the skin of the cow's teat is devoid of sebaceous glands, repeated application of oil may possibly improve the teat skin as an environment for staphylococcal multiplication.

The numbers of new infections observed in the Control

group of udder quarters were sufficiently large in almost all infection categories to permit statistically reliable demonstration of dip efficacy among quarters in the Treatment group. This is shown in Table 3, in which we list for each group of pathogens likely to be influenced by germicidal teat dipping the maximum number of new infections among the Treatment group of udder quarters which would have been significantly lower than the number of infections observed among the Control quarters ($P < .05$). For staphylococci and streptococci combined, the minimum group differences required for statistical inference correspond to 56% reduction in new infection rate by the teat dip containing 0.5% iodine and 58% reduction by the teat dip containing 1.0% iodine. Efficacy of this magnitude has been demonstrated for other commercial teat dips (8, 12, 18).

The high standard of management practiced in this herd and previous consistent use of an effective teat dip were reflected in a quite low level of intramammary infection at the beginning of the experiment and in a low rate and probably atypical species distribution of new infection during the study. Since one third of the new intramammary infections were caused by *Staphylococcus epidermidis*, their exclusion would have seriously hampered analysis of the results. Previous work in this laboratory on an assay of skin sanitization by teat dips has shown essentially no difference in response between

S. aureus and *S. epidermidis*. The advisability of including *S. epidermidis* among intramammary pathogens has been much debated. The common practice has been to ignore the species, probably because its infections do not often result in acute mastitis. The primary concern of the dairyman, however, is for production of salable milk. There is considerable evidence that *S. epidermidis* infection is prevalent among dairy cattle and that it can reduce milk production and also increase the somatic cell concentration of milk sufficiently to threaten its acceptability under abnormal milk control regulations. Thus, Stabenfeldt and Spencer (14) found in 12 of 13 quarters shedding *S. epidermidis* focal changes which, although milder and less extensive than those seen in *S. aureus* infected quarters, were clearly inflammatory and accompanied by atrophy. Ward and Schultz (17) estimated the somatic cell concentration by the filter-DNA method in quarter milk samples from 225 cows. Among 625 uninfected quarters it averaged 314,000/ml, whereas the mean for 58 quarters infected by coagulase-negative staphylococci was 1,432,000/ml. The latter concentration was little lower than that determined for *S. aureus* infected quarters. Their data on relation of quarter milk production to somatic cell concentration suggested that infection by coagulase-negative staphylococci could cause an average depression of quarter milk production approximating 11%. Andriole and Lyons (1) have discussed the recent evidence which is stimulating a similar reassessment of the pathogenicity of *S. epidermidis* in human medicine.

Although the low rate of new infection which we have observed in this herd during the past 18 months of intensive study is presently atypical, widespread adoption of effective teat dipping in combination with dry cow therapy is likely to make this situation increasingly common. Is it reasonable to expect efficacy of teat dipping in prevention of new infection to remain near 50% as a very low level of intramammary infection is approached in the herd? It is likely that the predominating pathogens will be *S. epidermidis*, streptococci other than *S. agalactiae*, and coliforms as found in this herd and in the U.S.D.A. herd at Beltsville (12). Coliforms have not been controlled successfully by teat dipping and research results conflict with regard to streptococci of environmental origin (2, 3, 9). However, to the extent that exposures to dip-susceptible pathogens occur, we have no evidence that the likelihood of dip efficacy will be less than that measured at high infection rate. On the other hand, the possibility exists that some proportion of new infection is introduced in a manner which renders teat orifice sanitization ineffective as a control measure.

One example of this would be the postulated "back jetting" of infected milk droplets into the streak canal or teat cistern during machine milking (15, 16). Infection by such means would explain at least in part the failure of any teat dip to approach 100% efficacy. As control

measures reduce the overall rate of new infection in a herd, this infection route would account for a progressively larger portion of the total new infection and would thus render teat dipping progressively less efficacious. We hope to examine this possibility in the Lewisburg herd.

The dairy husbandmen who participated in this study and maintained close observation of the cattle and of the milking process were unaware of the lack of efficacy of the dip formulation until informed of the trend of bacteriological findings. Indeed, they were impressed with the softness and tone of the skin of the dipped teats. There is a tendency among dairymen, shared by some commercial representatives and researchers, to equate teat skin emollience with antimicrobial efficacy. Our results suggest that cosmetic evaluation can be trusted only for assurance of nonirritancy of a teat dip.

REFERENCES

1. Andriole, V. T., and R. W. Lyons. 1970. Coagulase-negative *Staphylococcus*. Ann. N.Y. Acad. Sci. 174:533-544.
2. Dodd, F. H., F. K. Neave, R. G. Kingwill, C. C. Thiel, and D. R. Westgarth. 1966. The importance of hygiene in the control of udder disease. 17th Inter. Dairy Congr. A(2):383-390.
3. Eberhart, R. J., and J. M. Buckalew. 1972. Evaluation of a hygiene and dry therapy program for mastitis control. J. Dairy Sci. 55:1683-1691.
4. Evans, C. A., W. M. Smith, E. A. Johnston, and E. R. Giblett. 1950. Bacterial flora of the normal human skin. J. Invest. Dermatol. 15:305-324.
5. Lovell, D. L. 1945. Skin bacteria. Surg. Gynecol. Obstet. 80:174-177.
6. Natzke, R. P., and D. R. Bray. 1973. Teat dip comparisons. J. Dairy Sci. 56:148-150.
7. Neave, F. K. 1971. The control of mastitis by hygiene. pp. 55-71. In F. H. Dodd, and E. R. Jackson. (ed.) The control of bovine mastitis. Gresham Press, Old Working, Surrey, England.
8. Neave, F. K., F. H. Dodd, R. G. Kingwill, and D. R. Westgarth. 1969. Control of mastitis in the dairy herd by hygiene and management. J. Dairy Sci. 52:696-707.
9. Philpot, W. N. 1971. What research tells the dairy farmer about mastitis. pp. 3-23. Proc. Tenth Ann. Meet. Nat. Mastitis Coun. February 8-10.
10. Philpot, W. N. 1974. Personal communication.
11. Schultze, W. D., and J. W. Smith. 1970. Effectiveness of chlorhexidine in a postmilking teat dip. J. Dairy Sci. 53:38-45.
12. Schultze, W. D., and J. W. Smith. 1972. Effectiveness of postmilking teat dips. J. Dairy Sci. 55:426-431.
13. Schultze, W. D., and R. J. Eberhart. 1974. Progress toward regulation of commercial teat dips in the United States. Proc. 19th. Inter. Dairy Congr. (In press).
14. Stabenfeldt, G. H., and G. R. Spencer. 1966. The lesions in bovine udders shedding nonhemolytic coagulase-negative staphylococci. Path. Vet. 3:27-39.
15. Thiel, C. C., C. L. Thomas, D. R. Westgarth, and R. Reiter. 1969. Impact force as a possible cause of mechanical transfer of bacteria to the interior of the cows' teat. J. Dairy Res. 36:279-297.
16. Thiel, C. C., C. L. Cousins, D. R. Westgarth, and F. K. Neave. 1973. The influence of some physical characteristics of the milking machine on the rate of new mastitis infections. J. Dairy Res. 40:117-129.
17. Ward, G. E., and L. H. Schultz. 1972. Relationship of somatic cells in quarter milk to type of bacteria and production. J. Dairy Sci. 55:1428-1431.
18. Wesen, D. P., and L. H. Schultz. 1970. Effectiveness of a postmilking teat dip in preventing new udder infections. J. Dairy Sci. 53:1391-1403.

Microbiological Safety and Palatability of Selected Vended Burgers

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ABSTRACT

A total of 52 vended burgers from two vendors were assayed for total aerobic plate counts, coliforms, coagulase-positive staphylococci, salmonellae, and *Clostridium perfringens*. During the first year burgers were obtained from a single vendor, while in the second year two vendors' products were included. Palatability scores were obtained only in the second year of the study. Mean total aerobic plate counts ranged from the high value of 31×10^4 per gram for burgers as obtained to a low value of 84×10^2 per gram after reheating. Only four samples (three as obtained) contained coliforms in low numbers and no coagulase-positive staphylococci were detected. Only five samples were presumptive for salmonellae, and *Clostridium perfringens* was detected in very low numbers when present. It was concluded that these foods were microbiologically safe to consume but that there was a need for product improvement since taste panel ratings for general desirability ranged from fair to poor.

The effects of food processing and storage on the microbial populations of many foods have received much research emphasis, while comparatively little work has been done on the microbiological safety of foods marketed by newer methods such as automatic vending machines. According to Hartley (4) foods distributed through vending machines have shown a continued increase in sales volume. However, only one report directly related to the microbial content of vended food was found in the literature. Khan and McCaskey (6) reported no salmonellae in 13 different types of sandwiches from five vending firms.

Other organisms such as staphylococci and *Clostridium perfringens* can cause foodborne illness. In the 1972 yearly summary of foodborne disease outbreaks (2) 32.5% of the confirmed cases were caused by staphylococci and 16.2% by *C. perfringens*. Salmonellae caused 31.4% of the confirmed cases.

This study was undertaken to evaluate vended foods for known bacterial pathogens and palatability characteristics. Since approximately one-third of the foodborne disease outbreaks reported in 1972 involved meat or meat products and since meat is considered a good growth medium for microorganisms, meat products were chosen for the study. Burgers were selected since microbiological studies on commercially wrapped sandwiches were reported by Adame et al. (1) and McCroan et al. (7).

MATERIALS AND METHODS

Fifty-two samples of vended burgers were analyzed in this two-year study. Microbiological media were obtained from Difco Laboratories, Detroit, Michigan.

In the first year of the study, hamburgers and pizzaburgers were obtained from vendor A once a month for six months. Two samples of each product were obtained from the vending machine. One sample was analyzed as obtained while the second sample was analyzed after reheating at the vending area, in a Litton Industries, Inc. microwave oven, Model No. 500.015 EH. Products from vendor A contained a soy meat extender.

During the second year, hamburgers and pizzaburgers from vendor A were obtained once a month for four months while hamburgers and cheeseburgers from vendor B were purchased once a month for three months. Three samples of each product from each vendor were obtained at one time from the appropriate vending machine. One sample was analyzed as obtained; a second sample was analyzed after reheating in a Litton Systems MenuMaster Oven (a microwave oven), Model No. 70/50; and a third sample, similarly reheated, was used for palatability scoring.

Microbiological examination

Fifty-gram samples including both bun and meat were taken by cutting the circular product into six approximately equal pieces with a knife that had been dipped in 95% ethanol and flamed before use. Two wedges, numbers 1 and 3, numbering clockwise from noon, were removed and if additional sample was needed it was obtained from wedge number 5. Samples were blended for 3 min in a previously sterilized blender jar containing 200 ml of 0.1% peptone water (1:5 dilution). Further dilutions were made in 90 ml of sterile 0.1% peptone water (3).

Pour plates of tryptone glucose extract agar were made for total plate counts, violet red bile agar for coliforms, and sulfite-polymyxin sulfadiazine agar (SPS) for *C. perfringens* (8). For staphylococci, spread plates on Vogel and Johnson agar were prepared with 0.1 ml of the blended sample. Coagulase plasma was used to test for coagulase-positive organisms. Lactose broth and tetrathionate broth were mixed with blended samples for enrichment of salmonellae. Spread plates of MacConkey agar and bismuth sulfite agar were made from each broth after 24 h of incubation (9). Typical colonies from these two selective agars were tested further using triple sugar iron agar (TSI) slants. Samples presumptive for salmonellae were defined as those producing an alkaline slant with an acid butt, with or without gas or hydrogen sulfide on the TSI slants. All plates and tubes were incubated at 35 ± 1 C for 24 ± 2 h, including the anaerobically incubated SPS plates. In addition, Vogel and Johnson plates and selective agar plates for salmonellae were held for 48 ± 4 h before they were considered negative for that particular organism.

Palatability scoring

In the second year of the study, four to five members of the food research staff scored the burgers for palatability characteristics. Buns were scored for shape, crust, texture, grain, color, and flavor while the meat portions were scored for aroma, exterior color, juiciness, tenderness, and flavor. All of the characteristics were rated on a 5-point

basis where 5 corresponded to very good; 4, good; 3, fair; 2, poor; and 1, very poor. Descriptive terms for the highest score for each characteristic were given. General desirability was rated on a 9-interval basis ranging from 5 to 1 with one-half point gradations.

RESULTS AND DISCUSSION

Microbiological examination

A summary of data obtained from microbiological work in the first year of the study is presented in Table 1.

TABLE 1. Microbiological results—Year 1

	Hamburgers		Pizzaburgers	
	As obtained	Reheated	As obtained	Reheated
No. of samples	6	6	6	6
Mean plate count/g	31×10^4	40×10^3	25×10^3	22×10^3
Coliforms				
No. of presumptive samples	2	1	0	0
Mean count/g	5	5	0	0
Coagulase-positive staphylococci	none	none	none	none
<i>Clostridium perfringens</i>				
No. of presumptive samples	4	4	3	3
Mean count/g	21	20	28	22
Salmonellae				
No. of presumptive samples	2	0	0	1

Hamburgers as obtained from vendor A had a mean total aerobic plate count of 31×10^4 per gram. Approximately a ten-fold decrease in the mean plate count occurred after reheating the hamburgers. Mean plate counts from unpublished work in this laboratory were 52×10^5 per gram for raw market hamburger and 56×10^3 per gram for fried hamburger patties. Comparison with raw or cooked hamburger patties is not completely justified since the patties from vendor A contained a soy extender. A second difficulty arises when comparing plate counts of vended hamburgers with other cooked patties since plate counts of the former probably reflect a dilution effect of the bun. Therefore, results of this study are not directly comparable to other figures given in the literature.

In the same year pizzaburgers had similar mean plate counts regardless of the treatment. These counts,

however, were slightly lower than corresponding counts for hamburgers.

Presumptive coliforms were found in small numbers, when present, in the hamburger samples. No coliforms were detected in any of the pizzaburger samples.

As indicated in Table 1, no coagulase-positive staphylococci were detected in any of the hamburgers or pizzaburgers either before or after reheating.

Two-thirds of the hamburgers as obtained were presumptive for *C. perfringens* with organisms ranging from 5 to 40 per gram. After reheating four samples were still presumptive for the organisms with a similar range of 5 to 50 per gram. One-half of the pizzaburgers either as obtained or reheated were presumptive for *C. perfringens* with mean counts similar to those for hamburgers (Table 1).

Two hamburgers as obtained were presumptive for salmonellae while the organisms were not detected after the hamburgers were reheated. None of the pizzaburgers were presumptive for salmonellae as obtained and only one pizzaburger after reheating was presumptive for the organism.

The study was expanded in the second year to include an additional vendor with two similar products. Microbiological data for the second year of the study are summarized in Table 2. Each vendor's products will be discussed separately since the purpose of this study was not to compare vendors but to obtain information on the microbiological safety and palatability of vending machine burgers.

Hamburgers as obtained from vendor A during the second year of the study had total aerobic plate counts ranging from 42×10^2 to 46×10^3 per gram. After reheating the hamburgers had total plate counts from 30×10^2 to 56×10^3 per gram. Comparison of the mean plate counts of hamburgers from vendor A (Table 2) with those of the first year (Table 1) indicates that the former mean counts were lower than those of the first year. However, during the second year there appeared to be little or no reduction in the numbers or organisms after reheating. The latter may be due to the slightly wider range in plate counts for reheated hamburgers as opposed to the range for the hamburgers as obtained or to the very short heating time for burgers in the microwave oven.

TABLE 2. Microbiological results—Year 2

	Vendor A				Vendor B			
	Hamburgers		Pizzaburgers		Hamburgers		Cheeseburgers	
	As obtained	Reheated	As obtained	Reheated	As obtained	Reheated	As obtained	Reheated
No. of samples	4	4	4	4	3	3	3	3
Mean plate count/g	18×10^3	20×10^3	97×10^2	84×10^2	17×10^3	10×10^3	12×10^3	88×10^2
Coliforms								
No. of presumptive samples	0	0	1	0	0	0	0	0
Mean count/g	—	—	35	—	—	—	—	—
Coagulase-positive staphylococci	none	none	none	none	none	none	none	none
<i>Clostridium perfringens</i>								
No. of presumptive samples	2	1	3	2	1	1	1	0
Mean count/g	8	15	23	15	5	5	10	—
Salmonellae								
No. of presumptive samples	1	1	0	0	0	0	0	0

The mean plate counts for pizzaburgers were slightly reduced after reheating (Table 2) and were slightly lower than the mean plate counts for pizzaburgers of the previous year.

Presumptive coliforms were found in only one sample, a pizzaburger as obtained. None of the samples contained coagulase-positive staphylococci. Two of the hamburgers as obtained and one reheated hamburger were presumptive for *C. perfringens*. Three pizzaburgers as obtained and two reheated pizzaburgers were also presumptive for this organism (Table 2).

One hamburger as obtained and one after reheating were presumptive for salmonellae while the organisms were not detected in any pizzaburgers.

Hamburgers and cheeseburgers from vendor B had similar mean total plate counts. Reheating the burgers resulted in a slight reduction in the mean plate counts (Table 2).

None of the samples from vendor B contained coliforms or coagulase-positive staphylococci and no products were presumptive for salmonellae. One of the hamburgers as obtained and one as reheated were presumptive for *C. perfringens*. One cheeseburger was also presumptive for the organisms as obtained (Table 2).

It would appear that total aerobic plate counts of vended products could be used as indicators of product quality. In this small sample, organisms known to cause foodborne illness were entirely absent or present in such small numbers that illness would be very unlikely from the consumption of these products. For example, *C. perfringens* counts as high as 60 per gram in this study are very low compared to 1.6×10^7 to 2.4×10^7 organisms per milliliter used by Hauschild and Thatcher (5) to induce illness in human volunteer experiments. McCroan et al. (7) also found that commercially wrapped sandwiches were safe to consume despite handling and transporting.

The five out of 52 samples that were presumptive for salmonellae might cause some concern. However, the 9.6% incidence of TSI-presumptive salmonellae reported in this study is considerably lower than the 31.4% incidence reported by Khan and McCaskey (6). After additional completed tests they found no salmonellae present in the 646 sandwiches of thirteen different types obtained from vendors.

Palatability scoring

During the second year of the study, burgers from vendors A and B were rated for palatability characteristics and general desirability.

The buns of hamburgers obtained from vendor A were

scored between fair and good by a taste panel while the meat portion received mean scores below 3 (fair) for aroma, interior color, juiciness, and flavor. The hamburgers were given a mean score of 2.79 ± 0.08 for general desirability which is between poor and fair. Similarly buns of the pizzaburgers were scored fair to good, but the meat portion received slightly higher mean scores than did the meat portion of hamburgers. Pizzaburgers received a mean score of 3.24 ± 0.09 for general desirability which corresponded to fair.

Hamburgers from vendor B received mean scores of fair to good for the buns and the meat portions were scored fair to poor for aroma, juiciness, tenderness, and flavor. Hamburgers received a mean score for general desirability of 2.85 ± 0.19 indicating that the product was considered to be slightly below fair. Buns of cheeseburgers received scores similar to those for hamburger buns while the scores for the meat portion were slightly higher. A mean general desirability score of 3.12 ± 0.13 was given to the cheeseburgers indicating a fair product.

Palatability scoring of these products indicated that the eating quality of vended hamburgers, cheeseburgers, and pizzaburgers should be improved. Hamburgers only rated from poor to fair while cheeseburgers and pizzaburgers received slightly higher mean general desirability scores putting them in the fair category.

REFERENCES

1. Adame, J. L., F. J. Post, and A. H. Bliss. 1960. Preliminary report on a bacteriological study of selected commercially prepared, wrapped sandwiches. *J. Milk Food Technol.* 23:363-366.
2. Center for Disease Control. 1973. Foodborne outbreaks. Annual summary 1972. U.S. Dept. of Health, Education and Welfare. Public Health Service. Atlanta, Ga.
3. Food and Drug Administration. 1972. Bacteriological analytical manual for foods. U.S. Dept. of Health, Education and Welfare. Public Health Service. Washington, D.C.
4. Hartley, D. E. 1969. Vending sanitation and safety—a current report. *J. Milk Food Technol.* 32:474-476.
5. Hauschild, A. H. W., and F. S. Thatcher. 1967. Experimental food poisoning with heat susceptible *Clostridium perfringens* Type A. *J. Food Sci.* 32:467-469.
6. Khan, N. A., and T. A. McCaskey. 1973. Incidence of salmonellae in commercially prepared sandwiches for the vending trade. *J. Milk Food Technol.* 36:315-316.
7. McCroan, J. E., T. W. McKinley, A. Brim, and W. C. Henning. 1964. *Staphylococcus* and salmonellae in commercial wrapped sandwiches. *Public Health Reports* 79:997-1004.
8. Nickerson, J. T., and A. J. Sinskey. 1972. Microbiology of foods and food processing. American Elsevier Publishing Co., New York 306 p.
9. Thatcher, F. S., and D. S. Clark. 1968. Microorganisms in foods: their significance and methods of enumeration. University of Toronto Press. Toronto, Canada. 234 p.

Inhibition of *Streptococcus lactis* and *Salmonella typhimurium* by Mixtures of Some Volatile and Non-Volatile Compounds Associated with Milk¹

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ABSTRACT

APT broth inoculated with *Streptococcus lactis* or nutrient broth inoculated with *Salmonella typhimurium* was dispensed into epoxy-lined aerosol cans. Mixtures consisting of blends of fatty acids (10, 100, and 1000 ppm) containing formic, butyric, hexanoic, octanoic, and decanoic acid; amines (5 ppm) containing propyl- and hexylamine; and aldehydes and ketones (10 ppm) containing formaldehyde, acetaldehyde, acetone, 2-butanone, diacetyl, and pentanone were added to cans and they were sealed. Various combinations of fatty acids, amines, and aldehydes and ketones also were tested separately. Bacteria were enumerated at intervals during incubation at 30 or 37 C.

Mixtures of fatty acids at a concentration of 1000 ppm were most detrimental to both organisms. A marked reduction in growth of *S. lactis* also occurred when 100 and 10 ppm of mixed fatty acids were tested. Growth of *S. typhimurium* was generally unaffected by 10 ppm of mixed fatty acids. Mixtures of amines and of aldehydes and ketones were more inhibitory to *S. typhimurium* than to *S. lactis*. Mixtures of all compounds (fatty acids, amines, aldehydes, and ketones) were significantly inhibitory to both organisms.

Streptococcus lactis is one of the most common lactic acid bacteria used to manufacture fermented dairy products, and salmonellae are human pathogens that have appeared in milk products. Milk used to manufacture dairy products may contain numerous volatile and other compounds (13). That these compounds may influence growth of *S. lactis* (1,2,5,6,12,13,15,19-22) and *Salmonella typhimurium* (7,8,11,13,14,18,24) has been demonstrated. Earlier we briefly reviewed this information (16,17). We also reported that higher concentrations (usually 10 ppm or more) of fatty acids, aldehydes, ketones, amines, alcohols, acetonitrile, chloroform, ether, ethylenedichloride, and some sulfur compounds adversely affect growth of both *S. lactis* (17) and *S. typhimurium* (16), when chemicals were tested individually.

Experiments were done to learn how growth of *S. lactis* and *S. typhimurium* is affected by mixtures of some of these compounds at concentrations likely to be present in milk. Results are reported in this paper.

MATERIALS AND METHODS

Chemicals

Fatty acids. A mixture of fatty acids containing 10% formic acid, 25% butyric acid, 22.5% hexanoic acid, 12.5% octanoic acid, and 30%

decanoic acid was used. Withycombe and Lindsay (26) reported that free fatty acids in fresh raw milk may range from 222.8 to 432.2 ppm, and that mixtures of fatty acids in the milk can contain up to 24, 10, 5.7, and 15.5 ppm of C₄, C₆, C₈, and C₁₀ fatty acids, respectively. The formic acid content of heated milk can be as high as 218 ppm depending on heat treatment (9). When 100 ppm of fatty acids were used, the mixture provided 10, 25, 22.5, 12.5, and 30 ppm of formic, butyric, hexanoic, octanoic, and decanoic acid. The pH of nutrient broth with 1000 ppm of mixed fatty acids was 4.65 and that of APT broth with the same amount of acids was 6.35. The pH of either broth was 6.3-6.65 when 10 or 100 ppm of mixed fatty acids were added with or without other chemicals.

Amines. A mixture with equal parts of propyl- and hexylamine was used for these experiments since milk with good flavor contains almost equal amounts of C₁-C₃ and C₄ and higher amines. Since the lowest concentration of total amines in milk with a good flavor was reported to be 5 ppm (4), this concentration was selected for experiments. Amines at the concentrations used had no effect on the pH of either medium.

Aldehydes and ketones. This mixture contained 0.2% formaldehyde, 0.2% acetaldehyde, 10% acetone, 1% 2-butanone, 0.3% diacetyl, and 88.3% pentanone. The basis for choosing this mixture was the fact that milk contains approximately 1 ppm of acetone, 0.1 ppm of 2-butanone, 2 ppb of acetaldehyde, 1 ppb of formaldehyde (27), 30 ppb of diacetyl (23); and 9.5-18 ppm of total ketone bodies (3). The mixture of these compounds was not duplicated completely. Instead, 10 ppm of total aldehydes and ketones and 8.83 ppm of pentanone were used to compensate for compounds that were missing from our blend. The mixture of aldehydes and ketones at concentrations used had no effect on the pH of either medium.

Concentrations of these mixtures used in experiments were: fatty acids-10, 100, or 1000 ppm; amines-5 ppm; and aldehydes and ketones-10 ppm. Mixtures of amines and aldehydes and ketones also were tested in various combinations with 10 and 100 ppm of fatty acids. Thus final concentrations of mixtures of volatile compounds and their combinations tested were as follows: (a) 1000 ppm fatty acids, (b) 100 ppm fatty acids, (c) 10 ppm fatty acids, (d) 5 ppm amines, (e) 10 ppm aldehydes and ketones, (f) 5 ppm amines plus 10 ppm aldehydes and ketones, (g) 100 ppm fatty acids plus 10 ppm aldehydes and ketones, (h) 10 ppm fatty acids plus 10 ppm aldehydes and ketones, (i) 100 ppm fatty acids plus 5 ppm amines, (j) 10 ppm fatty acids plus 5 ppm amines, (k) 100 ppm fatty acids plus 5 ppm amines plus 10 ppm aldehydes and ketones, and (l) 10 ppm fatty acids plus 5 ppm amines plus 10 ppm aldehydes and ketones.

Cultures and media

A 12-16-h old APT broth culture of *S. lactis* C₁₀, obtained from the culture collection of Department of Food Science, University of Wisconsin-Madison, was used in these studies. APT broth (Difco) and APT agar (Difco) were used as growth and planting media, respectively. APT broth was inoculated with sufficient of the culture to yield a final concentration of $5 \times 10^2 - 1 \times 10^3$ organisms/ml, before it was dispensed into cans. All incubations were at 30 C. Approximately 1 h was required before broth in cans attained 30 C.

The culture of *S. typhimurium* used in these studies was obtained from the Department of Bacteriology, University of Wisconsin-Madi-

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son. Sufficient of a 12-16-h old actively growing nutrient broth culture to yield a final concentration of $5 \times 10^2 - 1 \times 10^3$ organisms/ml was added to broth before it was dispensed into cans. Nutrient broth (Difco) and Plate Count agar (Difco) were used as growth and plating media, respectively; all incubations were at 37 C. Approximately 3 h were required before broth in cans attained 37 C.

Procedure

Approximately 50 ml of inoculated broth, after plating to determine the initial number of organisms, was dispensed into epoxy-lined aerosol cans (capacity, about 99 ml) supplied by Continental Can Company, Chicago, Ill. A sufficient quantity of the mixture(s) of compounds to be tested was added to these cans which were immediately sealed, using stainless steel caps without dip tubes. Five cans containing each mixture of compounds were incubated at the appropriate temperature. One set of cans with each mixture of compounds was used to determine the number of organisms/ml after 2, 5, 8, 11, and 14 h of incubation. Plate counts, done according to standard methods (10), were used to enumerate the organisms. The percentage difference in log of population/ml between the sample and the control was calculated to determine degree of inhibition, inactivation, or stimulation of the test organism. Duncan's New Multiple Range test (25) was used to determine if numbers of organisms in treated samples were significantly different from those of controls.

RESULTS AND DISCUSSION

Data recorded in Tables 1 and 2 were obtained when different mixtures of compounds and combinations of

such mixtures were tested against *S. lactis*. Fatty acids at 1000 ppm were markedly bactericidal (31 to 70% reduction in population indicates inactivation). Lower concentrations (10 and 100 ppm) of fatty acids were almost always significantly inhibitory to this organism. The mixture of fatty acids generally was more detrimental to *S. lactis* than were the individual fatty acids when we tested them at the same concentrations (17). Amines (5 ppm) and aldehydes and ketones (10 ppm) were only rarely significantly inhibitory. This was not consistent with what we observed when individual compounds were tested (17). When amines (5 ppm) and aldehydes and ketones (10 ppm) were combined, they never significantly affected growth of *S. lactis*. The mixture of fatty acids (100 ppm) plus amines (5 ppm) and fatty acids (100 ppm) plus aldehydes and ketones (10 ppm) were always significantly inhibitory to *S. lactis* but the magnitude of inhibition was less than that caused by fatty acids alone. When 10 ppm of fatty acids were combined either with amines (5 ppm) or aldehydes and ketones (10 ppm), inhibition was seldom statistically significant. When the mixtures of amines and of aldehydes and ketones were combined either with 10 or 100 ppm of fatty acids, generally significant inhibition of

TABLE 1. Differences in population of *Streptococcus lactis* in APT broth caused by added mixtures of fatty acids, amines, and aldehydes and ketones

Chemicals and concentrations	Differences (%) from control in log of population after hours of incubation				
	2	5	8	11	14
Fatty acids 1000 ppm ^{1,3}	(-31.4*	(-46.3*	(-40.5*	(-50.8*	(-70.0*
Fatty acids 100 ppm ^{1,3}	(- 5.9*	(- 5.3*	(- 2.1*	(- 2.7*	(- 2.9*
Fatty acids 10 ppm ^{1,3}	(- 1.5*	(- 0.2	(- 0.7*	(- 1.4*	(- 0.3*
Amines 5 ppm ^{2,4}	(- 1.2	(- 1.1	(- 1.1*	(- 0.8	(- 1.7*
Aldehydes and ketones 10 ppm ^{2,5}	(- 0.5	(- 1.8	(- 0.8	(- 0.3	(- 1.2*
Amines 5 ppm + aldehydes and ketones 10 ppm ^{2,4,5}	(- 1.2	(- 0.4	(- 0.3	(- 0.2	(- 0.3

¹Control: Log of No./ml 4.04, 5.66, 7.24, 8.91, and 9.21 at 2, 5, 8, 11, and 14 h, respectively.

²Control: Log of No./ml 4.12, 5.65, 7.11, 8.92, and 9.03 at 2, 5, 8, 11, and 14 h, respectively.

³Fatty acids mixture contained: formic acid 10%, butyric acid 25%, hexanoic acid 22.5%, octanoic acid 12.5%, and decanoic acid 30%.

⁴Amines mixture contained: hexylamine 50% and propylamine 50%.

⁵Aldehydes and ketones mixture contained: formaldehyde 0.2%, acetaldehyde 0.2%, acetone 10%, 2-butanone 1%, diacetyl 0.3%, and pentanone 88.3%.

* : Population significantly different from control at 5% level.

TABLE 2. Differences in population of *Streptococcus lactis* in APT broth caused by added mixtures of fatty acids, amines, and aldehydes and ketones

Chemicals and concentrations	Differences (%) from control in log of population after hours of incubation				
	2	5	8	11	14
Fatty acids 100 ppm + aldehydes and ketones 10 ppm ^{1,4,5}	(-1.3*	(-1.7	(-3.5*	(-1.9*	(-1.2*
Fatty acids 10 ppm + aldehydes and ketones 10 ppm ^{1,4,5}	- ⁷	(-0.7	(-1.3	(-0.6*	(-0.3
Fatty acids 100 ppm + amines 5 ppm ^{2,4,6}	(-2.6*	(-2.5*	(-2.9*	(-1.5*	(-0.7*
Fatty acids 10 ppm + amines 5 ppm ^{2,4,6}	(-0.5	(-1.8*	(-1.1*	(-0.4	(-0.1
Fatty acids 100 ppm + amines 5 ppm + aldehydes and ketones 10 ppm ^{3,4,5,6}	(-3.3*	(-2.7*	(-4.2*	(-2.9*	(-1.8*
Fatty acids 10 ppm + amines 5 ppm + aldehydes and ketones 10 ppm ^{3,4,5,6}	(-2.3*	(-1.0*	(-1.8*	(-0.8	(-0.9*

¹Control: Log of No./ml 3.84, 5.79, 7.67, 8.31, and 9.19 at 2, 5, 8, 11, and 14 h, respectively.

²Control: Log of No./ml 3.91, 5.72, 7.34, 8.54, and 9.11 at 2, 5, 8, 11, and 14 h, respectively.

³Control: Log of No./ml 4.00, 5.90, 7.59, 9.07, and 9.15 at 2, 5, 8, 11, and 14 h, respectively.

⁴Fatty acids mixture contained: formic acid 10%, butyric acid 25%, hexanoic acid 22.5%, octanoic acid 12.5%, and decanoic acid 30%.

⁵Aldehydes and ketones mixture contained: formaldehyde 0.2%, acetaldehyde 0.2%, acetone 10%, 2-butanone 1%, diacetyl 0.3%, and pentanone 88.3%.

⁶Amines mixture contained: hexylamine 50% and propylamine 50%.

⁷-: No difference

* : Population significantly different from control at 5% level.

S. lactis was noted. The magnitude of inhibition was greater with 100 ppm than with 10 ppm of fatty acids. Mixtures of compounds including 100 ppm of fatty acids generally were less inhibitory than were 100 ppm of fatty acids alone. When amines plus aldehydes and ketones were combined with 10 ppm of fatty acids, such mixtures generally were more inhibitory than were 10 ppm of fatty acids alone. However, fatty acids alone usually were equally or more inhibitory than fatty acids plus amines or fatty acids plus aldehydes and ketones.

Tables 3 and 4 deal with data obtained when mixtures of compounds were tested against *S. typhimurium*. At 1000 ppm fatty acids completely inactivated *S. typhimurium* in less than 2 h, probably because of the low pH (4.65) of the medium. Fatty acids at 100 ppm were less but always significantly inhibitory to this organism. The smallest amount (10 ppm) of fatty acids had no significant effect on *S. typhimurium*. At both 10 and 100 ppm the mixture of fatty acids was less detrimental to *S. typhimurium* than were the individual fatty acids (16). Amines (5 ppm) and aldehydes and

ketones (10 ppm) generally were significantly inhibitory both as separate mixtures and when combined. Combining aldehydes and ketones with amines yielded a blend that was no more effective and often less so than individual mixtures. Fatty acids (100 ppm), when combined with either 5 ppm of amines or with 10 ppm of aldehydes and ketones, yielded a mixture that always was significantly inhibitory. A mixture of amines (5 ppm) plus 10 ppm of fatty acids was significantly inhibitory only between 5-11 h of incubation; whereas aldehydes and ketones (10 ppm) plus the same amount of fatty acids significantly inhibited *S. typhimurium* only up to 8 h of incubation. Blends of all mixtures [amines (5 ppm), aldehydes and ketones (10 ppm), and fatty acids (10 or 100 ppm)] always were significantly inhibitory to *S. typhimurium*. Blends of mixtures of chemicals generally were more inhibitory to this bacterium than were the individual mixtures.

As previously stated, quantities of compounds used in these experiments were comparable to those found in milk. This is particularly true of amines and of aldehydes

TABLE 3. Differences in population of *Salmonella typhimurium* in nutrient broth caused by added mixtures of fatty acids, amines, and aldehydes and ketones

Chemicals and concentrations	Differences (%) from control in log of population after hours of incubation				
	2	5	8	11	14
Fatty acids 1000 ppm ^{1,3}	NG ^{6*}	NG*	NG*	NG*	NG*
Fatty acids 100 ppm ^{1,3}	(-2.7*	(-2.3*	(-2.5*	(-1.4*	(-1.8*
Fatty acids 10 ppm ^{1,3}	7	-	(+)0.3	(-)0.1	(-)0.1
Amines 5 ppm ^{2,4}	(-2.4*	(-1.5*	(-1.1*	(-)0.4	(-)1.0*
Aldehydes and ketones 10 ppm ^{2,5}	(-3.8*	(-1.3*	(-)0.9*	(-)1.2*	(-)1.0*
Amines 5 ppm + aldehydes and ketones 10 ppm ^{2,4,5}	(-)0.6*	(-1.5*	(-)2.1*	(-)0.6	(-)0.5*

¹Control: Log of No./ml 2.98, 5.57, 7.61, 8.00, and 8.26 at 2, 5, 8, 11, and 14 h, respectively.

²Control: Log of No./ml 3.40, 5.50, 7.54, 8.08, and 8.39 at 2, 5, 8, 11, and 14 h, respectively.

³Fatty acids mixture contained: formic acid 10%, butyric acid 25%, hexanoic acid 22.5%, octanoic acid 12.5%, and decanoic acid 30%.

⁴Amines mixture contained: hexylamine 50% and propylamine 50%.

⁵Aldehydes and ketones mixture contained: formaldehyde 0.2%, acetaldehyde 0.2%, acetone 10%, 2-butanone 1%, diacetyl 0.3%, and pentanone 88.3%.

⁶NG: Less than 10 organisms/ml of test liquid.

⁷-: No difference.

* : Population significantly different from control at 5% level.

TABLE 4. Differences in population of *Salmonella typhimurium* in nutrient broth caused by added mixtures of fatty acids, amines, and aldehydes and ketones

Chemicals and concentrations	Differences (%) from control in log of population after hours of incubation				
	2	5	8	11	14
Fatty acids 100 ppm + aldehydes and ketones 10 ppm ^{1,4,5}	(-)8.0*	(-)6.3*	(-)2.0*	(-)2.1*	(-)2.2*
Fatty acids 10 ppm + aldehydes and ketones 10 ppm ^{1,4,5}	(-)1.6*	(-)2.8*	(-)0.5*	(-)0.1	(+) 0.1
Fatty acids 100 ppm + amines 5 ppm ^{2,4,6}	(-)3.6*	(-)3.2*	(-)2.8*	(-)3.6*	(-)2.9*
Fatty acids 10 ppm + amines 5 ppm ^{2,4,6}	(-)1.6	(-)1.9*	(-)2.2*	(-)1.5*	7
Fatty acids 100 ppm + amines 5 ppm + aldehydes and ketones 10 ppm ^{3,4,5,6}	(-)8.8*	(-)4.6*	(-)4.8*	(-)3.9*	(-)6.1*
Fatty acids 10 ppm + amines 5 ppm + aldehydes and ketones 10 ppm ^{3,4,5,6}	(-)3.8*	(-)3.8*	(-)1.5*	(-)2.2*	(-)2.9*

¹Control: Log of No./ml 3.14, 5.40, 7.41, 8.19, and 8.36 at 2, 5, 8, 11, and 14 h, respectively.

²Control: Log of No./ml 3.05, 5.26, 7.42, 8.30, and 8.60 at 2, 5, 8, 11, and 14 h, respectively.

³Control: Log of No./ml 3.17, 5.50, 7.44, 8.39, and 8.55 at 2, 5, 8, 11, and 14 h, respectively.

⁴Fatty acids mixture contained: formic acid 10%, butyric acid 25%, hexanoic acid 22.5%, octanoic acid 12.5%, and decanoic acid 20%.

⁵Aldehydes and ketones mixture contained: formaldehyde 0.2%, acetaldehyde 0.2%, acetone 10%, 2-butanone 1%, diacetyl 0.3%, and pentanone 88.3%.

⁶Amines mixture contained: hexylamine 50% and propylamine 50%.

⁷-: No difference.

* : Population significantly different from control at 5% level.

and ketones. Fatty acids were tested at several concentrations because at 1000 ppm they were very detrimental to the organisms and thus masked the effect of other compounds. It is evident that mixtures of fatty acids at concentrations approaching the amounts in milk significantly inhibited both *S. lactis* and *S. typhimurium*. Mixtures of amines or of aldehydes and ketones, either separately or combined, did not significantly retard growth of *S. lactis* but they were significantly inhibitory to *S. typhimurium*. Data in Tables 2 and 4 indicate that generally, when mixtures of compounds were blended and tested, growth of both organisms was retarded significantly. This suggests some synergistic action among these volatile compounds.

These experiments were done using broth rather than milk. Milk contains still other compounds that were not included in these studies. These compounds were not investigated because they are present in milk in only minute quantities or are very volatile and thus almost impossible to handle. Hence, results of these experiments are only indicative of how some volatile and non-volatile compounds in milk can affect growth of certain bacteria. Additional studies using certain components of milk in the substrate and involving more compounds are needed to conclusively establish the role of volatile and other compounds in controlling the growth and activity of bacteria in milk.

We reported earlier (16) that higher concentrations (10, 100, and 1000 ppm) of many volatile and non-volatile compounds inhibit *S. typhimurium*. Results of these experiments indicate that low concentrations of some of the compounds, if present as mixtures, also are significantly inhibitory to this organism. However, how the fate of *S. typhimurium* and other potentially hazardous organisms in some foods is influenced by such compounds in suitable amounts, remains to be determined.

Results of these experiments also indicate that generally mixtures of volatile and non-volatile compounds were more detrimental to *S. typhimurium* than to *S. lactis*. If this holds true when both these organisms are grown in milk, then the possible use of some of these compounds to create conditions that favor growth of one and retardation of the other might be considered.

REFERENCES

1. Abo-Elnaga, I. G., L. Abdel-Motaleb, and S. M. El-Gindi. 1972. Effect of various concentrations of formalin on the bacterial flora of milk and growth of some species. *Zentralblatt für Veterinärmedizin B* 19: 479-485. (Food Sci. Technol. Abstr. 5: No. 6P 825, 1973).
2. Anders, R. F., and G. r. Jago. 1964. The effect of fatty acids on the metabolism of lactic acid streptococci. I. Inhibition of bacterial growth and proteolysis. *J. Dairy Res.* 31: 81-89.
3. Bertoni, G. 1965. Variations in the ketone bodies in milk. *Annali Gac. Agr. S. Cuore.* 5: 511-520. (Dairy Sci. Abstr. 29: No. 2474, 1967).
4. Cole, D. D., W. J. Harper, and C. L. Hankinson. 1961. Observations on ammonia and volatile amines in milk. *J. Dairy Sci.* 44: 171-173.
5. Costilow, R. N., and M. L. Speck. 1951. Inhibition of *Streptococcus lactis* in milk by fatty acids. *J. Dairy Sci.* 34: 1104-1110.
6. Costilow, R. N., and M. L. Speck. 1951. Inhibitory effect of rancid milk on certain bacteria. *J. Dairy Sci.* 34: 1119-1127.
7. Daly, C., W. E. Sandine, and P. R. Elliker. 1972. Interactions of food starter cultures and food-borne pathogens: *Streptococcus diacetilactis* versus food pathogens. *J. Milk Food Technol.* 35: 349-357.
8. Goepfert, J. M., and R. Hicks. 1969. Effect of volatile fatty acids on *Salmonella typhimurium*. *J. Bacteriol.* 97: 956-958.
9. Goule, I. A., and R. S. Frantz. 1946. Formic acid content of milk heated to high temperatures as determined by the distillation procedure. *J. Dairy Sci.* 29: 27-31.
10. Hausler, W. J., Jr. (ed). 1972. Standard methods for the examination of dairy products. 13th ed. Amer. Public Health Ass., Inc., New York, pp 71-87.
11. Khan, M., and M. Katamay. 1969. Antagonistic effect of fatty acids against *Salmonella* in meat and bone meal. *Appl. Microbiol.* 17: 402-404.
12. Kulshrestha, D. C., and E. H. Marth. 1969. Effect of volatile compounds associated with milk on lactic acid bacteria. *J. Dairy Sci.* 52: 894-895.
13. Kulshrestha, D. C., and E. H. Marth. 1970. Inhibition of lactic streptococci and some pathogenic bacteria by certain milk associated volatile compounds as measured by the disc assay. *J. Milk Food Technol.* 33: 305-310.
14. Kulshrestha, D. C., and E. H. Marth. 1972. Inhibition of *Staphylococcus aureus* and *Salmonella typhimurium* by some volatile compounds associated with milk. *J. Dairy Sci.* 55: 670.
15. Kulshrestha, D. C., and E. H. Marth. 1973. Inhibition of *Streptococcus lactis* and *Leuconostoc citrovorum* by some volatile compounds associated with milk. *J. Dairy Sci.* 56: 638-639.
16. Kulshrestha, D. C., and E. H. Marth. 1974. Inhibition of bacteria by some volatile compounds associated with milk. II. *Salmonella typhimurium*. *J. Milk Food Technol.* 37:539-544.
17. Kulshrestha, D. C., and E. H. Marth. 1974. Inhibition of bacteria by some volatile compounds associated with milk. IV. *Streptococcus lactis*. *J. Milk Food Technol.* 37:593-599.
18. Levine, A. S., and C. R. Fellers. 1940. Action of acetic acid on food spoilage microorganisms. *J. Bacteriol.* 39: 499-515.
19. Maxcy, R. B., and R. C. Chandan. 1962. Inhibitory effects of fatty acids and other surface active compounds on *Streptococcus lactis*. *J. Dairy Sci.* 45: 654.
20. Nilsson, R., and S. Willart. 1966. Influence of fatty acids on activity of starter culture. *Svenska Mejeritidn.* 58: 253-256. (Dairy Sci. Abstr. 28: No. 2497, 1966).
21. Podesta, A., and G. Bertoldini. 1967. Relationship between fatty acid contents and microflora of milk. I. Inhibitory action of fatty acids on *Str. lactis*, *Str. agalactiae*, *L. bulgaricus*, *Staph. aureus*, *E. coli*, and *B. cereus*. *Boll. Ist. sieroter. Milan.* 46: 548-553. (Dairy Sci. Abstr. 30: No. 3151, 1968).
22. Pozanski, S., A. Surazycki, and T. d'Obyrn. 1968. Fermentation and proteolysis of certain strains of lactic acid bacteria in the presence of fatty acids. *Lait* 48: 261-274. (Dairy Sci. Abstr. 30: No. 3543, 1968).
23. Scanlan, R. A., and R. C. Lindsay. 1968. Quantitative determination of diacetyl by electron capture. *J. Food Sci.* 33: 440-441.
24. Sorrells, K. M., and M. L. Speck. 1970. Inhibition of *Salmonella gallinarum* by culture filtrates of *Leuconostoc citrovorum*. *J. Dairy Sci.* 53: 239-241.
25. Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw Hill Book Co., Inc., New York. pp 107-109.
26. Withycombe, D. A., and R. C. Lindsay. 1969. Evidence for losses of free fatty acids in heated milk. *J. Dairy Sci.* 52: 1100-1104.
27. Wong, N. P., and S. Patton. 1962. Identification of some volatile compounds related to the flavor of milk and cream. *J. Dairy Sci.* 45: 724-728.

Role of Enterococci in Cheddar Cheese: Organoleptic Considerations¹

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ABSTRACT

Eight lots of Cheddar cheese were manufactured with two strains each of *Streptococcus faecalis* and *Streptococcus durans* and subjected to combinations of two early cooling treatments (air vs. brine cooling) and two curing temperatures (7.2 and 12.8 C). The enterococcus cultures were used as supplemental starters in combination with a commercial lactic culture. These cheeses were analyzed for microbiological growth and survival, proteolysis, lactic acid development, free fatty acid appearance, and citric acid utilization—each being compared with a control cheese made without enterococci. Results were presented in three previous articles. This series is concluded with the results of organoleptic analysis of the cheeses. Cheeses made with *S. faecalis* were either comparable to or less desirable than their respective control cheeses. Those made with *S. durans*, however, were in all instances more desirable than their controls. Cheeses cured at 7.2 C were always given the better scores, but there was no statistically significant difference between air- and brine-cooled cheeses.

Development of a method by which cheese of consistently high quality may be produced has been attempted through use of selected strains of *Streptococcus faecalis* and *Streptococcus durans*. A previous article has discussed the microbiological responses of these organisms in curing cheese as compared with those of lactic streptococci ordinarily employed as starters (11). Proteolysis, lactic acid development, free fatty acid development, and citrate utilization were evaluated (12,13) as parameters of chemical change. Although definite and consistent chemical differences were observed with different starters, with different curing temperatures, and sometimes with early cooling treatment, the most valid index of fine cheese quality lies in organoleptic attributes.

This article is the last in a series and discusses the organoleptic evaluation of experimental and control cheeses manufactured as a part of this study.

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MATERIALS AND METHODS

Cheese was manufactured and treated as described by Jensen et al. (11). When the cheeses were approximately 9 months old, they were evaluated by a panel of nine experienced judges. All taste panels were conducted at the same time of day, with each judge having his own booth. Lighting conditions and the temperatures of the sample and the room were closely controlled.

At each meeting, judges were presented with the control and experimental cheeses from one lot, totaling eight samples. To eliminate bias in detecting subtle flavor differences, samples cured at the same temperature were grouped together, and the two groups were considered separately. Table 1 shows the cheeses as grouped for each organoleptic sampling.

TABLE 1. Sample grouping for organoleptic analysis of cheese from a single lot

Group 1 (Cured at 7.2 C)	Group 2 (Cured at 12.8 C)
Enterococcus cheese, air cooled	Enterococcus cheese, air cooled
Enterococcus cheese, brine cooled	Enterococcus cheese, brine cooled
Control cheese, air cooled	Control cheese, air cooled
Control cheese, brine cooled	Control cheese, brine cooled

Flavor only was considered in the judging, and values were assigned from a 10-point scale. Samples within each group of four cheeses were randomized. Scores were subjected to an analysis of variance, and an F-test was applied to determine if there was any significant difference in flavor quality between treatments. Each lot was considered separately in the statistical analyses because of inherent differences in milk composition and adventitious flora between lots. All statistical data are given in Table 2.

RESULTS

Statistical analyses of judges' scores for the eight lots of cheese manufactured in this investigation showed no significant flavor differences between air- and brine-cooled cheeses cured at the same temperature. Although statistically significant differences in amounts of lactic acid were found in the chemical analyses (12), these evidently were not discernible by the judges. Frequencies with which certain defects were noted in air- and brine-cooled cheeses cured at the same temperature were generally the same (when the comparison was made within each inoculation group, but not among inoculation groups).

The differences, as measured organoleptically, between cheeses cured at 7.2 and 12.8 C were always statistically significant, with Lots D, W, XX, Y, and Z

having a level of significance of 1%, and Lots A, B, and C having a level of significance of 5%. Lot designations are described in a previous paper (11) and at the bottom of Table 2. In all instances, cheeses cured at 7.2 C received

TABLE 2. Analysis of variance; organoleptic results

Source of variation	Lot ^a	d.f.	M.S.	F values	Level of significance
1. Judges	A	8	1.87	4.53	1%
	B	8	2.14	6.11	1%
	C	8	1.81	7.54	1%
	D	8	1.37	4.28	1%
	W	7	2.62	4.30	1%
	XX	7	1.10	2.82	5%
	Y	7	1.11	3.36	1%
	Z	7	0.82	73	1%
2. Groups within judges	A	9	2.76	6.68	1%
	B	9	0.67	1.91	
	C	9	3.44	14.33	1%
	D	9	4.21	13.16	1%
	W	8	6.07	9.95	1%
	XX	8	6.89	17.67	1%
	Y	8	4.93	14.94	1%
	Z	8	3.97	18.05	1%
2a. Curing temp. (7.2 vs. 12.8 C)	A	1	14.22	10.69	5%
	B	1	2.80	6.82	5%
	C	1	16.53	9.13	5%
	D	1	31.33	38.21	0.5%
	W	1	38.75	27.48	0.5%
	XX	1	48.65	52.88	0.5%
	Y	1	38.13	200.68	0.5%
2b. Remainder	A	8	1.33		
	B	8	0.41		
	C	8	1.81		
	D	8	0.82		
	W	7	1.41		
	XX	7	0.92		
	Y	7	0.19		
3. Inoculation (enterococcus vs. no enterococcus)	A	1	0.22	0.53	
	B	1	3.83	10.94	1%
	C	1	3.16	13.16	1%
	D	1	0.05	0.16	
	W	1	4.20	6.88	5%
	XX	1	7.43	19.05	1%
	Y	1	18.70	56.67	1%
4. Cooling rate (air vs. brine)	A	1	1.12	2.71	
	B	1	0.53	1.51	
	C	1	0.0	0.0	
	D	1	0.36	1.13	
	W	1	1.05	1.72	
	XX	1	0.81	2.08	
	Y	1	0.10	0.30	
5. Inoculation × cooling rate	A	1	0.13	0.31	
	B	1	1.94	5.54	5%
	C	1	0.13	0.54	
	D	1	0.19	0.59	
	W	1	0.72	1.18	
	XX	1	0.01	0.03	
	Y	1	0.01	0.03	
6. Inoculation × curing temp.	A	1	2.72	6.58	5%
	B	1	0.85	2.43	
	C	1	0.14	0.58	
	D	1	0.05	0.16	
	W	1	0.01	0.02	
	XX	1	3.15	8.08	1%
	Y	1	3.60	10.91	1%
7. Cooling rate vs. curing temp.	A	1	0.99	2.40	
	B	1	0.94	2.68	
	C	1	0.09	0.38	
	D	1	0.07	0.22	
	W	1	0.60	0.98	
	XX	1	0.12	0.31	
	Y	1	0.03	0.09	
8. Inoculation × cooling rate × curing temp.	A	1	2.15	5.20	5%
	B	1	0.23	0.66	
	C	1	0.03	0.13	
	D	1	0.14	0.44	
	W	1	2.89	4.74	5%
	XX	1	0.72	1.85	
	Y	1	0.22	0.67	
Z	1	0.76	3.45		

7. Cooling rate vs. curing temp.	A	1	0.99	2.40	
	B	1	0.94	2.68	
	C	1	0.09	0.38	
	D	1	0.07	0.22	
	W	1	0.60	0.98	
	XX	1	0.12	0.31	
	Y	1	0.03	0.09	
8. Inoculation × cooling rate × curing temp.	A	1	2.15	5.20	5%
	B	1	0.23	0.66	
	C	1	0.03	0.13	
	D	1	0.14	0.44	
	W	1	2.89	4.74	5%
	XX	1	0.72	1.85	
	Y	1	0.22	0.67	
Z	1	0.76	3.45		

^aAll experimental cheeses were made with 1% commercial mixed-strain lactic starter in addition to enterococcal inoculation. All control cheeses were manufactured with 1% commercial mixed-strain lactic starter. Each lot consisted of one experimental and one control vat of cheese cooled and cured as described elsewhere. Lot A—*S. faecalis* 47-13, 150 ml concentrate/2270 kg milk; Lot B—*S. faecalis* 47-13, 75 ml; Lot C—*S. faecalis* 24-23, 150 ml; Lot D—*S. faecalis* 24-23, 75 ml; Lot W—*S. durans* 15-20, 150 ml; Lot XX—*S. durans* 15-20, 75 ml; Lot Y—*S. durans* 9-20, 150 ml; Lot Z—*S. durans* 9-20, 75 ml.

the better scores. Negative controls and cheeses manufactured with *S. faecalis* and *S. durans* and cured at 12.8 C were all more severely criticized for excess acidity, for fruity, fermented, and unclean flavors, and for a sulfhydryl background than were cheeses cured at 7.2 C.

When the cheeses made with *S. faecalis* (Lots A, B, C, and D) were compared with their respective negative controls and statistically analyzed, there were no significant differences between flavor scores of enterococci and control cheeses in Lots A and D. Lots B and C, however, showed statistically significant differences between enterococci cheeses and their controls at the 1% level, with the negative controls receiving the higher scores. The *S. faecalis* cheeses were more severely criticized for excess acidity as compared with their controls for all four treatments, and in cheeses cured at 7.2 C, and the *S. faecalis* cheeses were noted to have more bitterness than their controls. When cured at 12.8 C, the *S. faecalis* cheeses were more severely criticized for fermented and unclean flavors than were their controls, whereas bitterness was not noted in the enterococci cheeses. Although control cheeses also were criticized for fermented and unclean flavors, the *S. faecalis* cheeses received more frequent and critical mention of these defects.

When cheeses made with *S. durans* (Lots W, XX, Y, and Z) were compared with their respective negative controls and statistically analyzed, differences caused by the enterococci addition were significant at the 5% level in Lot W and Z and, at the 1% level, in Lots XX and Y. In all four lots, cheeses made with *S. durans* received the better scores. Usually, the *S. durans* cheeses were criticized for acidity when cured both at 7.2 and 12.8 C. Cheeses made with *S. durans* consistently received less criticism for bitterness than did controls for all treatments, however, and were criticized much less

severely for fermented and unclean flavors than were their controls for all treatments.

Analysis of variance computations for taste panel results of all eight lots are given in Table 2.

DISCUSSION

The components that must be present, and the proportion in which they are present, in well-flavored Cheddar cheese has been a long-standing topic for debate. Publications by Kristoffersen and Gould (15,16,17) and Kristoffersen et al. (18) have suggested that the desired quality of Cheddar cheese is dependent upon the ratio of free fatty acids to hydrogen sulfide. Ohren and Tuckey (24), also proponents of the Component Balance Theory, have suggested that typical Cheddar flavor is dependent on the ratio of free fatty acids to acetate. The effect of the three primary variables employed in this investigation (curing temperature, early cooling rate, and addition of enterococci) have been examined to different degrees by other workers. Miah (22) and Miah et al (23) reported that rapid cooling of "green" cheese curd by immersion in brine reduced defects noted by his judging panel, although he was unable to show this effect statistically. Numerous workers (1,6,9,10,21,26) have reported differences in flavor intensities in cheeses cured at different temperatures. Reports on the effect of addition of enterococci on flavor quality have been inconclusive. Some workers (5,6,9,14,19,20) have concluded favorably as to the use of *S. faecalis*, whereas others have inferred that it had no appreciable effect (25,27). Use of *S. durans* as a starter has been encouraged by some (3,4,28,29), whereas other workers found that *S. thermophilus* or *L. bulgaricus* were more suitable for use as a thermophilic starter (4,7,8).

The greater demonstration of defects in cheeses manufactured with *S. faecalis* is consistent with its alleged ability for greater fermentative capacities over those possessed by *S. durans* and lactic streptococci. The cheeses manufactured with *S. durans* were criticized generally for excess acidity as compared with the negative controls. The adventitious flora and residual lactic streptococci, which would be expected to be equally prevalent in negative controls and in their respective enterococcus cheeses, may be affected differentially by a significantly greater acidity in the *S. durans* cheeses (12). If the pH in the *S. durans* cheeses is lower, this may effect enough inhibition of the activity of adventitious flora to prevent development of the overfermented and unclean flavors noticed in the control cheeses.

Whereas cheeses manufactured with *S. faecalis* cultures were criticized more frequently for excess acidity than either the controls or cheeses made with *S. durans*, this seemingly has had no effect on development of fermented or unclean flavors. Because of the recognized fermentative powers of *S. faecalis* and its tolerance of the environment of curing cheese (11), *S. faecalis* may utilize a larger spectrum of substrates for energy and produce a broader range of end products, which would contribute

to the off-flavors observed in the cheeses. Furthermore, an earlier article in this series (13) reported data that demonstrated the production and subsequent disappearance of free fatty acids in cheeses made with *S. faecalis*. It was hypothesized that the fatty acids may have been oxidized to other components, which may have contributed to the criticisms of fermented and unclean flavors.

Results of the organoleptic evaluation indicate that the strains of *S. faecalis* used as supplemental starters in this investigation are not suitable for Cheddar cheese manufacture because they produced more defective flavors than did their controls in all treatments. The two strains of *S. durans* definitely could be considered for supplemental use as commercial starters because they significantly and consistently produced cheeses with fewer defects than their controls, which were manufactured with only lactic streptococci.

REFERENCES

1. Babcock, S. M., H. L. Russell, A. Vivian, and U. S. Baer. 1901. Influence of cold-curing on the quality of cheese. Wis. Agr. Exp. Stn. Annu. Rep. 18:136-161.
2. Crawford, J. M. 1956. The short time method for Cheddar cheese manufacturing. Dairy Ind. 21:534-536.
3. Czulak, J., and L. A. Hammond. 1956. Acid development and pH in the new method of Cheddar cheese manufacture. Aust. J. Dairy Technol. 11:165-166.
4. Czulak, J., and L. A. Hammond. 1956. The use of *Streptococcus durans* as a cheese starter. 14th Int. Dairy Congr., Vol. 2, Part 2:158-165.
5. Dahlberg, A. C., and F. V. Kosikowsky. 1948. The development of flavor in American Cheddar cheese made from pasteurized milk with *Streptococcus faecalis* starter. J. Dairy Sci. 31:275-284.
6. Dahlberg, A. C., and F. V. Kosikowsky. 1949. The influence of temperature of ripening on the tyramine content and flavor of American Cheddar cheese. J. Dairy Sci. 32:316-321.
7. Downs, P. A. 1958. Further studies on Cheddar cheese making by the Australian short method. J. Dairy Sci. 41:718. (Abstr.).
8. Downs, P. A., and K. M. Nilson. 1961. Studies on the Australian short time method of making Cheddar cheese. Nebr. Agr. Exp. Stn. Bull. 467.
9. Freeman, T. R. 1959. Accelerating the aging process in Cheddar cheese. Ky. Agr. Exp. Stn. Bull. 666.
10. Hansen, H. C. 1946. Influence of temperature on the curing of Cheddar cheese. Can. Dairy Ice Cream J. 25(6):48, 50.
11. Jensen, J. P., G. W. Reinbold, C. J. Washam, and E. R. Vedamuthu. 1973. Role of enterococci in Cheddar cheese: Growth of enterococci during manufacture and curing. J. Milk Food Technol. 36:613-618.
12. Jensen, J. P., G. W. Reinbold, C. J. Washam, and E. R. Vedamuthu. 1975. Role of enterococci in Cheddar cheese: Proteolytic activity and lactic acid development. J. Milk Food Technol. 38: (In press).
13. Jensen, J. P., G. W. Reinbold, C. J. Washam, and E. R. Vedamuthu. 1975. Role of enterococci in Cheddar cheese: Free fatty acid appearance and citric acid utilization. J. Milk Food Technol. 38: (In press).
14. Kosikowsky, F. V., and A. C. Dahlberg. 1948. The growth and survival of *Streptococcus faecalis* in pasteurized milk American Cheddar cheese. J. Dairy Sci. 31:285-292.
15. Kristoffersen, T., and I. A. Gould. 1957. The organoleptic evaluation and biochemical analysis of commercial Cheddar cheese. J. Dairy Sci. 40:607-608. (Abstr.).
16. Kristoffersen, T., and I. A. Gould. 1958. Characteristic Cheddar cheese flavor in relation to hydrogen sulfide and free fatty acids. J. Dairy Sci. 41:717. (Abstr.).

17. Kristoffersen, T., and I. A. Gould. 1960. Cheddar cheese flavor. II. Changes in flavor quality and ripening products of commercial Cheddar cheese during controlled curing. *J. Dairy Sci.* 43:1202-1215.
18. Kristoffersen, T., I. A. Gould, and W. J. Harper. 1959. Cheddar cheese flavor. I. Flavor and biochemical relationships of commercial Cheddar cheese. *Milk Prod. J.* 50(5):14-15, 20-22.
19. Kurmann, J. A. 1963. Pre-ripening of cheese milk with a mesophilic *Str. faecalis* culture in poorly managed Emmental and Gruyere cheese factories. *Dtsch. Milk.-Ztg.* 84:1732-1734. (*Dairy Sci. Abstr.* 29:504.)
20. Kurmann, J. A. 1966. Use of a *Str. faecalis* starter and its tendency for mesophilic growth in the manufacture of hard cheese from raw milk with a low bacterial count. *Lait* 46:499-512. (*Dairy Sci. Abstr.* 29:1084.)
21. Lochry, H. R. 1947. Curing Cheddar cheese at different temperatures. *Amer. Butter Rev.* 9:18, 20.
22. Miah, A. H. 1968. Effect of temperature during early stage of curing upon Cheddar cheese characteristics. Ph.D. thesis. Iowa State University of Science and Technology, Ames.
23. Miah, A. H., G. W. Reinbold, E. R. Vedamuthu, and E. G. Hammond. 1969. Cooling rates of green Cheddar cheese under normal conditions and under immersion in brine. *J. Dairy Sci.* 52:971-975.
24. Ohren, J. A., and S. L. Tuckey. 1969. Relation of flavor development in Cheddar cheese to chemical changes in the fat of the cheese. *J. Dairy Sci.* 52:598-607.
25. Reiter, B., T. F. Fryer, A. Pickering, H. R. Chapman, R. C. Lawrence, and M. E. Sharpe. 1967. The effect of the microbial flora on the flavor and free fatty acid composition of Cheddar cheese. *J. Dairy Res.* 34:257-272.
26. Sanders, G. P., R. P. Tittsler, and H. E. Walter. 1946. The rapid ripening of Cheddar cheese made from pasteurized milk. *J. Milk Technol.* 9:171-172.
27. Tittsler, R. P., G. P. Sanders, H. R. Lochry, and O. S. Sager. 1948. The influence of various lactobacilli and certain streptococci on the chemical changes, flavor development, and quality of Cheddar cheese. *J. Dairy Sci.* 31:716. (Abstr.)
28. Walter, H. E., A. M. Sadler, J. P. Malkames, and C. D. Mitchell. 1956. A simplified short-time method for making Cheddar cheese from pasteurized milk. 14th Int. Dairy Congr. Part 2. PP. 598-606.
29. Walter, H. E., A. M. Sadler, J. P. Malkames, and C. D. Mitchell. 1956. A simplified short-time method for making Cheddar cheese from pasteurized milk. *J. Dairy Sci.* 39:917. (Abstr.)

Microbiology of Delicatessen Salads

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ABSTRACT

Prepared salads obtained from 11 convenience food manufacturers in eight geographical locations throughout the United States were examined microbiologically upon their arrival at the laboratory, stored at 2 C and examined microbiologically weekly thereafter for 5 weeks. Microbiological evaluation included determination of total plate count, coliforms, fecal coliforms, yeasts and molds, *Clostridium perfringens*, *Staphylococcus aureus*, and salmonella; pH of the salads also was measured. Microorganisms of public health significance were detected initially in few samples; during storage these microorganisms decreased in number and no longer could be detected. Yeasts and molds, and microorganisms enumerated by the total plate count consistently proliferated to extremely high numbers in shrimp, macaroni, carrot and raisin, and egg salads. Additionally, 64 prepared salads representing 13 convenience food manufacturers from 10 geographic locations were examined microbiologically for compliance with Army and Air Force Exchange Service microbiological limits. Counts in excess of the limits were found in 36 of 64 (56%) samples; violations in total plate count, coliform, and yeast and mold limits occurred in 16, 22, and 45% of the samples, respectively.

During the past few decades the American public has become an affluent society, eager and willing to accept new ideas, products, and techniques. It has come to demand the products of our expanding technology, and guides industry development and growth by identifying product priorities. In keeping with this modern concept, the food industry has developed innumerable new "convenience" food items which often have enjoyed instantaneous acceptance. Included in this category are a series of familiar items, the delicatessen salads, which have become extremely popular due to their adaptability to modern food service techniques, their potential for increasing profits to the food purveyor, and their ready acceptance by the consuming public. The military services, particularly the Army and Air Force Exchange Service (AAFES), are using prepared salads extensively in their food service operations.

In adopting new techniques of food merchandising and bulk purchasing methods, the military services have accomplished the desirable goals of efficiency and dollar savings in food service operations. However, in so doing, internal control over the preparation of salads and other convenience items has been sacrificed. The responsibility for safety in their preparation has, of necessity, been transferred from the military services to food processors. The generalized use of delicatessen salads has resulted in

an expanded industry which has developed in a relatively short period; unfortunately finished product microbiological standards have not been developed for these items. Inspection and laboratory control of these items are almost non-existent. In addition, data on safe shelflife for delicatessen salads generally are not available. Therefore, this work was undertaken to develop information about the microbial quality of freshly prepared delicatessen salads and to establish an initial source of data relating to the anticipated keeping quality of the salads.

MATERIALS AND METHODS

Source of samples

Twenty-three salads representing 12 different types, were obtained from 11 manufacturers in eight geographical locations. Salads were procured fresh, refrigerated at 2 C, and expeditiously transported to the laboratory for testing. Upon receipt at the laboratory, salads were examined for initial quality and then stored at 2 C for 5 weeks, undergoing weekly sampling and analysis.

Sixty-four prepared salads, selected to represent each type currently being procured for military use (i.e., seafood, meat, vegetable, cheese, etc.) were obtained fresh from 10 geographic locations, refrigerated, and transported as above. Samples were examined within 24 h of receipt at the laboratory. Initial testing, without storage studies, was done.

Sample preparation and microbiological methods

Twenty-five grams of sample were weighed into sterile 1-liter stainless steel blender cups and 225 ml of sterile buffered distilled water (1) were added. The sample was blended for 3 min at high speed. Consecutive serial dilutions to 10^{-4} routinely were prepared, but in some instances dilutions to 10^{-8} were necessary due to high counts previously encountered. From these dilutions, the following analyses were performed: (a) total plate count (5); (b) Coliform count, plate method (1); when present, coliforms were verified by transferring at least five colonies per plate to sterile brilliant green bile broth dispensed in 10-ml amounts in test tubes containing fermentation tubes; the percentage of tubes showing visible gas in the fermentation tubes after incubation at 32 C for 48 h was determined, multiplied by the presumptive count, and the results reported as the "verified total coliform count;" (c) coliform count, 3-tube MPN method (7); (d) fecal coliform (7); IMViC series was done on all positive tubes; fecal coliform MPN was calculated from a standard MPN table on the basis of the confirmed results, and the IMViC reactions used to confirm *E. coli*; (e) fecal Streptococcus count (4); (f) *Clostridium perfringens* count (4); (g) *Staphylococcus aureus* MPN (8) except that tubes in each dilution demonstrating growth were streaked on sterile, pre-poured tellurite polymy in-B egg yolk (TPEY) agar plates and incubated at 35 C for 48 h (2); isolates were confirmed by the coagulase test; (h) yeast and mold count (1); and (i) *Salmonella* (3).

pH Measurement

Five grams of salad were blended for 3 min at high speed with 25 ml of distilled water in a semi-micro blender cup. After transferring to a

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TABLE 1. pH and total plate counts of delicatessen salads during storage at 2 C

Type of salad	Total plate count/g						pH ^a	
	Initial	Week 1	Weeks 2	Week 3	Week 4	Week 5	Initial	Final
Bean and garbanzo	120	80	150	190	90	110	4.3	4.5
Carrot and raisin	3800	3600	2000	— ^b	— ^b	— ^b	4.5	— ^b
Carrot and raisin	47 × 10 ³	56 × 10 ³	18 × 10 ⁴	24 × 10 ⁴	56 × 10 ⁴	74 × 10 ⁴	4.5	4.5
Chicken	450	620	550	450	350	510	4.4	4.6
Chicken	47 × 10 ³	49 × 10 ³	33 × 10 ³	31 × 10 ³	11 × 10 ⁴	46 × 10 ³	4.9	4.9
Cole slaw	17 × 10 ⁴	16 × 10 ⁴	15 × 10 ⁴	12 × 10 ⁴	68 × 10 ³	35 × 10 ³	4.3	4.6
Cole slaw	1300	940	650	490	800	550	4.5	4.4
Cole slaw	13 × 10 ³	6100	6300	4600	650	210	4.9	4.9
Cole slaw	10 × 10 ³	2400	1300	810	580	570	4.5	4.5
Egg	12 × 10 ³	13 × 10 ³	7400	17 × 10 ⁵	51 × 10 ⁶	11 × 10 ⁸	c	4.5
Egg	57 × 10 ⁵	20 × 10 ⁷	40 × 10 ⁷	40 × 10 ⁷	64 × 10 ⁶	57 × 10 ⁶	5.3	4.9
Ham	6200	4500	1200	1000	760	290	4.3	4.3
Ham	9900	7700	12 × 10 ³	7800	10 × 10 ³	11 × 10 ³	4.8	4.6
Jalapeno spread	1400	1500	980	1000	760	820	5.4	5.3
Macaroni	7200	5700	5800	7600	5000	— ^c	4.6	— ^c
Macaroni	82 × 10 ³	36 × 10 ³	93 × 10 ³	15 × 10 ⁴	79 × 10 ³	23 × 10 ⁵	4.4	4.5
Macaroni	4400	3900	8500	11 × 10 ⁵	37 × 10 ⁵	— ^c	5.2	— ^c
Macaroni	3900	1400	3000	950	3200	1200	5.7	5.3
Pimento	9700	9500	4200	2200	710	410	4.3	4.3
Potato	8000	4900	3400	3100	3000	— ^c	4.7	c
Potato	2800	1400	840	670	540	— ^c	4.9	c
Potato	12 × 10 ⁵	31 × 10 ⁷	25 × 10 ⁶	15 × 10 ⁶	63 × 10 ⁵	59 × 10 ⁵	5.7	4.5
Shrimp	130	120	140	190	95	180	4.7	4.5
Tuna	130	120	140	190	95	180	4.7	4.5

^apH rounded to nearest tenth.

^bStudy discontinued due to excessive mold growth.

^cDetermination not made.

100-ml plastic disposable beaker, pH measurements were made using a Model 55-2 Expandomatic Beckman pH meter (Beckman Instruments Inc., 2500 Harbor Blvd., Fullerton, CA. 92631).

RESULTS AND DISCUSSION

Storage samples

Total plate counts of salads (Table 1) upon initial examination ranged from a low of 120/g for bean and garbanzo salad to a high of 57×10^5 for one of the egg salads. In the former, the total plate count remained constant throughout the storage period. With the latter salad, the total plate count increased to 40×10^7 after storage for 2 weeks; it then declined to 57×10^6 by the fifth week of storage.

Both egg salad samples had high total plate counts. The shrimp salad and two of the three macaroni salads studied also had relatively high plate counts. Salad types having low total plate counts throughout the study were: tuna, bean and garbanzo, potato, pimento, and jalapeno spread.

Seven of the 23 salads showed constant plate counts throughout the study; four salads showed increased counts; 10 had lower counts following the 5-week storage study; and two samples showed noticeable increases and highest counts approximately half-way through the storage period; counts then decreased.

Current Army and Air Force Exchange Service (AAFES) microbiological specifications(4) on prepared salads (except gelatin) specify a total plate count not exceeding 100,000/g. Three salads (13%) (shrimp, one cole slaw, and one egg salad) did not meet these specifications upon receipt at the laboratory. After 3 weeks of storage (at 2 C), seven salads (30%) exceeded AAFES total plate count specifications. Storage for

longer periods resulted in only one additional sample exceeding the AAFES limits. While it is estimated that most prepared salads would be consumed within a period of 3 weeks, it appears that microbiologically sound salads of the types studied can be stored as long as 5 weeks without extensive microbial growth. Except when overgrowth of mold occurred, salads remained organoleptically acceptable for the entire storage period.

Coliforms were found in nine (39%) of the salads. When examined initially, six (26%) of the salads had coliform counts that exceeded the AAFES limits of ≤ 10 /g. Of these six, three were salads that also exceeded the AAFES specification for total plate count upon their receipt at the laboratory. In only two of the nine salads containing coliforms were the organisms detected beyond the third week of storage. *E. coli* was detected in only one instance (potato salad).

The pattern for coliform organisms was one of decreasing numbers during storage at 2 C. It is evident that the delicatessen salads studied were not substrates favorable for multiplication, or perhaps even survival, of coliform organisms. The decrease in coliform flora was constant across all types of salads (i.e., seafood, meats, vegetables, etc.).

Fecal streptococci (for which there are no AAFES limits) were found in nine (39%) of the samples. The significance of this finding is not entirely clear due to the uncertainty concerning this organism's role in food poisoning outbreaks. In addition, the common occurrence of these organisms in vegetable sources is reason to question the importance of their presence (6).

Fecal streptococcus counts neither increased nor decreased during the storage period. These organisms

TABLE 2. Classification of salads (single analysis) by plate count range

Type of salad	Number of salads	Total plate count range/g				
		5,000	5,000-10,000	10,000-100,000	100,000-1,000,000	>1,000,000
Bean	6	A, J, L, L, L ^a		J		
Carrot and raisin	2	L		L		
Chicken	6	D, L	F	C, D		I
Cole Slaw	11	A, J, L	H, L	I, I, M, M	B, L	
Egg	3			F		I, I
Ham	5	J	C, D	D, F		
Macaroni	9	G, J	E, L, M	A, L	L	I
Potato	9	G, H, J, L, L	E, F	A, M		
Shrimp	2					I, I
Tuna	8	D, D, D, D, D, J	F			I
Miscellaneous ^b	3	C, K, L				
Total	64	28	11	15	3	7

^aLetters designate source of salad.

^bIncludes 1 garden salad, 1 jalapeno spread salad, and 1 pimento salad.

TABLE 3. Number of samples and count ranges (total plate, yeast and mold, and fecal streptococci) for 64 salads (single analysis)

Type of salad	Number of samples in TPC Range/g ^a					Number of samples in yeast and mold range/g					Number of samples in fecal streptococcus range/g.				
	5	5-10	10-100	100-1000	>1000	20	20-100	100-500	500-1000	>1000	<10	10-50	50-100	100-1000	>1000
Bean	5	0	1	0	0	4	1	1	0	0	6	0	0	0	0
Carrot and raisin	1	0	1	0	0	1	0	0	0	1	2	0	0	0	0
Chicken	2	1	2	0	1	3	0	2	0	1	5	0	0	1	0
Cole slaw	3	2	4	2	0	3	6	0	1	1	8	2	1	0	0
Egg	0	0	1	0	2	1	0	0	1	1	1	0	0	2	0
Ham	1	2	2	0	0	3	1	0	0	1	3	1	0	1	0
Macaroni	2	3	2	1	1	4	3	1	1	0	7	0	1	0	1
Potato	5	2	2	0	0	4	4	0	0	1	7	1	1	0	0
Shrimp	0	0	0	0	2	0	1	0	0	1	1	0	0	0	1
Tuna	6	1	0	0	1	6	0	1	0	1	6	0	2	0	0
Misc ^b	3	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Sub-totals	28	11	15	3	7	32	16	5	3	8	49	4	5	4	2
% of totals	44	17	23	5	11	50	25	8	5	12	77	6	8	6	3

^aTotal plate count range in 1000's/g.

^bIncludes 1 Garden Salad, 1 Jalapeno Spread Salad, and 1 Pimento Salad.

were able to survive the storage conditions fairly well when present on initial analysis.

S. aureus was detected in one macaroni salad and in two potato salads. Most probable number counts were 3.6, 20, and 9.1/g, respectively. Since the MPN procedure is far more sensitive than direct plating, it is likely that these would not have been detected by direct plating. The salads containing *S. aureus* were not conducive to its multiplication as increases in *S. aureus* levels were not detected during storage.

The AAFES specifications for yeasts and molds in prepared salads is ≤ 20 /g. Seven of the 23 storage study samples exceeded this limit. The same samples which failed to meet plate count limits also did not comply with yeast and mold limits.

On the basis of the testing done (types of salads as well as numbers and types from the same source), it was not possible to clearly indicate whether particular types of salads should be expected to contain specific microbial loads or whether source of the salad is of primary importance. However, the latter is believed to be of greater significance.

Salad acidity, as measured by the pH, is shown in Table 1. Regardless of salad type, the pH range was 4.3

to 5.7 with no significant change in pH throughout the storage period. As might be anticipated, the acidic nature of these salads was conducive to multiplication of yeasts and molds. Both of the egg and carrot and raisin salads, the shrimp and one of the macaroni salads showed pronounced increases in yeast and mold counts during storage. After 3 weeks of storage, two samples showed macroscopic mold growth. It was not possible to correlate salad pH with specific increases or decreases in other microbial counts, although it is speculated that pH was responsible for decreases in microbial numbers.

Single analyses

Total plate count results, by type and source of salad tested, are presented in Table 2. Ten (16%) of the samples exceeded the AAFES specification. Of these 10 samples, seven were obtained from one supplier. In addition, it should be noted that all of these samples, regardless of salad type, had total plate counts exceeding 1×10^6 . Since this manufacturer supplied nine salads, of six different types, 78% exceeded the AAFES total plate count specification.

Fourteen salad samples (22%) exceeded the coliform limits of ≤ 10 /g; *E. coli* was isolated from only one

sample. Two salads (shrimp and egg) contained coliforms in excess of 10,000/g. These samples were obtained from the same manufacturer, I.

Ranges of yeast and mold counts are shown in Table 3. Only one-half of the samples studied met existing AAFES yeast and mold limitations. All samples obtained from one supplier (I) exceeded these limits.

Forty-nine of the 64 salads examined contained < 10 fecal streptococci per gram (Table 2), four contained 10-50/g, five contained 50-100/g, four contained 100-1,000/g, and two exceeded 1,000/g. Unfortunately, the significance of these findings cannot be interpreted on the basis of existing knowledge.

No *salmonellae* or *C. perfringens* were isolated for these samples; *S. aureus* was recovered in low numbers from 6 samples, with a MPN range of 3.6 to 20/g.

CONCLUSIONS

Based on the microbiological data reported herein, considerable variation was noted in results from different samples. Inspection reports of sanitary conditions in each plant at the time salads were produced were not available; such information would have been valuable in evaluating the microbiological quality of the salads. In view of the number of fresh salads exceeding the AAFES microbiological specifications, further testing and accumulation of data are necessary to determine the validity of present specifications. Development of separate microbial limits for various types of salads may be necessary.

Mircoorganisms of public health significance were not found to be a problem in the present study; however, the occurrence of coliforms is of concern and the incidence of fecal streptococci certainly is to be questioned. Due to the high total counts which developed in shrimp, egg, carrot and raisin, and macaroni salads, it appears that storage of these products should be limited to 2 weeks at a temperature not exceeding 2 C.

REFERENCES

1. American Public Health Association. 1972. Standard methods for the examination of dairy products. 13th edition. New York, N.Y.
2. Crisley, F. D. 1964. Multiplication of *Staphylococcus aureus* in synthetic cream fillings and pies. Pub. Health Report 79:369.
3. Food and Drug Administration. 1969. Bacteriological analytical manual. 2nd edition. Division of Microbiology, USDHEW/PHS/FDA. Washington, D.C.
4. Fowler, J. L., R. E. Thomas, J. J. Jorgensen, and D. Stutzman. 1973. Microflora of prepared salads and specialty items procured for use by DOD installations. Laboratory Report No. 338. U.S. Army Medical Research and Nutrition Laboratory, Fitzsimons Army Medical Center. Denver, CO.
5. Grogan, E. W. 1972. Veterinary laboratory service technical letter number 72-287. Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington, D.C.
6. Mundt, J. O. 1961. Occurrence of enterococci: Bud, blossom and soil studies. Appl. Microbiol. 9: 541.
7. National Academy of Sciences. 1971. Reference methods for the microbiological examination of foods. Food Protection Committee, National Research Council.
8. U.S. Department of Agriculture. 1974. Microbiology laboratory guidebook. APHIS. Wahington, D.C.

Survival of *Salmonella dublin* and *Salmonella typhimurium* in Lebanon Bologna

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ABSTRACT

Survival and destruction of *Salmonella dublin* and *S. typhimurium* added to Lebanon bologna was studied during manufacture of this sausage. During the aging period of salted cubed beef at 5 C, viable cell counts of *S. dublin* did not change over a 10-day period. Cell counts of *S. Dublin* were reduced 3 to 4 log cycles during the 4-day fermentation at 35 C; further reduction in the viable *Salmonella* count occurred during mellowing of the bolognas at 5 C. The number of *S. typhimurium* was usually reduced to an undetectable level before the end of the fermentation. *Salmonella typhimurium* was consistently more sensitive to the acid conditions of Lebanon bologna than was *S. dublin*. Introduction of an optional cooking step indicated that heating of bolognas to 51.7 C or above led to destruction of salmonellae. Unaged beef which was not inoculated with starter culture did not ferment and there was very little reduction in numbers of added salmonellae. Salmonellae were destroyed more rapidly in Lebanon bologna made from unaged beef with starter culture than in bologna made from aged beef (natural flora fermentation). Smoking also appeared to contribute to destruction of salmonellae. Four commercial Lebanon bolognas were tested for the presence of salmonellae but none were detected.

Occurrence of salmonellae in a wide variety of fresh meats has been well documented (3, 5, 14, 16, 18) but little information is available regarding the presence of these organisms in fermented and dried sausages. Only rarely have outbreaks of salmonellosis been attributed to these sausages; for example, the presence of *Salmonella choleraesuis* in salami was reported by Marazza and Crespi (8) to be responsible for a food poisoning outbreak. Behavior of *Salmonella* in artificially contaminated fermented sausages has been investigated in a few studies. Ostlund and Regner (9) reported that *Salmonella typhimurium* survived in artificially contaminated "Isterband," a Swedish fermented sausage; however, the influence of storage on continued survival of the organisms was not studied. Numbers of salmonellae in artificially contaminated thuringer declined during fermentation and subsequent refrigerated storage of the finished sausage (4). However, the rate of decline was too slow to ensure complete destruction of salmonellae even at low levels of contamination. When Takacs and Simonffy (15) inoculated dry sausage with low levels of salmonellae before ripening, the rate of

decline of the organisms was a function of the pH, salt, and water content. If the initial count of salmonellae was approximately 10^4 /g or more, the sausages remained contaminated up to the time of consumption. Therefore, it would appear that salmonellae are able to survive in dry and fermented sausages. The purpose of this investigation was to study the fate of salmonellae in artificially contaminated Lebanon bologna during the manufacturing process.

MATERIALS AND METHODS

Preparation of Lebanon Bologna

Beef chuck (canner and cutter grade) was ground through a 3/4-inch plate and NaCl was added to obtain a final concentration of 3%. Fresh or frozen beef was used; if frozen, the meat (previously ground through a 3/4-inch plate) was thawed for 24 h at 12 C, reground through a 3/4-inch plate and then salted. Salted meat was placed in plastic bags (3-4 kg per bag) and aged at 5 C for approximately 10 days. At the end of the aging period, sugars, spices, and potassium nitrate were added to the salted meat according to the formulation of Palumbo et al. (10) and the mixture ground through a 3/32-inch plate. The material was then stuffed into fibrous casings 55 mm in diameter. Sausages were covered with paraffin (mp 52 C) and allowed to ferment in an incubator at 35 C and 80-85% RH for up to 4 days. Paraffin was added to prevent drying of sausages and to prevent growth of mold. When the effect of smoke was studied, bolognas (without the paraffin coating) were placed, immediately after stuffing, into the smoke house at 35 C and about 90% RH. At the end of the fermentation period, bolognas were either allowed to mellow at 5 C or were heat processed. For more complete details concerning the processing of Lebanon bologna see (10). In certain experiments, unaged beef, fresh or frozen, was used to make bolognas. Salt, sugars, nitrate, and spices were added to the meat (thawed if frozen beef) and the mixture was ground through a 3/32-inch plate and stuffed into casings.

Inoculation of bolognas with salmonellae or starter culture

Twenty-four hour cultures of *Salmonella dublin* or *S. typhimurium* grown in tryptic soy broth (Difco)² at 37 C were diluted in 0.1% peptone water to give the appropriate concentration of cells and aseptically mixed into the meat by hand kneading before aging or stuffing. Lactacel MC starter culture (Merck and Co. Rahway, N.J.; a mixture of *Lactobacillus plantarum* and *Pediococcus cerevisiae*) was utilized in certain experiments; unaged beef was used and the starter was added before stuffing. Handling and addition of the starter culture was according to recommendations on the manufacturer's label. However, in contrast to their general directions, a straight nitrate cure was employed.

Acid tolerant *S. dublin* and *S. typhimurium*

Gradient agar plates (bottom layer, Tryptic Soy Agar (TSA, Difco); upper layer, TSA + 0.34% lactic acid in slanted square petri dishes) were used to isolate acid-tolerant *S. dublin* and *S. typhimurium*. By

¹Agricultural Research Service, U.S. Department of Agriculture.

²Reference to brand or firm name does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

continued replating of isolated colonies from the most acid part of the gradient plates, acid-tolerant salmonellae were obtained. Acid-tolerant strains of both species had a minimum pH for growth of 4.6; wild-types had a minimum of 5.2.

Determination of the viable count of salmonellae

Three separate 112-g portions (one from each end and one from the middle) of an individual salmonellae-contaminated bologna were removed from the casing and added to 370 ml of Selenite-Cystine broth (Difco) and blended for 3 min at high speed in a Waring Blender. Both the direct count and the Most Probable Number (MPN) counts were made from the blended sample. For the direct count of viable salmonellae, appropriate dilutions were spread on the surface of Brilliant Green Agar (BGA, Difco) plates and typical magenta colonies were counted after 24 h at 35 C. For the MPN count, graded volumes of 430, 43, 4.3, 0.43, and 0.043 ml of the blended mixtures (equivalent to 100, 10, 1.0, 0.1, and 0.01 grams of the original bologna) were placed in glass bottles or test tubes. The first three (430, 43, 4.3 ml) were added directly to the container; for the 0.43 ml sample, 0.5 ml of the blend was diluted with 7.5 ml Selenite-Cystine broth (0.4 ml was discarded); and for the 0.043 ml level, 0.7 ml of the preceding dilution was added to 4.9 ml of Selenite-Cystine (0.1 ml was discarded). Incubation was at 35 C for 24 h. Portions of these enrichments (0.01 ml) were streaked onto BGA and incubated 24 h at 35 C. Typical magenta colonies were picked and inoculated into Lysine Iron Agar (Difco); lysine decarboxylase positive slants were confirmed as salmonellae by use of somatic "O" antisera. The MPN/g was calculated by the use of a table.

The possibility existed that the above procedures for quantitating salmonellae may not recover cells that were injured by acid or heat. A limited number of samples were first preenriched in lactose broth (Difco nutrient broth + 1% lactose) and then treated by the above isolation techniques. Samples preenriched in lactose broth gave no higher counts than did samples processed in the usual way. Therefore, injury was not considered to be a problem and techniques utilized were adequate to quantitate the salmonellae present in the Lebanon bolognas.

Determination of the pH of meat and bolognas

The pH of bolognas or meat was determined by placing the electrode of the pH meter directly into the meat mass or into a slurry containing 1/5 dilution of meat in distilled water.

Heat processing of contaminated Lebanon bolognas

Thermal destruction of salmonellae in Lebanon bologna was studied by adjusting the smoke house temperature and humidity settings to 76.7 C (dry bulb) and 65.5 C (wet bulb). A thermocouple was inserted into a noncontaminated bologna and at predetermined internal temperatures, bolognas were removed, quickly quartered with a sterile knife, placed in plastic bags, and cooled in an ice bath. Quartered bolognas were kept refrigerated until counts were made.

EXPERIMENTAL AND RESULTS

Lebanon bologna is a fermented, highly spiced and smoked all beef sausage. Its manufacture consists of three steps: (a) aging salted beef cubes for about 10 days at 5 C; (b) smoking the sausage 4 days at 35 C; and (c) mellowing the smoked bolognas at 5 C for at least 3 days. Details of Lebanon bologna processing and microbiology are given elsewhere (10, 13). Data showing the fate of added salmonellae during the three steps are presented below.

When *S. dublin* was added to salted beef at 5 C, there was no growth of the organism over a 10-day period. At zero time, the number of viable *S. dublin* was 1.6×10^4 /g meat; at 10 days, it was 1.9×10^4 /g. Thus, *S. dublin* survived the aging process in salted beef but showed no growth.

The fate of salmonellae during the fermentation and mellowing periods in artificially contaminated bolognas is summarized in Table 1. At the end of 4 days of fermentation, the pH of the sausages dropped from 5.7 to 4.3-4.4. The acid-tolerant strains of *S. dublin* and *S. typhimurium* survived the fermentation period better than did the wild-type strains. All strains of *S. dublin* showed better survival during fermentation than *S. typhimurium*. After fermentation was complete, the Lebanon bolognas were mellowed at 5 C for several days. In Table 1, it can be seen that the wild-type of *S. dublin* survived for at least 11 days of mellowing at 5 C and the acid-tolerant type was still present at 24 days even though the environment of the bolognas was quite acid. *S. typhimurium* appeared to be more sensitive to the acid than *S. dublin* because after 4 days of fermentation, neither the wild-type nor the acid-tolerant types of *S. typhimurium* were present. *S. typhimurium* was detected in small numbers during mellowing, indicating that the acid environment may not be consistent in killing salmonellae.

Although not typically part of the Lebanon bologna process, a cooking (heating) step was investigated to determine the heat sensitivity of salmonellae in the acid environment of the bolognas (Table 2). A shortened fer-

TABLE 1. Survival of wild-type and acid-tolerant strains of *Salmonella dublin* and *Salmonella typhimurium* during fermentation and mellowing of Lebanon bologna made from aged beef

Total days	Days-fermentation	<i>Salmonella dublin</i>				<i>Salmonella typhimurium</i>				
		Wild-type		Acid-tolerant		Wild-type		Acid-tolerant		
		Number/g	pH	Number/g	pH	Number/g	pH	Number/g	pH	
0	0	5.7×10^4	5.7	1.4×10^4	5.7	4.5×10^4	5.7	8.5×10^3	5.7	
2	2	9.4×10^2	4.5	2.1×10^2	4.5	1.4×10^1	4.6	8.6×10^1	4.6	
3	3	1.1	4.4	positive ^a	4.4	0 ^b	4.4	0.007	4.4	
4	4	0.075	4.4	0.21	4.3	0	4.3	0	4.3	
Days-mellowing										
7	3	positive	4.4	0.46	4.4	0	4.3	0.02	4.3	
15	11	0.21	4.4	0.15	4.4	0.007	4.4	0	4.4	
28	24	0	4.3	0.007	4.3	0	4.3	0	4.3	

^aAll MPN tubes were positive.

^bThe lowest number of salmonellae that could be detected was 0.003 cells/g; any number less than 0.003 was considered to be zero.

TABLE 2. Effect of fermentation and cooking on the survival of acid-tolerant *Salmonella dublin* and *Salmonella typhimurium* in Lebanon bologna

Days-fermentation	<i>Salmonella dublin</i>		<i>Salmonella typhimurium</i>	
	Number/g	pH	Number/g	pH
0	1.2×10^5	5.6	3.1×10^3	5.6
1	1.7×10^4	5.0	5.7×10^1	5.0
2	1.7×10^4	4.7	1.1×10^1	4.7

After 2 days fermentation, the bolognas were placed in the smoke house at 76.7 C (dry bulb) and 65.6 C (wet bulb) without smoking.

Internal temperature of bologna (C)	Time to reach internal temperature (min)	<i>Salmonella dublin</i>		<i>Salmonella typhimurium</i>	
		Number/g	pH	Number/g	pH
27.2	0	1.7×10^4	5.6	1.1×10^1	5.6
35.0	18	1.1×10^4	5.0	3.4	5.0
43.3	27	0.015	4.7	2.1	4.7
48.9	36	0 ^a	4.7	0.15	4.7
51.7	42	0	4.7	0	4.7
54.4	52	0	4.7	0	4.7

^aThe lowest number of salmonellae that could be detected was 0.003 cells/g; any number less than 0.003 was considered to be zero.

mentation period (2 days in contrast to the usual 4) was utilized to ensure that viable salmonellae would be present before the heating step. Data in Table 2 indicate that at internal temperatures of 51.7 C or above, viable salmonellae could not be detected.

Survival of *S. typhimurium* in Lebanon bologna prepared from unaged beef, aged beef, and unaged beef plus stater culture is shown in Table 3. The characteristic flavor of Lebanon bologna is brought about by a fermentation mediated by lactic acid bacteria which develop during the aging of salted beef at low temperature. However, the aging step can be eliminated by using unaged beef plus a lactic acid starter culture.

TABLE 3. The survival of *Salmonella typhimurium* in Lebanon bologna made from unaged beef, unaged beef plus starter culture, and aged beef

Days-fermentation	Unaged beef		Aged beef		Unaged beef plus starter culture	
	Number/g	pH	Number/g	pH	Number/g	pH
0	1.4×10^4	5.3	1.3×10^4	5.3	8.4×10^3	5.3
1	4.5×10^5	5.4	3.0×10^3	4.5	3.5×10^4	4.8
2	4.5×10^5	5.4	1.1×10^3	4.3	2.4×10^1	4.1
3	5.4×10^4	5.3	2.4×10^2	4.1	0 ^a	4.0
4	2.2×10^4	5.3	3.6	4.1	0	4.0

^aThe smallest number of salmonellae that could be detected was 0.003 cells/g; any number less than 0.003 was considered to be zero.

TABLE 4. Effect of nonsmoking and smoking on the survival of *Salmonella dublin* and *Salmonella typhimurium* during fermentation of Lebanon bologna

Days-fermentation	<i>Salmonella dublin</i>				<i>Salmonella typhimurium</i>			
	Nonsmoked		Smoked		Nonsmoked		Smoked	
	Number/g	pH	Number/g	pH	Number/g	pH	Number/g	pH
Unaged beef plus starter culture								
0	4.0×10^4	5.2	4.0×10^4	5.2	3.0×10^4	5.2	3.0×10^4	5.2
1	7.8×10^3	4.5	2.7×10^3	4.5	2.2×10^3	4.5	5.0×10^2	4.5
2	0 ^a	4.0	0	4.0	0	4.0	0	4.0
4	0	4.2	0	4.2	0	4.2	0	4.2
Aged beef								
0	2.5×10^4	5.3	2.5×10^4	5.3	6.1×10^4	5.3	6.1×10^4	5.3
1	1.6×10^6	5.2	5.5×10^4	5.2	8.2×10^4	5.2	2.8×10^4	5.2
2	1.5×10^6	4.5	1.5×10^6	4.5	4.1×10^3	4.5	5.6×10^2	4.6
3	6.9×10^4	4.4	3.4×10^4	4.4	4.6×10^1	4.4	0	4.4
4	8.2×10^3	4.4	0	4.4	0	4.4	0	4.4

^aThe lowest number of salmonellae that could be detected was 0.03 cells/g; any number less than 0.03 was considered to be zero.

Acid production does not occur in bolognas made from unaged beef in the absence of starter. In Lebanon bologna made from unaged beef, there was no decrease in the pH and an initial slight increase in numbers of salmonellae was followed by a decrease to about the original starting level. Bolognas made from aged beef showed a rapid decrease in pH but *S. typhimurium* was not completely killed in the 4-day fermentation period. The natural fermentation process with aged beef varies with each batch of meat and this could influence salmonellae survival. When starter culture was used, no viable *S. typhimurium* could be detected by the third day of fermentation.

Survival of *Salmonella* shown in Tables 1, 2, and 3 is for bolognas fermented in a constant temperature-constant humidity incubator. Since Lebanon bologna is typically given a long smoke, the effect of smoking and nonsmoking (incubator) conditions on survival of salmonellae was studied. Use of starter culture led to a more effective destruction of *S. dublin* and *S. typhimurium* when compared to the natural fermentation involved in aged beef (Table 4). With both the starter culture and aged beef systems, there were fewer salmonellae surviving under smoked conditions in contrast to nonsmoked conditions. In Lebanon bolognas made from aged beef, regardless of whether they were smoked or not, *S. dublin* was more resistant than *S. typhimurium*.

Data in Tables 1, 2, 3, and 4 strongly suggest that commercial Lebanon bologna should contain few if any viable salmonellae after processing. Duplicate 100-g samples of Lebanon varieties from three companies (one

regular and one sweet Lebanon bologna from one company and one regular variety from each of the other two companies) were tested for the presence of salmonellae; all were negative.

DISCUSSION

During the aging step in the Lebanon bologna process, ¾-inch cubes of salted beef (3% NaCl) are held for approximately 10 days at 5 C. *S. dublin*, added to aging beef, survived but did not grow. This is not surprising because it has been shown in a variety of foods that salmonellae are able to survive but do not multiply at 5 C (2, 6).

Fermentation of the stuffed bolognas at 35 C is the second stage of Lebanon bologna processing. The lactic population which had developed during the aging step grows out rapidly due to the increase in temperature during fermentation, and ferments the sugars to lactic acid with a concomitant lowering of the pH (13). Most of the salmonella population was inactivated during the fermentation period. In the absence of fermentation (Table 3, unaged beef), there was some growth of salmonellae during the first 24 h with a slow reduction in numbers during the remaining 3 days. It would appear then, that the acid conditions of Lebanon bologna contribute greatly to destruction of both *S. dublin* and *S. typhimurium*. Goepfert and Chung (4), studying survival of salmonellae during the processing of thuringer, concluded that both the presence of salt and acid were the prime factors contributing to destruction of salmonellae. Salmonellae were not killed in thuringer sausage that lacked a fermentable sugar. Work with cottage cheese whey and fermented skimmilk (11, 17) suggested that the major factors responsible for the loss of viability in salmonellae in these fermented milk products was the low pH and acid produced by the lactic acid starter culture.

At the end of the fermentation period, Lebanon bolognas are stored at 5 C for several days; this third step of processing is called mellowing. Mellowing appears to be necessary to allow full development of the typical flavor (10). Data in Table 1 indicate that there were decreases in *Salmonella* numbers during the mellowing period; however, the acid tolerant strain of *S. Dublin* was still present in small numbers at 24 days of storage. In thuringer, *S. typhimurium* survived storage at 5 C for 28 days (4). The pH of thuringer is generally higher than that of Lebanon bologna and this fact may explain the longer survival of *S. typhimurium* in thuringer.

Smoking of Lebanon bolognas appears to have some destructive effects on *Salmonella* populations (Table 4). Anderton (1) suggested that smoking exerts an inhibitory action on salmonellae near the surface of the meat product but does not necessarily inhibit organisms in the deeper layers. Smoking had no effect on survival of salmonellae in thuringer (4). However, thuringer is generally smoked for less than 24 h in comparison to the 96 h smoke given Lebanon bologna.

Cooking of the bolognas to a temperature above 51.7 C at a pH of 4.7 is necessary to ensure complete destruction of salmonellae in Lebanon bologna. Goepfert and Chung (4) showed that *S. typhimurium* was not detectable in thuringer (pH 4.8) that had been heated for 1 h at 52 C. A cooking temperature above 48.9 C was recommended to ensure complete destruction of salmonellae during the manufacture of cottage cheese (7).

Use of a starter culture resulted in more efficient and quicker killing of salmonellae than with the natural flora fermentation. Destruction of salmonellae under natural fermentation conditions was not uniform. For example, in Table 1, *S. typhimurium* could not be detected by the third day of fermentation. However, data in Table 3 indicate that viable *S. typhimurium* could be detected at 4 days even though the pH of bolognas was quite similar as shown in Tables 1 and 3 (aged beef data). Park and Marth (12) noted that in cultured skimmilks contaminated with *S. typhimurium*, the survival of the pathogen differed markedly depending on the type of lactic acid starter culture used even though the pH of the milk products produced by these starters were often similar. Strain differences were noted also. It may be possible that in the natural fermentation of Lebanon bologna different batches may have completely different lactic populations which could explain the variability in the destruction of *S. typhimurium* in natural flora fermentations.

A high level of salmonellae contamination was used in the experimental Lebanon bolognas to facilitate enumeration of these organisms. Large numbers should provide a model demonstrating the effects of normal processing conditions on survival of any size population of salmonellae. It is probable that salmonellae contamination in commercial Lebanon bologna is of a very low order of magnitude, if present. Such a low level of contamination by *Salmonella* species has been demonstrated in fresh pork sausage (14) and similar levels should be expected in fresh beef.

While an exhaustive search of the literature was not made, only one paper was found which discussed an outbreak of salmonellosis resulting from Italian dry sausage (8). Thus, the lack of documentation suggests that fermented and dry sausages may rarely be involved in salmonellae food poisoning outbreaks.

To ensure control of *Salmonella* during sausage manufacture, our data suggest that the processor who wishes to use a natural flora fermentation can effectively reduce or eliminate salmonellae from his product by heating the sausage to an internal temperature of 52 C at a pH of approximately 4.7; if a lower pH is achieved, a short period of mellowing should be effective and a heating step is unnecessary. Alternately, the processor who properly uses a known starter culture with proven acid producing ability can be quite confident that the sausage will be free of *Salmonella*.

ACKNOWLEDGMENTS

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REFERENCES

1. Anderton, J. I. 1963. Pathogenic organisms in relation to pasteurized cured meats. British Food Manufacturing Industries Research Association, Scientific and Technical Surveys, No. 40.
2. Angelotti, R., M. J. Foter, and K. H. Lewis. 1961. Time-temperature effects on salmonellae and staphylococci in foods. 1. Behavior in refrigerated foods. Amer. J. Public Health 51:76-83.
3. Bowmer, E. J. 1965. Salmonellae in foods—a review. J. Milk Food Technol. 28:74-86.
4. Goepfert, J. M., and K. C. Chung. 1970. Behavior of *Salmonella* during the manufacture and storage of a fermented sausage product. J. Milk Food Technol. 33:185-191.
5. Galton, M. M., W. D. Lowery, and A. V. Hardy. 1954. *Salmonella* in fresh and smoked pork sausage. J. Infect. Dis. 95:232-235.
6. Julseth, R. M., and R. H. Deibel. 1969. Effect of temperature on growth of *Salmonella* in rehydrated skim milk from a food-poisoning outbreak. Appl. Microbiol. 17:767-768.
7. McDonough, F. E., R. E. Hargrove, and R. P. Titsler. 1967. The fate of salmonellae in the manufacture of cottage cheese. J. Milk Food Technol. 30:354-356.
8. Marazza, V., and A. Crespi. 1963. Osservazioni sulla sopravvivenza di *Salmonella choleraesuis* in insaccati naturalmente inquinati. Atti d Soc. Ital. d. Sci. Vet. 17:537-541.
9. Östlund, K., and B. Regner. 1968. Undersökningar rörande mikrofloran i isterband. Nord. Vet-Med. 20:527-542.
10. Palumbo, S. A., J. L. Smith, and S. A. Ackerman. 1973. Lebanon bologna. 1. Manufacture and processing. J. Milk Food Technol. 36:497-503.
11. Park, H. S., and E. H. Marth. 1972. Behavior of *Salmonella typhimurium* in skimmilk during fermentation by lactic acid bacteria. J. Milk Food Technol. 35:482-488.
12. Park, H. S., and E. H. Marth. 1972. Survival of *Salmonella typhimurium* in refrigerated cultured milks. J. Milk Food Technol. 35:489-495.
13. Smith, J. L., and S. A. Palumbo. 1973. Microbiology of Lebanon bologna. Appl. Microbiol. 26:489-496.
14. Surkiewicz, B. F., R. W. Johnston, R. P. Elliott, and E. R. Simons. 1972. Bacteriological survey of fresh pork sausage produced at establishments under federal inspection. Appl. Microbiol. 23:515-520.
15. Takacs, J., and Z. Simonffy. 1970. Das Salmonellen-problem bei Dauerwürsten. Die Fleischwirtschaft 50:1200-1202.
16. Weissman, M. A., and J. A. Carpenter. 1969. Incidence of salmonellae in meat and meat products. Appl. Microbiol. 17:899-902.
17. Westhoff, D. C., and T. Engler. 1973. The fate of *Salmonella typhimurium* and *Staphylococcus aureus* in cottage cheese whey. J. Milk Food Technol. 36:19-22.
18. Wilson, E., R. S. Paffenbarger, Jr., M. J. Foter, and K. H. Lewis. 1961. Prevalence of salmonellae in meat and poultry products. J. Infect. Dis. 109:166-171.

Conference on Mechanized Microbiology

An International Conference on Mechanized Microbiology will be held in Canada on 10-12 Sept., 1975, in Ottawa under the auspices of Health Protection Branch, Dept. of National Health and Welfare, Canada. The official Conference languages will be English and French.

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BOD, COD, and TOC Values for Liquid Wastes from Selected Blue Crab Pilot Processes^{1,2,3}

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ABSTRACT

Experiments were done on selected blue crab (*Callinectes sapidus*) processes using pilot plant systems. BOD, COD, and TOC values were determined on the total cooking loss fluid from the cooking of crabs at 100 C and 121 C. These indices were also determined on liquids following the rinsing of crab meat with a tap water spray and the dipping of crab meat in a NaCl brine for the two cooking temperatures. In all instances the BOD, COD, and TOC values were higher for the fluids (cooking loss, tap water rinse, NaCl brine dip) obtained from the 100 C cooking temperature than for the 121 C. These were inversely related to the total protein content of the fluids; the protein content being higher in fluids from the 121 C cooking temperature. However, after centrifugation of cooking loss fluids, COD values were higher for the supernatant obtained with the 121 C cooking temperature than that of the 100 C. Estimates for BOD, COD, TOC, and protein loss were calculated on the basis of raw crab and crab meat weights. The BOD, COD, and TOC values per 100 lb raw crab for the cooking loss fluid were 0.169, 0.572, and 0.182 lb for the 100 C and 0.344, 1.155, and 0.333 lb for the 121 C cooking temperature, respectively. Since the rinsing and dipping treatments were simulated pilot processes, the BOD, COD, and TOC values per 100 lb crab meat were considered to be indicators of the pollution load from a plant. These were found to be of substantial magnitude.

Disposal of waste products from blue crab (*Callinectes sapidus*) processing plants has become of increasing concern to the industry. A significant portion of the crab is not utilized, due to soluble portions being lost in liquids discharged from processing operations and the inadequate utilization of solid wastes. Soderquist et al. (9) estimated that 85% of the blue crab is lost during processing. The major losses of soluble substances occur during the cooking, cooling, flotation rinsing, and cleaning phases of the operation. In some blue crab

processing operations wastes are discharged directly into the sounds or estuaries. Research on utilization of wastes from blue crab processing has been primarily on analysis and recovery of by-products from solid wastes. Few crab processing plants are equipped to measure volumes of water or liquid wastes. Consequently there are no available data on the volume of water used to process blue crab. Furthermore, the literature contains no information describing the volume or concentration of matter in liquid wastes from blue crab processing operations (8). Hanover et al. (3) investigated the amount of liquid waste produced as an exudate from the cooking of blue crabs in pilot plant processing operations. Total losses from the cooking of raw crabs and the resultant loss of protein were higher when cooking was at 121 C than at 100 C. When the liquid from cooking operations was centrifuged, protein in the supernatant fluid from the 121 C temperature of cooking was slightly higher than that of the 100 C. However, the protein content of the solid fraction (residue) showed an inverse relationship, being significantly higher for the 100 C temperature of cooking than that of the 121 C.

Hanover et al. (3) also found that the rinsing with tap water or dipping in NaCl brine of fresh picked blue crab meat resulted in loss of substantial quantities of protein. Loss of protein was approximately 1 lb. per 100 lb live crab for the 121 C temperature of cooking. The amount of protein obtained in the tap water and NaCl brine dipping experiments was substantial. For crabs cooked at 121 C, 2.25 and 1.46 lb of total protein were lost per 100 lb of crab meat for the tap water rinse and the NaCl brine dip, respectively. The water from a Dungeness crab cooking tank is changed two to four times a day, and is highly colored, containing some oil (fat) and a heavy solids load (5). Peniston et al. (6) found that the composition of a waste can be approximately calculated from determinations of total nitrogen, moisture, fat, and sulfated ash. These results suggested that substantial quantities of total nitrogen are probably lost during commercial processing operations.

The objective of this study was to determine the biological oxygen demand (BOD), chemical oxygen demand (COD), and total organic carbon (TOC) of liquid wastes produced from selected blue crab pilot plant processing operations.

¹Paper No. 4425 of the Journal Series of the North Carolina Agricultural Experiment Station, Raleigh, N.C. The use of trade names in this publication does not imply endorsement by the North Carolina Agricultural Experiment Station of the products named, nor criticism of similar ones not mentioned.

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MATERIAL AND METHODS

Sampling

To maintain precise control for selected crab processing operations, simulated processing experiments were done in the pilot laboratory of the Food Science Department. Samples of market size, live blue crabs were harvested from the sounds of Pamlico County, North Carolina and transported to the laboratory within 12 h after harvesting. Crabs were placed in an open ice chest, underlined with ice and wet burlap and then covered with wet burlap. The crabs were stored in a cooler at 1.6 C before processing.

Sample preparation

Ten trial replications were completed over a period of 5 months. For each trial, crabs were randomly divided into two treatment lots of 15 each. Crabs were steam cooked in a laboratory autoclave from the live state within 24 h following harvesting. The two treatment lots were cooked as follows: (a) steamed at 100 C for 8 min and (b) steamed under pressure (15 psig) at 121 C for 10 min. Crabs were placed in an aluminum pan in the autoclave to collect fluids lost during cooking. After steaming, crabs were individually removed from the cooking container, drained free of excess fluid, transferred to another pan, covered, and air cooled 24 h at 1.6 C. Fluids collected from the cooking process were measured and refrigerated for subsequent analyses of 5-day BOD, COD, and TOC.

Chilled crabs were hand picked to remove only the backfin lump meat. Two 150-g samples of meat were randomly selected from each lot (15 crabs) for use in the tap water rinsing and NaCl brine dipping experiments.

Tap water rinsing procedures were designed to simulate the rinsing of crab meat, as is practiced in some commercial operations in North Carolina. To obtain samples for BOD, COD, and TOC from the tap water rinsing of crab meat a rinsing apparatus was constructed as described by Hanover et al. (3). Samples were rinsed for 1.5 min and the rinse water collected and analyzed for BOD, COD, and TOC.

For studying the effect of NaCl brine dipping, the 150-g samples of crab meat was immersed in NaCl brine to simulate a mechanical method of meat extraction (4). Crab meat was placed on a wire screen, as described by Hanover et al. (3) and dipped into 1550 ml of the 8% NaCl brine solution (22.2 C) for 10 sec. Meat was drained and the brine solution was analyzed for COD and TOC. No analysis was made for the BOD due to the high salt concentration of the brine. Total protein levels were determined on all fractions and have been previously reported (3).

Analytical procedures

Fluids from the cooking process were blended in a Sunbeam blender (Model No. 800) for 4 min. An aliquot of homogenate was removed, analyzed for BOD and COD, and the remainder centrifuged for 10 min at $7970 \times g$ at 5 C. The supernatant fluid was decanted and each fraction analyzed for COD.

The BOD test was done according to the procedures of *Standard Methods for the Examination of Water and Wastewater* (2). An unacclimated seed was obtained from copper-free swine waste sludge from a model activated sludge unit (Department of Biological and Agricultural Engineering, N.C. State University). The effluent from this sludge unit, when used in small amounts (0.5-0.6 ml/300 ml BOD bottle), provided reproducible results. Samples were analyzed in triplicate, for each of three dilutions. Dissolved oxygen was determined by the azide modification of the iodometric method (2).

Chemical oxygen demand (COD) was determined with a Beckman Model according to the dichromate reflux method (2).

Total organic carbon (TOC) was determined with a Beckman Model 915 TOC Analyzer (1).

Data were analyzed statistically by the procedures of Snedecor and Cochran (7). Analyses of variance, including determination of F-values, were calculated.

RESULTS AND DISCUSSION

Results of BOD and COD tests on the total cooking loss fluid and the supernatant fluid from centrifugation

TABLE 1. Mean BOD and COD values for the fluid exuded from the cooking of blue crabs at two temperatures

	Cooking temp. (C)	BOD, (mg O ₂ /l)	COD, (mg O ₂ /l)
Total cooking loss	100	17,622	59,602
	121	16,557	55,568
Supernatant from cooking loss fluid	100		27,708**
	121		45,702

** Significant at .01 level.

of the fluid are presented in Table 1. These data show that the total liquid resulting from the 100 C temperature of cooking had slightly, but not significantly higher BOD and COD values than that from 121 C. Differences among trials were not significant. The BOD and COD values were inversely related to the previously reported protein concentrations for the total cooking loss fluids (3). It is believed that non-protein constituents were responsible for this increase in oxygen demand in the cooking loss fluids from the 100 C cooking temperature. There were large differences between the two oxygen demand tests. Apparently there was a sufficient amount of oxidizable material present in the fluid exuded from the crabs which was chemically oxidized but was not utilized by bacteria used for the BOD test.

The COD values for the supernatant fluid from the 121 C cooking were significantly higher ($P < .01$) than those of the fluid from 100 C. According to these data, a significant portion of the total oxidizable material was present in the supernatant fluid, especially for the fluid from the 121 C cook. This indicated that the fluids lost from the crabs cooked at the lower cook temperature contained a greater amount of particulate matter which settled upon centrifugation than for the higher temperature.

Results of the COD and BOD tests on the tap water rinse and salt brine dip are presented in Table 2. Results

TABLE 2. Mean BOD₅ and COD values of the tap water rinse and the NaCl brine dip from crab meat cooked at two temperatures of cooking

Treatment	Cooking temp. (C)	BOD, (mg O ₂ /l)	COD, (mg O ₂ /l)
Tap water rinse	100	1,476 ± 43.5	2,453 ± 139**
	121	1,186 ± 40.3	2,017 ± 135
NaCl dip	100	—	3,121 ± 247
	121	—	2,769 ± 218

**Significant at .01 level

indicate higher, although not significantly, BOD values for the rinse water of meat obtained from crabs cooked at 100 C than for those cooked at 121 C. BOD tests were not completed on the salt brine dip due to the inhibiting effect of high salt concentrations on the type bacteria used in this investigation. The COD values of the water used to rinse meat from crabs cooked at 100 C were

significantly higher than those for 121 C ($P < .01$), thus agreeing with the trend for BOD values. The COD values for the two temperature treatments of the salt brine dip were not significantly different although the 100 C treatment was slightly higher. Hanover et al. (3) reported that the soluble protein content was higher in the tap water rinse and the salt brine dip for meat from crabs cooked to 100 C than those cooked to 121 C. Since less protein was lost from crabs during cooking at 100 C than at 121 C (3), there was probably a greater amount of soluble protein remaining in the crab meat cooked to the lower temperature (100 C). Therefore, it appears that less utilizable material was rinsed from meat from crabs cooked to 121 C and this would explain the higher BOD and COD values for the 100 C treatment.

TABLE 3. Mean values for TOC of the cook loss fluid, tap water rinse, and NaCl dip for two temperatures of cooking^a

Treatment	Cooking temp. (C)	TOC (mg/l)
Total cooking loss fluid	100	19,000
	121	16,000
Tap water rinse	121	1,180
	121	710

^aAll inorganic carbon values were less than 2 mg/l, therefore, total carbon was considered to equal total organic carbon.

Results of the TOC analyses are presented in Table 3. There was a greater amount of total organic carbon in the fluid from the crabs cooked at 100 C than for those cooked at 12 C. These results confirm those for the BOD and COD tests on the total cooking loss fluids. The TOC results were similar in trend to those of the BOD tests for the respective temperature treatments. Although there is no inherent relationship between the BOD and TOC, their quotients may be calculated as a means of comparison. Quotients for the BOD/TOC, BOD/COD and COD/TOC relationships are given in Table 4.

TABLE 4. Relationships between COD, BOD, and TOC for the total cooking loss fluid, tap water rinse and NaCl brine dip at two temperatures of cooking

Treatment	Cooking temp. (C)	Quotients		
		BOD/TOC	COD/TOC	BOD/COD
Total cooking loss fluid	100	0.93	3.14	0.30
	121	1.03	3.43	0.30
Tap water rinse	100	—	—	0.60
	121	1.00	1.71	0.59
NaCl dip	121	—	3.90	—

Among the three samples for which a BOD/TOC relationship was calculated, a close positive relationship was found between the BOD and TOC. In all instances the ratio approached 1.0. Wastes which are relatively constant in qualitative composition but vary in concentration generally give good correlations between BOD and TOC results. Higher correlations are usually obtained between BOD and TOC values for wastes containing a larger number of organic compounds.

The ratios for the COD/TOC values are presented in

Table 4 but they do not indicate an inherent relationship. Generally, if the COD/TOC ratio is high (< 4), the sample is in a low oxidation state (highly reduced) and will require extensive oxidation for stabilization; thus resulting in a high BOD. The COD/TOC values for the total cooking loss fluid were 3.14 and 3.48 for 100 C and 121 C, respectively. These results indicate that the waste would be expected to have a medium BOD. The 1.71 value for the tap water rinse after treating the crab meat indicated a low BOD. These results agreed closely with the actual BOD results which were shown in Tables 1 and 2. BOD tests for the NaCl brine dip after treating the crab meat were not done due to the high salt level but the COD/TOC value indicated that a high to medium BOD value (estimated 2,000 mg O_2/l) would be expected.

Ratios for the BOD/COD values which are presented in Table 4 indicate the amount of readily biodegradable matter in the sample compared to the total amount of oxidizable material present. Therefore, ratios between the BOD and COD methods for total cooking loss fluid indicated a relatively small amount of the material was readily oxidized. When this ratio (0.295) is compared with the BOD/COD ratio for the tap water rinse (0.602, approximately 60%), it is apparent that the latter material was more readily oxidized. This indicated that the type of organic matter from rinsing the crab meat was more readily utilized by organisms than that of the cooking loss fluids.

In an attempt to relate these results to the initial treated products, the BOD, COD, TOC values of the total cooking loss fluid were expressed in pounds per 100 lb of live crabs. The BOD, COD, and TOC values for the tap water rinse and NaCl dip after treatment of the crab meat were expressed in pounds per 100 lb of crab meat. These values are reported in Table 5. The volume of

TABLE 5. Effect of cooking temperature, tap water rinse and NaCl brine dip on the liquid wastes from a blue crab pilot processing system^a

Treatment	Cooking temp. (C)	Volume loss (pt)	Protein loss (lb)	BOD (lb)	COD (lb)	TOC (lb)
Total cooking loss fluid	100	8.24	0.29	0.169	0.572	0.182
	121	17.86	0.94	0.344	1.155	0.333
Tap water rinse	100	—	2.48	1.527	2.538	—
	121	—	2.25	1.227	2.087	1.221
NaCl dip	100	—	2.28	—	3.229	—
	121	—	1.46	—	2.865	0.735

^aTotal cooking loss fluid quantities are expressed on the basis of 100 lb of live crabs, whereas tap water rinse and NaCl dip quantities are expressed on the basis of 100 lb of crab meat.

cooking loss fluid and amount of protein loss for the three liquids were expressed on the same basis by using the data reported by Hanover et al. (3).

The total cooking loss values can be assumed to be fairly close estimates of commercial conditions as the time and pressure for the 121 C treatment were based upon present industry practice. Data for the tap water

rinse and NaCl dipping processes were obtained under carefully controlled pilot processing conditions. Values for protein, BOD, COD, and TOC for the tap water rinse and NaCl brine dip are probably low compared to commercial processing operations. This is based upon the relatively low pressure (tap water rinse) and short time of exposure for the tap water rinse and NaCl brine dip.

Nevertheless, the data are indicative of the fairly substantial losses which probably occur in commercial operations. Also, the data indicate the importance of developing systems to reduce the loss of organic matter during the processing of crabs. Further research is needed to determine losses in commercial operations and to develop systems to prevent high losses of components from the blue crab.

REFERENCES

1. Association of Official Agricultural Chemists. 1970. Official methods of analysis. Ass. Off. Anal. Chem., Washington, D.C.
2. American Public Health Association. 1971. Standard methods for the examination of water and wastewater, 13th ed. Amer. Public Health Ass., New York.
3. Hanover, L. M., N. B. Webb, A. J. Howell, and F. B. Thomas. 1973. Effects of cooking and rinsing on the protein losses from blue crabs. *J. Milk Food Technol.* 36:409-413.
4. Harris, S. 1959. Machine for recovering meat from animal carcasses. U.S. Patent 2,895,162.
5. Peniston, Q. P., E. L. Johnson, C. N. Turrill, and M. L. Hayes. 1969. A new process for recovery of by-products from shellfish waste. Proc. 24th Indus. Waste Conf., Purdue University, Lafayette.
6. Slavin, J. W., and J. A. Peters. 1969. A survey of waste disposal methods for the fish processing plants on the Oregon coast. Oregon State Sanitary Authority, Portland, Ore. 77 pp.
7. Snedecor, G. W., and W. G. Cochran. 1967. Statistical methods. The Iowa State Univ. Press, Ames.
8. Soderquist, M. R., K. J. Williamson, G. I. Blanton, D. C. Phillips, D. K. Law, and D. L. Crawford. 1970. Current practices in seafoods processing waste treatment. Publ. No. 12060ECF04/70, Environmental Protection Agency, Water Quality Ofc., Washington, D.C.
9. Soderquist, M. R., K. J. Williamson, and G. I. Blanton, Jr. 1970. Seafoods processing: Pollution problems and guidelines for improvement. p. 189-225. In: Proc. 1st Natl. Symp. Food Processing Wastes, Portland, Ore., April 6-8, Pacific Northwest Water Laboratory, Federal Water Quality Administration, Corvallis, Ore.

Food Science Students Sponsor Conference on World Food Needs

On Friday, April 25 the Student Division of the Institute of Food Technologists and the University of Minnesota Food Science and Nutrition Club will present a program entitled, "World Food Needs-Challenge and Opportunity for the Upper Midwest" on the St. Paul campus of the University. The purpose of this conference is to provide people in the upper midwest with a better understanding of the world food situation and the role that food producers, food processors, educators, students and the general public of the upper midwest can play in assuring an adequate world food supply.

Several well-known U.S. political figures and representatives from both the food industry and several universities have been invited to discuss the world food shortage. The meeting will be opened by Governor Wendell Anderson welcoming the participants to Minnesota and the Upper-Midwest-"The Nation's Breadbasket." Dr. W. F. Hueg, Vice President and Dean of the University of Minnesota's Institute of Agriculture, Forestry and Home Economics, will discuss agriculture in the upper midwest. Dr. Max Milner, former Secretary of the Protein Advisory Group of the United Nations, will speak on "The World and Its Hungry People." Earl Butz has been invited to discuss "The Realities of the U.S. Agricultural System in Solving This World Food Problem." Senator Hubert H. Humphrey has been invited to discuss

the decisions and developments from the recent World Food Conference held in Rome, Italy.

Over the last few years, the U.S. food industry has played an ever-increasing role in this fight against hunger. A panel of food industry representatives from the Twin Cities area will discuss the responsibility of the food industry in meeting world food needs. Dr. Keith Huston, Director of the Agricultural Experiment Station at the University of Minnesota, will explain how research at universities can help meet these world food needs. Representatives from several other universities in the midwest will attend the program to serve as panel members.

On April 24, a dedication of the new Food Science and Nutrition complex will be held. This addition to the presently existing building will give the University of Minnesota one of the finest facilities in the country for research in food science and nutrition. In addition, on the evening of April 24, the Centennial Banquet for the Agricultural Experiment station will be held at the Radisson South Hotel.

For further information contact the Office of Special Programs, Coffey Hall, University of Minnesota, St. Paul, Minnesota (612-373-0725).

Holders of 3-A Symbol Council Authorizations on February 20, 1975

"Questions or statements concerning any of the holders of authorizations listed below, or the equipment fabricated, should be addressed to Earl O. Wright, Sec'y.-Treas., 413 Kellogg Ave., P.O. Box 701, Ames, Iowa 50010."

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115	DeLaval Company, Ltd. 113 Park Street, So., Peterborough, Ont., Canada	(9/28/59)
109	Girton Manufacturing Company Millville, Pennsylvania 17846	(9/30/58)
114	C. E. Howard Corporation 9001 Rayo Avenue, South Gate, California 90280	(9/21/59)
127	Paul Mueller Company P.O. Box 828, Springfield, Missouri 65801	(6/29/60)
197	Paul Mueller (Canada), Ltd. 84 Wellington St., South, St. Marys, Ont., Canada	(9/ 9/67)
31	Walker Stainless Equipment Co. Elroy, Wisconsin 53929	(10/ 4/56)

02-03 Pumps for Milk and Milk Products as Amended

214R	Ben H. Anderson Manufacturers Morrisonville, Wis. 53571	(5/20/70)
212R	Babson Bros. Co. 2100 S. York Rd., Oak Brook, Ill. 60621	(2/20/70)
29R	Cherry-Burrell Corporation 2400 Sixth St., S. W., Cedar Rapids, Iowa 52406	(10/ 3/56)
63R	CREPACO, Inc. 100 C. P. Ave., Lake Mills, Wisconsin 53551	(4/29/57)
205R	Dairy Equipment Co. 1919 So. Stoughton Road, Madison, Wis. 53716	(5/22/69)
65R	G & H Products, Inc. 5718 52nd Street, Kenosha, Wisconsin 53140	(5/22/57)
145R	ITT Jabsco, Incorporated 1485 Dale Way, Costa Mesa, Calif. 92626	(11/20/63)
26R	Ladish Co., Tri-Clover Division 9201 Wilmot Road, Kenosha, Wisconsin 53140	(9/29/56)
236	Megator Corporation 125 Gamma Drive, Pittsburgh, Pa. 15238	(5/ 2/72)
241	Purity S. A. Alfredo Noble #38, Industrial Pte. deVigas Tlalnepantla, Mexico	(9/12/72)

148	Robbins & Myers, Inc. Moyno Pump Division 1345 Lagonda Ave., Springfield, Ohio 45501	(4/22/64)
163R	Sta-Rite Industries, Inc. P.O. Box 622, Delavan, Wisconsin 53115	(5/ 5/65)
72R	L. C. Thomsen & Sons, Inc. 1303 53rd Street, Kenosha, Wisconsin 53140	(8/15/57)
219	Tri-Canada Cherry-Burrell Ltd. 6500 Northwest Drive, Mississauga, Ont., Canada L4V 1K4	(2/15/71)
175R	Universal Milking Machine Div. National Cooperatives, Inc. First Avenue at College, Albert Lea, Minn. 56007	(10/26/65)
52R	Viking Pump Div. Houdaille Industries, Inc. 406 State Street, Cedar Falls, Iowa 50613	(12/31/56)
5R	Waukesha Foundry Company Waukesha, Wisconsin 53186	(7/ 6/56)

04-03 Homogenizers and High Pressure Pumps of the Plunger Type, As Amended

247	Bran and Lubbe, Inc. 2508 Gross Point Road, Evanston, Illinois 60201	(4/14/73)
87	Cherry-Burrell Company 2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404	(12/20/57)
37	CREPACO, Inc. 100 C.P. Ave., Lake Mills, Wis. 53538	(10/19/56)
75	Gaulin, Inc. 44 Garden Street, Everett, Massachusetts 02149	(9/26/57)
237	Graco Inc. 60-Eleventh Ave., N.E., Minneapolis, Minn. 55413	(6/ 3/72)
256	Hercules, Inc. 2285 University Ave., St. Paul, Minnesota 55114	(1/23/74)

05-11 Stainless Steel Automotive Milk Transportation Tanks for Bulk Delivery and/or Farm Pick-up Service, As Amended

131R	Almont Welding Works, Inc. 4091 Van Dyke Road, Almont, Michigan 48003	(9/ 3/60)
98R	Beseler Steel Products, Inc. 417 East 29th, Marshfield, Wisconsin 54449	(3/24/58)
70R	Jacob Brenner Company 450 Arlington, Fond du Lac, Wisconsin 54935	(8/ 5/57)
40	Butler Manufacturing Co. 900 Sixth Ave., S.E., Minneapolis, Minn. 55114	(10/20/56)
66	Dairy Equipment Company 1818 So. Stoughton Road, Madison, Wisconsin 53716	(5/29/57)
45	The Heil Company 3000 W. Montana Street, Milwaukee, Wisconsin 53235	(10/26/56)
201	Paul Krohnert Mfg., Ltd. 811 Steeles Ave., Milton, Ontario, Canada L9T 2Y3	(4/ 1/68)
80	Paul Mueller (Canada), Ltd. 84 Wellington Street, So., St. Marys, Ont., Canada	(11/24/57)
85	Polar Manufacturing Company Holdingford, Minn. 56340	(12/20/57)

- 71 Progress Industries, Inc. (8/ 8/57)
400 E. Progress Street, Arthur, Illinois 61911
- 121 Technova Inc. Gosselin Division (12/ 9/59)
1450 Hebert c. p. 758
Drummondville, Quebec, Canada
- 47 Trailmobile, Div. of Pullman, Inc. (11/ 2/56)
701 East 16th Ave., North Kansas City, Mo. 64116
- 189 A. & L. Tougas, Ltée (10/ 3/66)
1 Tougas St., Iberville, Quebec, Canada
- 25 Walker Stainless Equipment Co. (9/28/56)
New Lisbon, Wisconsin 53950

**08-09 Fittings Used on Milk and Milk Products
Equipment, and Used on Sanitary Lines Conducting
Milk and Milk Products**

- 79R Alloy Products Corporation (11/23/57)
1045 Perkins Avenue, Waukesha, Wisconsin 53186
- 138R A.P.V. (Canada) Equipment, Ltd. (12/17/62)
103 Rivalda Rd., Weston, Ont., Canada
- 245 Babson Brothers Company (2/12/73)
2100 S. York Road, Oak Brook, Illinois 60521
- 82R Cherry-Burrell Company :12/11/57)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52406
- 124R DeLaval Company, Ltd. (2/18/60)
113 Park Street, South, Peterborough, Ont.,
Canada
- 67R G & H Products, Inc. (6/10/57)
5718 52nd Street, Kenosha, Wisconsin 53140
- 199R Graco, Inc. (12/ 8/67)
60 Eleventh Ave., N.E., Minneapolis, Minn. 55413
- 203R Grinnell Company (11/ 7/68)
260 W. Exchange St., Providence, R. I. 02901
- 218 Highland Corporation (2/12/71)
74-10 88th St., Glendale, N.Y. 11227
- 34R Ladish Co., Tri-Clover Division (10/15/56)
2809 60th St., Kenosha, Wisconsin 53140
- 239 LUMACO (6/30/72)
Box 688, Teaneck, N.J. 07666
- 200R Paul Mueller Co. (3/ 5/68)
P.O. Mox 828, Springfield, Mo. 65801
- 242 Purity, S. A. (/12/72)
Alfredo Nobel #39 Industrial Pte. de Vigas Tlal-
pantla, Mexico
- 149R Q Controls (5/18/64)
Occidental, California 95465
- 227 Stainless Steel Craft Corporation (1/11/72)
4503 Alger Street, Los Angeles, California
- 89R Sta-Rite Industries, Inc. (12/23/68)
P.O. Box 622, Delavan, Wis. 53155
- 73R L. C. Thomsen & Sons, Inc. (8/31/57)
1303 43rd Street, Kenosha, Wisconsin 53140
- 191R Tri-Canada Cherry-Burrell, Ltd. (11/23/66)
6500 Northwest Drive, Mississauga, Ontario,
Canada L4V 1K4
- 250 Universal Milking Machine Division (6/11/73)
Universal Cooperatives, Inc.
408 First Ave. S.
Albert Lea, Mn. 56007
- 86R Waukesha Specialty Company, Inc. (12/20/57)
Darien, Wisconsin 53114

**09-00 Thermometer Fittings and Connections Used
on Milk and Milk Products Equipment and
Supplement 1, As Amended**

- 32 Taylor Instrument Process Control,
Div. Sybron Corp. (10/ 4/56)
95 Ames Street, Rochester, New York 14601
- 206 The Foxboro Company (/11/69)
Neponset Ave., Foxboro, Mass. 02035
- 246 United Electric Controls (3/24/73)
85 School Street, Watertown, Massachusetts 02172

**10-01 Milk and Milk Products Filters Using Disposable
Filter Media, As Amended**

- 35 Ladish Co., Tri-Clover Division (10/15/56)
2809 60th Street, Kenosha, Wisconsin 53140

**11-03 Plate-Type Heat Exchangers for Milk and Milk
Products, As Amended**

- 20 A.P.V. Company, Inc. (9/ 4/56)
137 Arthur Street, Buffalo, New York 14207
- 30 Cherry-Burrell Corporation (10/ 1/56)
2400 Sixth Street, S.W., Cedar Rapids, Iowa 52404
- 14 Chester-Jensen Co., Inc. (8/15/56)
5th & Tilgham Streets, Chester, Pennsylvania
19013
- 38 CREPACO, Inc. (10/19/56)
100 CP Avenue, Lake Mills, Wisconsin 53551
- 120 DeLaval Company, Ltd. (12/ 3/59)
113 Park Street, South Peterborough, Ont.,
Canada
- 17 The DeLaval Separator Company (8/30/56)
Dutchess Turnpike, Poughkeepsie, N.Y. 12602
- 15 Kusel Dairy Equipment Company (8/15/56)
100 W. Milwaukee Street, Watertown, Wisconsin
53094

**12-04 Internal Return Tubular Heat Exchangers,
for Milk and Milk Products, As Amended**

- 248 Allegheny Bradford Corporation (4/16/73)
P.O. Box 264, Bradford, Pa. 16701
- 243 Babson Brothers Company (10/31/72)
2100 S. York Road, Oak Brook, Illinois 60521
- 103 Chester-Jensen Company, Inc. (6/ 6/58)
5th & Tilgham Street, Chester, Pennsylvania
19013
- 152 The DeLaval Separator Co. (11/18/69)
350 Dutchess Turnpike, Poughkeepsie, N.Y. 12602
- 217 Girton Manufacturing Co. (1/23/71)
Millville, Pa. 17846
- 252 Ernest Laffranchi (12/27/73)
P.O. Box 455, Ferndale, Calif. 95536
- 238 Paul Mueller Company (6/28/72)
P.O. Box 828, Springfield, Missouri 65801
- 96 C. E. Rogers Company (3/31/64)
P.O. Box 118, Mora, Minnesota 55051

**13-01 Farm Milk Cooling and Holding Tanks,
As Amended**

- 240 Babson Brothers Company (9/ 5/72)
2100 S. York Road, Oak Brook, Illinois 60521
- 11R CREPACO, Inc. (7/25/56)
100 C. P. Ave.
Lake Mills, Wisconsin 53551
- 119R Dairy Craft, Inc. (10/28/59)
St. Cloud Industrial Park, St. Cloud, Minn. 56301
- 4R Dairy Equipment Company (6/15/56)
1919 S. Staughton Road, Madison, Wisconsin 53716
- 92R DeLaval Company, Ltd. (12/27/57)
113 Park Street, South Peterborough, Ontario,
Canada
- 49R The DeLaval Separator Company (12/ 5/56)
Dutchess Turnpike, Poughkeepsie, N.Y. 12602
- 10R Girton Manufacturing Company (7/25/56)
Millville, Pennsylvania 17846
- 95R Globe Fabricators, Inc. (3/14/58)
3350 North Gilman Rd., El Monte, California 91732
- 179R Heavy Duty Products (Preston), Ltd. (3/ 8/66)
1261 Industrial Road, Preston, Preston, Ont.,
Canada
- 12R Paul Mueller Company (7/31/56)
P.O. Box 828, Springfield, Missouri 65801
- 249 Sunset Equipment Co. (4/16/73)
3765 North Dunlap Street
St. Paul, Minnesota 55112
- 216R Valco Manufacturing Company (10/22/70)
3470 Randolph St., Huntington Pk., Calif. 90256
- 42R VanVetter, Inc. (10/22/56)
2130 Harbor Avenue S.W., Seattle, Washington
98126
- 16R Zero Manufacturing Company (8/27/56)
Washington, Missouri 63090

**14-00 Inlet and Outlet Leak Protector Plug Valves
for Batch Pasteurizers, As Amended**

- 122R Cherry-Burrell Company (12/11/59)
2400 Sixth St., S.W., Cedar Rapids, Iowa 52406
- 69 G & H Products Corporation (6/10/57)
5718 52nd Street, Kenosha, Wisconsin 53140
- 27 Ladish Co. - Tri-Clover Division (9/29/56)
2809 60th Street, Kenosha, Wisconsin 53140
- 78 L. C. Thomsen & Sons, Inc. (11/20/57)
1303 43rd Street, Kenosha, Wisconsin 53140

**16-04 Evaporators and Vacuum Pans for Milk and
Milk Products**

- 254 Anhydro, Inc. (1/ 7/74)
130 S. Washington St., North Attleboro, Mass.
02760
- 132R A.P.V. Company, Inc. (10/26/60)
137 Arthur Street, Buffalo, New York 14207
- 164R Anderson IBEC (4/25/65)
19609 Progress Drive
Strongsville, Ohio 44136
- 263 C. E. Howard Corporation (12/21/74)
9001 Rayo Avenue
South Gate, California 90280
- 107R C. E. Rogers Company (8/ 1/58)
P. O. Box 118, Mora, Minnesota 55051

- 186R Marriott Walker Corporation (9/ 6/66)
925 East Maple Road, Birmingham, Mich. 48010
- 259 Pollution Control, Inc. (4/ 5/74)
P.O. Box 208, Wilson Place, South Barre, Vt. 05670

**17-00 Fillers and Sealers of Single Service Containers,
For Milk and Milk Products, As Amended**

- 192 Cherry-Burrell Corporation (1/ 3/67)
2400 Sixth St., S.W., Cedar Rapids, Iowa 52404
- 137 Ex-Cell-O Corporation (10/17/62)
P.O. Box 386, Detroit, Michigan 48232
- 220 Hercules, Inc., Package Equipment
Division (4/24/71)
2285 University Ave., St. Paul, Minnesota 55114
- 211 Twinpack, Inc. (2/ 4/70)
2225 Hymus Blvd., Dorval 740 P.Q.

**19-00 Batch and Continuous Freezers, For Ice Cream,
Ices and Similarly Frozen Dairy Foods, As Amended**

- 141 CREPACO, Inc. (4/15/63)
100 C. P. Avenue, Lake Mills, Wisconsin 53551
- 146 Cherry-Burrell Company (12/10/63)
2400 Sixth Street, S. W., Cedar Rapids, Iowa 52404

**22-03 Silo-Type Storage Tanks for Milk and
Milk Products**

- 168 Cherry-Burrell Corporation (6/16/65)
575 E. Mill St., Little Falls, N.Y. 13365
- 154 CREPACO, Inc. (2/10/65)
100 C.P. Ave., Lake Mills, Wisconsin 53551
- 160 Dairy Craft, Inc. (4/ 5/65)
St. Cloud Industrial Park
St. Cloud, Minn. 56301
- 181 Damrow Company, Division of DEC
International, Inc. (5/18/66)
196 Western Ave., Fond du Lac, Wisconsin 54935
- 156 C. E. Howard Corporation (3/ 9/65)
9001 Rayo Avenue, South Gate, California 90280
- 155 Paul Mueller Co. (2/10/65)
P.O. Box 828, Springfield, Missouri 65801
- 195 Paul Mueller (Canada), Ltd. (7/ 6/67)
84 Wellington St., So., St. Marys, Ont., Canada
- 165 Walker Stainless Equipment Co. (4/26/65)
Elroy, Wisconsin 53929

**23-00 Equipment for Packaging Frozen Desserts,
Cottage Cheese and Milk Products Similar to Cottage
Cheese in Single Service Containers**

- 174 Anderson Bros. Mfg. Co. (9/28/65)
1303 Samuelson Road, Rockford, Illinois 61109
- 209 Dobby Packaging Machinery (7/23/69)
Domain Industries, Inc.
869 S. Knowles Ave., New Richmond, Wis. 54017
- 258 Hercules, Inc. (2/ 8/74)
2285 University Ave., St. Paul, Minnesota 55114
- 222 Maryland Cup Corporation (11/15/71)
Owings Mills, Maryland 21117
- 193 Triangle Package Machinery Co. (1/31/67)
6655 West Diversey Ave., Chicago, Illinois 60635

24-00 Non-Coil Type Batch Pasteurizers

- 161 Cherry-Burrell Corporation (4/ 5/65)
575 E. Mill St., Little Falls, N.Y. 13365
- 158 CREPACO, Inc. (3/24/65)
100 C. P. Avenue, Lake Mills, Wisconsin 53551
- 187 Dairy Craft, Inc. (9/26/66)
St. Cloud Industrial Park
St. Cloud, Minn. 56301
- 177 Girton Manufacturing Co. (2/18/66)
Millville, Pennsylvania 17846
- 166 Paul Mueller Co. (4/26/65)
P.O. Box 828, Springfield, Mo. 65601

25-00 Non-Coil Type Batch Processors for Milk and Milk Products

- 162 Cherry-Burrell Corporation (4/ 5/65)
575 E. Mill St., Little Falls, N.Y. 13365
- 159 CREPACO, Inc. (3/24/65)
100 C.P. Avenue, Lake Mills, Wisconsin 53551
- 188 Dairy Craft, Inc. (9/26/66)
St. Cloud Industrial Park
St. Cloud, Minn. 56301
- 167 Paul Mueller Co. (4/26/65)
Box 828, Springfield, Mo. 65801
- 196 Paul Mueller (Canada), Ltd. (7/ 6/67)
84 Wellington St., So., St. Marys, Ont., Canada
- 202 Walker Stainless Equipment Co. (9/24/68)
New Lisbon, Wis. 53950

26-00 Sifters for Dry Milk and Dry Milk Products

- 228 J. H. Day Co. (2/28/72)
4932 Beech Street, Cincinnati, Ohio 45202
- 229 Russell Finex Inc. (3/15/72)
156 W. Sandford Boulevard, Mt. Vernon, N.Y.
10550
- 173 B. F. Gump Division (9/20/65)
Blaw-Knox Food & Chem. Equip. Inc.
750 E. Ferry St., P.O. Box 1041
Buffalo, New York 14240

- 185 The Orville-Simpson Co. (8/10/66)
1230 Knowlton St., Cincinnati, Ohio 45223
- 176 Sprout, Waldron & Co., Inc. (1/ 4/66)
Munsey, Pennsylvania 17756
- 172 SWECO, Inc. (9/ 1/65)
6111 E. Bandini Blvd., Los Angeles, California
90022

28-00 Flow Meters for Milk and Liquid Milk Products

- 253 Badger Meter, Inc. (1/ 2/74)
4545 W. Brown Deer Road, Milwaukee, Wis. 53223
- 223 C-E IN-VAL-CO, a division of Combustion
Engineering, Inc. (11/15/71)
P.O. Box 556, 3102 Charles Page Blvd., Tulsa
Oklahoma 74101
- 231 The DeLaval Separator Company (3/27/72)
350 Dutchess Turnpike
Poughkeepsie, New York 12603
- 226 Fischer & Porter Company 12/ 9/71)
County Line Road, Warminster, Pa. 18974
- 261 Foss America, Inc. (11/ 5/74)
Route 82
Fishkill, N.Y. 12524
- 224 The Foxboro Company (11/16/71)
Foxboro, Massachusetts 02035

29-00 Air Eliminators for Milk and Fluid Milk Products

- 251 The DeLaval Separator Company (12/10/73)
350 Dutchess Turnpike, Poughkeepsie, N.Y. 12603

30-00 Farm Milk Storage Tanks

- 257 Babson Bros. Co. (2/ 7/74)
2100 S. York Road, Oak Brook, Illinois 60521

32-00 Uninsulated Tanks for Milk and Milk Products

- 264 Cherry-Burrell Company, Division (1/27/75)
of Paxall, Inc.
575 E. Mill St., Little Falls, N.Y. 13365

Food Soils, Water Hardness, and Alkaline Cleaner Formulations

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ABSTRACT

Cleaning of food processing equipment involves the proper interrelationship between ingredients in cleaners formulated for specific food soils and the detergent solvent, usually water. Solution temperatures and times are critical for efficient soil removal. Many commercial detergents contain large amounts of phosphorus, usually as polyphosphates, so they can be used with very hard water. Ion exchange units to remove objectionable cations from water will permit use of cheaper cleaners that contribute less phosphorus to the environment.

Clean food processing equipment is essential to public health. Current food distribution systems also require food relatively free from microflora associated with spoilage. While modern food processing equipment is, in general, well designed, too often cleaning and sanitizing methods are poorly understood. Excellent cleaners, properly engineered cleaning programs, and professional expertise are readily available to the food processor. In many instances, however, management's lack of knowledge of the chemistry of cleaning leads to quality problems. In many instances poorly trained, or new workers, without adequate supervision are shown where the "soap" is, given a perfunctory explanation of the job, and turned loose to do their best. The results are predictable. And then, technical assistance is needed, quickly, to reestablish a food processor's good name. I've tried, over the years, to make management understand the interrelationship of water conditions, food soils, and detergents. This does involve some basic knowledge of these three factors: food soils, water, and detergents. It also involves a willingness to insist that the cleaning and sanitizing job be done according to prescribed conditions.

NATURE OF FOOD SOILS

Perhaps the first essential is to understand the nature of food soils and their characteristics as shown in Table 1. Table 1 indicates that solubility of food components vary and that food processing changes the characteristics of the residual soils. An understanding of these facts is essential in planning an efficient cleaning program.

THE SOLVENT: WATER

The primary solvent for many foods and most detergents is water. Water is not just H₂O. It is H₂O plus

TABLE 1. *Soil Characteristics*^a

Component on surface	Solubility characteristics	Ease of removal	Changes induced by heating soiled surfaces
Sugar	Water soluble	Easy	Carmelization, more difficult to clean
Fat	Water insoluble, alkali soluble	Difficult	Polymerization, more difficult to clean
Protein	Water insoluble, alkali soluble, slight acid soluble	Very difficult	Denaturation, much more difficult to clean
Salts			
Monovalent	Water soluble, acid soluble	Easy to difficult	Generally not significant
Polyvalent (i.e., CaPO ₄)	Water insoluble, acid soluble		Interactions with other constituents, more difficult to clean

^aFood Sanitation, The AVI Publishing Co., 1972, p. 135

many cations, anions, and dissolved and suspended solids. It also may have a wide pH range. When water falls as rain, it picks up carbon dioxide from the air, making a dilute solution of carbonic acid. As this dilute acid percolates through soil it dissolves acid soluble components. These include many alkaline metals, especially calcium and magnesium. Other cations and anions are often in abundance. The U.S. Geological Survey Classification of water hardness is given in Table 2. From the standpoint of a detergent solvent, calcium

TABLE 2. *U.S. Geological Survey Classification of Water Hardness*

Hardness	As ppm	As grains/gal ^a
Soft	0-60	0- 3.5
Moderately hard	60-120	3.5- 7.0
Hard	120-180	7.0-10.5
Very hard	over-180	over 10.5

^aGrains per gal × 17.1 = ppm

and magnesium, and to a lesser extent iron, are especially troublesome. Under conditions of heat and alkalinity, calcium and magnesium combine with the HCO₃ ion, forming insoluble carbonates. All basic alkalies soften water by precipitation of calcium

and magnesium as the carbonate. Heating hard water causes a similar precipitate. The nature of the precipitate varies, of course, depending on the concentration of various cations and anions that are present.

In addition to ions from water, food itself contributes various ions, their concentration varying with the food and its treatment. For example, some milk films contribute the equivalent of 5 grains of calcium hardness per gallon.

Thus, water for cleaning is a variable medium. For effective and economical cleaning it must be softened by ion exchange, or cleaner formulations must include agents to prevent deposition of insoluble salts. Softening by ion exchange, or so-called zeolite softening, is the most practical way of removing objectionable calcium and magnesium. Special ion exchange units are available to remove practically any ions found in water.

THE CLEANING COMPOUND

The alternative to zeolite softening is to formulate alkaline cleaners with cationic sequestering or chelating agents. The usual sequestering agents are complex phosphates, called polyphosphates. Table 3 lists three of

TABLE 3. *Some Polyphosphates Commonly used in Detergents*

	Active alkalinity as % NaOH	pH of 1% sol.	Total action ^a on			Remarks
			P ₂ O ₅	Ca	Mg	
Sodium hexametaphosphate	None	6.5	69.6	E	P	Expensive, unstable
Sodium tripolyphosphate	4.0	9.4	57.0	G	E	Fairly cheap, stable
Tetrasodium pyrophosphate	10.3	10.2	51.8	F	VG	Cheap, stable

^aE, excellent; VG, very good; G, good; F, fair; P, poor

TABLE 4. *Examples of Alkaline Cleaners for Manual use*

Component	Temporary (bicarbonate) water hardness				
	5 grains/gal		20 grains/gal		
	%	% active alkalinity as NaOH	Contribution	%	Contribution
Sodium carbonate	50	37.3	18.65	27	10.02
Sodium carbonate (anhydrous)	32	63.2	20.22	20	12.64
Sodium tripolyphosphate	15	4.0	0.60	50	2.0
Non-ionic medium foaming wetting agent	3			3	
Percent active alkalinity as NaOH			39.47		24.66
P ₂ O ₅ (%)	8.55			28.5	
Phosphorus % (Approx.)	3.76			12.5	
Amount needed per 100 gal of cleaning solution at 0.05% active alkalinity	1.09 lb			1.74 lb	
Grams of phosphorus per 100 gal of cleaning solution	18.61			98.8	

the commonly used polyphosphates and their attributes.

The most common chelating agents, ethylene diamine tetraacetic acid (E.D.T.A.), or its sodium salts, are too expensive for inclusion in most common detergents. Other cationic sequestrants include gluconic acid and the questionable nitrilotriacetic acid (N.T.A.). Either cost or possible public health problems have generally ruled out all but the polyphosphates for cationic sequestrants in commercial cleaning compounds for food contact surfaces. E.D.T.A. or its sodium salts, combined with certain basic alkalis and wetting agents, are sold commercially for specialized cleaning purposes, especially as a tile cleaner.

Table 4 gives formulations of detergents that are rather typical of those designed for manual alkaline cleaners for both soft and hard waters. While probably no commercial detergent has these exact specifications, they represent concepts used to develop formulations.

The cleaner for manual use, as indicated in Table 4, is designed for soft water, or water plus soil containing not over 5 grains per gallon temporary hardness, and offers the necessary alkalinity for soil removal. The amount of sodium tripolyphosphate is adequate for most soft waters and cations contributed by food soils. However, the cleaner designed for 20 grains total hardness contains less of the basic alkali and more of polyphosphate. The pounds per 100 gal of cleaning solution with an active alkalinity of 0.05% are shown in Table 4. Note that not only is much more of the hard water detergent needed for alkalinity but also that over five times as much phosphorus would be present at use concentration.

TABLE 5. *Examples of Alkaline Cleaners for Circulation Cleaning for some Food Processing Equipment and Dishwashing*

Component	Temporary (bicarbonate) water hardness				
	5 grains/gal		20 grains/gal		
	%	% active alkalinity as NaOH	Contribution	%	Contribution
Sodium carbonate	60	37.3	22.38	33	12.31
Sodium metasilicate (anhydrous)	27	63.2	17.06	20	12.64
Sodium tripolyphosphate	10	4.0	0.40	45	1.80
Non-ionic or anionic low foaming wetting agent	3			2	
Present active alkalinity as NaOH			39.84		26.75
P ₂ O ₅ (%)	5.7			25.65	
Phosphorus % (Approx.)	2.51			11.29	
Amount needed per 100 gal of cleaning solution at 0.20% active alkalinity	4.32 lb			6.43 lb	
Grams of phosphorus per 100 gal of cleaning solutions	49.22			329.58	

Table 5 illustrates an alkaline detergent designed for circulation cleaning of certain food processing equipment and for mechanical dishwashing. At alkali concentrations needed for hard water the percentage of polyphosphate has been greatly increased, with a concomitant decrease in the basic alkalis. Thus, about 50% more of the hard water detergent must be used than

the detergent designed for soft water. The amount of phosphorus is increased over six-fold.

Even if the hard water detergents designed for manual or circulation cleaning were used at correct concentrations, they would contribute an unnecessary phosphorus load to the environment. Unnecessary, that is, if the water had been properly softened by ion exchange to remove objectionable hardness. And expensive. Cost data on how much can be saved by ion exchange water softening reflect many factors. An extreme variation exists in the price of salt used in water softeners as purchased by homeowners compared to mass purchases by industrial concerns.

At present, household salt, sodium chloride, costs from \$3 to \$4 per 100 lb, or a cost of 0.75 to 2.0 cents per kilograin of hardness removed. Large commercial users can purchase salt for \$16 to \$20 per ton, and thus their costs could be as low as 0.2 cent per kilograin of hardness removed.

The question is often asked as to how much water in home or industry should be softened. Obviously, hard water supplies that cause cleaning problems, or that are responsible for scale formation in heating or cooling equipment should be softened. For many other commercial uses water needs not only softening but removal of other troublesome ions. The list of such ions is too numerous for this discussion. On the other hand, it is a waste of money to soften water where no advantage occurs, such as for watering lawns. Perhaps the best guide is common sense.

Detergents for manual and circulation cleaning with hard water that I have suggested are subject to a common criticism. They contain excessive phosphorus for most water supplies. Also, people are prone to use excessive quantities. Thus, the cost of their use and the violation to our environment are proportionally increased. Solutions to these problems are obvious. Cleaners should be designed for the intended job under the existing water conditions, and used at correct concentrations. A better solution, obviously, is to decrease the need for cation sequestrants by zeolite ion exchange. Soil removal involves, then, the nature of the soil, and detergents designed to disperse the soil in the water available.

OTHER FACTORS IN CLEANING

Other factors in cleaning include solution temperature, circulation time, and velocity or force. Use of low temperatures to remove food soils ignores some basic facts. Raising temperatures of cleaning solutions decreases the strength of bonds between the soil and the surface, increases solubility of soluble materials, and accelerates reaction rates. For milk soils, an increase of 18 F for temperatures between 90 and 185 F will double the efficiency of the cleaning operation. With milk soils, at temperatures below 90 F, milk fat remains in a solid state. At temperatures over 185 F heat-induced interactions bind milk proteins more tightly to the equipment surface, decreasing cleaning efficiency. For any food, the minimum effective detergent solution temperature will be at least 5 F higher than the melting point of the fat present. The maximum temperature will depend on the temperature at which the proteins in the system are denatured.

Cleaning solution velocity cannot be ignored. In hand washing of equipment, this involves "elbow grease." Circulation cleaning, to be effective, must be turbulent. The degree of turbulence varies greatly, but increases reduce markedly the difficulty of soil removal.

With circulation cleaning, all other factors remaining constant, lengthening the cleaning time, up to a point, increases effective soil removal. Circulation times vary greatly, and are interrelated to quantity and nature of the soil, temperatures, and concentrations of the detergent solutions.

IN CONCLUSION

In conclusion, cleaning food processing equipment involves the nature of the soil to be removed, the chemical composition of water as the solvent, and cleaners designed for the job. The need for water treatment to remove objectionable ions is apparent. Effective economical cleaning requires the application of the concepts I have discussed.

ACKNOWLEDGMENT

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The National Dairy Council's Nutrition Research Program and Its Relationship to a National Nutrition Policy

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ABSTRACT

During the past decade an intense consumer interest has developed in food, nutrition, and health. Evidence has been accumulated documenting extensive malnutrition within the United States. Although some people are not getting sufficient food, others who have an abundance of foods are not choosing them wisely. Concomitant with these developments is the critical world food situation, in which industrial nations must play a vital role in preventing global starvation before the end of the twentieth century.

Sound nutrition is an integral component in the attainment of optimal health. Therefore, many leaders in the professional community are of the opinion that it is essential for the United States to formulate a National Nutrition Policy which will marshal those resources in industry, government, medical and allied health, and academia necessary to improve our quality of life. A National Nutrition Consortium has been formed to provide technical leadership in this area. Activities in 1974 by the U.S. Senate Select Committee on Nutrition and Human Needs and by its Chairman Senator McGovern, as well as by the National Nutrition Consortium, have provided a framework for a National Nutrition Policy.

The purpose of the National Dairy Council's (NDC) Nutrition Research Program is to investigate the nutritional value of dairy foods and define their relationship to the attainment of optimal health. The three fronts of this Program are Grants-In-Aid, Professional Contacts and Support of Scientific and Medical Conferences, and Library Research. The three are integrally related to our efforts to discover, educate, and answer. The NDC Nutrition Research staff work on a regular basis with national leaders responsible for development and implementation of a National Nutrition Policy. We are an influential nutritional spokesman at the national level responsible for defining how dairy foods will fill a vital nutritional role in carrying out this Policy. We therefore serve as the foundation for the dairy industry's total marketing concept and help to insure a continuing market for dairy foods.

THE DOMESTIC SITUATION

During the 1960's public concern was aroused by nationwide studies showing that the U.S. diet was poorer than it should be. In 1967, for example, investigations by the U.S. Senate Poverty Subcommittee in the Mississippi Delta and visits to this area by doctors sponsored by the Field Foundation uncovered the existence of hunger and malnutrition in the United States. This stimulated the establishment of a Citizens Board of Inquiry and led to publication of a report entitled *Hunger USA*. The report was followed by a CBS documentary which brought hunger and malnutrition into the home of almost every American. The reaction was shock and disbelief that extensive hunger and malnutrition could exist in such an affluent country.

Later in the same year, the U.S. Senate requested the

Department of Health, Education, and Welfare to make a comprehensive survey of the incidence of these problems. Between 1968-1970 a Ten-State Nutrition Survey was carried out, including a survey of New York City, with attention being directed primarily to the lower income segment of the population (4). This survey confirmed data accumulated in 1955 (30) and again in 1965 (31) by the U.S. Department of Agriculture: namely, that some people are eating less than desirable amounts of certain nutrients (some of which are found primarily in dairy foods), while others, although ingesting enough food, may not be eating wisely. Commensurate with these findings is the widespread occurrence of obesity, hypertension, diabetes, anemia, coronary heart disease, osteoporosis, periodontal disease, and tooth decay.

It follows then that a National Nutrition Policy is a governmental concern because of the improper nutritional habits of the population which have led to health problems. In addition, there is concern, at least in the scientific community, with regard to lactose intolerance and the nutritional value of fabricated products which resemble traditional foods and purport to equal them nutritionally. Therefore, the dairy industry must be concerned not only with assisting in the development and implementation of a National Nutrition Policy, but also in defining how dairy foods will fill a vital nutritional role in carrying out this Policy.

Also in 1968, the U.S. Senate appointed a Select Committee on Nutrition and Human Needs (9). Hearings were begun in December of that year and continue today. Much testimony has been gathered as to the importance of nutrition in health and the nutritional problems that are present in this country and that require attention. The hearings of the Select Committee continue to document the food, nutrition, and health problems that exist in the United States and provide a legislative core for collective decision-making as to how a national policy can be formulated which addresses itself to these problems.

The findings of these national nutrition surveys, testimony before the U.S. Senate Select Committee, public statements by nutritionists, physicians, welfare workers, and consumer advocates along with other publicized reports, have served to heighten public concern about the quality of the family diet. In response to this growing interest, President Nixon called for a White House Conference on Food, Nutrition, and Health. Held in December 1969, this Conference focused

national attention on the country's remaining—and changing—nutrition problems (32). A follow-up Conference was held in 1970 to assess progress (33).

These conferences brought our national nutrition problems into sharp focus. As leaders in government, industry, science, medicine, and education evaluated the problems it was evident that something must be done not only to improve the quality of life in the United States but also to assist the world in meeting its food and nutrition problems.

On the domestic front, U.S. Department of Agriculture responded by expanding the Child Nutrition Programs as well as other food assistance programs. The U.S. Food and Drug Administration responded to the challenge to develop a system for identifying the nutritional qualities of food. On January 19, 1973, FDA launched an unprecedented series of proposals, with subsequent final regulations, pertaining to food labeling which will affect almost everyone in the food industry (6). These new regulations are "designed to provide the American consumer with specific and meaningful new information on the identity, quality, and nutritional value of a wide variety of general and specific foods in the marketplace"—including dairy foods.

THE INTERNATIONAL SITUATION

With respect to the international situation, in 1966 President Johnson appointed a Panel on the World Food Supply to study all aspects of this problem and report to his Science Advisory Committee. The report, published in 1968 (28) stressed: "(a) The scale, severity, and duration of the world food problems are so great that a massive, long-range, innovative effort, unprecedented in human history will be required to master it. (b) The solution to the problem that will exist after 1985 demands that programs of population control be initiated now. For the immediate future the food supply is critical. (c) Food supply is directly related to agricultural development and, in turn, agricultural development and overall economic development are critically interdependent in the hungry countries. (d) A strategy for attacking the world food problem will of necessity encompass the entire foreign economic assistance effort of the U.S. in concert with other developed countries, voluntary institutions and international organizations."

Our nation probably is entering a new era in its international relations—one not characterized by weapons or money, but by food. History has revealed that a hungry world is a politically unstable world. It is no secret that U.S. Secretary of State Kissinger has used U.S. agricultural productivity as a strong instrument for peace throughout the world. Nevertheless, continued population growth in developing nations, changing rainfall patterns and economic priorities influence food availability. Many leaders of the professional community believe that we will experience a food crisis before the turn of the century that will make the energy crisis of the 1970's seem miniscule in comparison. It is estimated that

the world population will double by the year 2000 to approximately 7 billion people (28). Borgstrom has stated: ". . . the human race long ago exceeded the limits of what the world can feed." . . . "If we were to ration what the globe totally carries in food in such a way that each individual received an equal share, this would mean universal malnutrition" (3). And yet the world population is expected to double in the next 25-30 years. Can agricultural productivity even keep up with such a pace?

We are already experiencing a "Green Revolution" which many believe will help provide food for more people because it appears to provide a more efficient use of land and energy than does animal production. The Green Revolution is the term applied to increased agricultural production resulting from the use of new cereal grains, particularly rice and wheat. While great strides have been made in plant genetics, this revolution is heavily dependent on available energy (fuel, fertilizer, etc.). Nevertheless it will become increasingly difficult to justify animal production in lieu of plant production. And yet the dairy cow can be grazed on untillable land and can convert agricultural by-products into food of high biological value. Agricultural abundance in the past has made us wasteful of our natural resources. We can no longer afford this luxury. We must involve those who know and understand plant and animal production in planning national priorities so that we may strike a reasonable agricultural balance to meet our growing food needs. A world Food Conference was held November 5-11, 1974 in Rome to discuss some of these very issues.

NATIONAL POLICY ON NUTRITION

Today, the United States should have as great an interest and responsibility in developing a National Nutrition Policy as the developing countries of the world, in spite of our lower incidence of malnutrition. Three of the most urgent international problems are: (a) serious malnutrition in developing countries of the world, (b) rapidly expanding population in these areas, and (c) the provision of an adequate food supply to meet future needs. To maintain leadership in this important international area, as well as to address ourselves to the domestic problems of food, nutrition, and health, many leaders in the professional community are of the opinion that the United States must have a National Nutrition Policy (7, 8, 10, 11, 16, 17), a policy which would involve agriculture, the food industry, government, academia, the medical community, and the consumer.

To combine the efforts of the professional food and nutrition societies, a National Nutrition Consortium representing 40,000 scientifically trained professionals in the American Institute of Nutrition, American Society for Clinical Nutrition, Institute of Food Technologists, and American Dietetic Association was formed in 1973. National Dairy Council (NDC) staff has been working closely with this Consortium and its members to formulate national guidelines in nutrition research and

nutrition education. The purpose of the Consortium has been tentatively stated as follows: "The public, and particularly its leaders in Government and industry, are entitled to sound nutritional information and responsible technical guidance on program plans and policies. A National Nutrition Consortium of scientists and specialists in food science, nutrition, and dietetics can contribute much toward meeting these needs. Responsible nutrition and food science authorities should have a common voice and coordinated action to help guide the application of food and nutrition knowledge to the public good. Professional societies serve to advance the acquisition of scientific and technological knowledge and exchange of this information among specialists; there remains a need in applying sound concepts of this food and nutrition knowledge to upgrade awareness and responsibility by, and on behalf of, the consumer. The professional associations supporting the Consortium recognize a responsibility for such a coordinated effort in meeting this need" (14). One of their highest priorities is to provide a framework, a National Nutrition Policy.

GUIDELINES FOR NUTRITION POLICY

A special committee of the Consortium recently published *Guidelines for a National Nutrition Policy* (25). The foreword of the proposed policy states that a "concise statement of a National Nutrition Policy is timely and desirable" and that the National Nutrition Consortium had addressed itself to preparation of guidelines for a National Nutrition Policy to identify the many considerations to be brought into focus in effective long-range governmental planning and implementation of programs for foods and nutrition in relation to the nation's health and other national responsibilities.

The Guidelines are organized into five sections. (a) *Need for a Stated National Nutrition Policy*—to ensure that food will be available to provide an adequate diet at a reasonable cost to every person within the United States. (b) *Goals of a National Nutrition Policy*—to assure an adequate wholesome food supply at reasonable cost, to maintain a system of quality and safety control, to maintain food resources sufficient to meet emergency needs, to develop a level of sound public knowledge of nutrition and foods, and to support research and education in foods and nutrition. (c) *Measures to Attain Goals*—It is essential to maintain surveillance of the nutritional status of the population and to determine the nature of nutritional problems observed. The Policy recognizes the need to cooperate with other nations and international agencies in developing measures for solving the world food and nutrition problems. (d) *Programs Needed to Meet Objectives* and, (e) *Requirements to Establish and Effectively Implement* outline in some detail the programs needed to meet these objectives, and the requirements for establishment and effective implementation of a National Nutrition Policy.

These Guidelines were submitted to the U.S. Senate

Select Committee on Nutrition and Human Needs just before the National Nutrition Policy Study/Hearings June 19-21, 1974. The Consortium concludes the Guidelines by stating: "Finally, the National Nutrition Consortium urges responsible officials and members of the Congress to consider such policy as a whole, and give appropriate priorities to necessary legislation and funding."

NUTRITION LABELING

Another activity of the National Nutrition Consortium involves nutrition labeling. Almost two years ago, as nutrition labeling regulations were emerging, it was decided that development and implementation of nutrition labeling could be strengthened through a unified effort. A group of concerned scientists joined with the food industry to form the National Committee for Nutrition Labeling Education. When the National Nutrition Consortium was formed, it was felt that this body should be the one to establish a set of authoritative guidelines to help those who communicate with the consumer understand the use of nutrition labeling. The National Committee for Nutrition Labeling Education proposed this to the National Nutrition Consortium. In March 1974, the Consortium established a Steering Committee for their project on nutrition labeling.

The Steering Committee organized three Panels to achieve their objectives: (a) Panel on Nutrition Labeling; (b) Panel on Nutrition Information; and (c) Panel on Communications. A workshop of the Steering Committee and the three Panels was held May 16, 1974 in conjunction with the Annual Meeting of the Institute of Food Technologists to finalize a draft of guidelines for using nutrition labeling as a vehicle for nutrition education. A booklet, written by Mr. Ronald Deutsch, is being developed which will explain the nutrition label and provide pertinent nutrition information (a primer in nutrition) for those professionals who communicate regularly with the consumer.

DEVELOPING THE POLICY

I personally look to the National Nutrition Consortium as the prime mover in development and implementation of a National Nutrition Policy. It is important for the dairy industry, through the National Dairy Council (NDC), to continually have direct input into formulation and implementation of a National Nutrition Policy. For once established, such a Policy will permeate from the national level to every community. It is therefore vital that the National Nutrition Policy be consistent with the goals and objectives of the dairy industry.

Dr. Jean Mayer, Harvard University, assisted the U.S. Senate Select Committee on Nutrition and Human Needs in the development of the National Nutrition Policy Study/Hearings. NDC was listed as a "Cooperating National Organization" in these Hearings. NDC staff attended the Hearings and as a member of the Panel on Nutrition and the Consumer presented testimony

outlining a six-point program to improve and expand nutrition education (24).

In announcing the hearings, Senator McGovern, Chairman of the Select Committee, said: "The purpose of the Select Committee's study and hearings is to identify the measures necessary to develop a comprehensive National Nutrition Policy that will permit the United States to continue to fulfill its traditional goals—to insure the American people good nutrition at an affordable price, to encourage the American farmer to maximum production by guaranteeing a decent return on his investment and labor, to continue exporting food for foreign exchange so vital to the nation's general economic health and growth, and to meet our moral concern for the world's poor and hungry who are unable to sustain themselves. The recent disorientation of the American market is dramatic evidence of the fact that we cannot isolate ourselves from the problems of the world and must take account of them in setting our national policy.

"In today's world of increasing affluence, exploding population, variable weather and critical resource shortages, it is no longer possible to leave these goals to chance. We must have clear, long-term, and flexible policies that anticipate and adapt to changing world conditions."

The experts for the Conference were divided into 6 panels: (a) Nutrition and the International Situation, (b) Nutrition and Special Groups, (c) Nutrition and Food Availability, (d) Nutrition and the Consumer, (e) Nutrition and Health, and (f) Nutrition and Government. Background documents were prepared for each of the areas. Before the hearings, each panel prepared a detailed report containing an analysis of the nutrition problems in their subject area, including recommendations for governmental or other kinds of action. Unfortunately, all panel members did not review the recommendations of their respective panels before the conference; hence, the recommendations reflected opinions of only a select few. The panel recommendations were not available until the morning of testimony making it difficult for comprehensive analyses and preparation of testimony by discussants for the afternoon hearing. As a partial remedy, the hearing record was kept open until July 31, 1974.

NDC staff, in presenting testimony to the Panel on Nutrition and the Consumer, urged that strong efforts be made to bring nutrition education into the curriculum and teacher training with future efforts to be centered in the following areas: (a) increased programs of nutrition research to identify medical problems related to nutritional health and to seek answers to them; (b) establishing nutrition education as a part of the discipline of every child from kindergarten through grade 12; (c) increasing funding of nutrition education programs at all age levels; (d) adoption of legislation where necessary, at both state and federal levels, to provide guidance for development of a comprehensive

nutrition education curriculum in the nation's schools; (e) development of innovative curriculum that will make nutrition education exciting, meaningful and relevant to educators and children; and (f) modification of teacher-training programs so that the fundamentals of nutrition education are a requirement for teacher certification.

Since the hearings, Senator McGovern, as Chairman of the Select Committee, introduced on the Senate floor the National Nutrition Education Act of 1974 (18). This legislation embraced many of the recommendations made by NDC during the National Nutrition Policy Study/Hearings and represents one of the first legislative steps toward a National Nutrition Policy.

Notable among the many recommendations the Panels made to the Select Committee were these: (a) reorganization of the Federal structure to place all programs dealing with food policy in one agency; (b) increased emphasis on nutrition education, including a time bank by which free time would be provided for such education on radio and television; (c) stricter labeling regulations for food products, including the display of grades; (d) a "shock absorber" against both scarcity and surplus in the form of a national food reserve system; (e) formation of a high-level food and nutrition policy board and an office of nutrition to implement and coordinate programs; (f) compilation and release every three years or less of a statement on food practices and nutrition-related health conditions "as they are and as they are changing;" (g) ongoing analysis of representative foods and diets; (h) a system to monitor the nutritional status of "high-risk groups;" (i) Government support of 100 teaching institutes in nutrition and food at an annual cost of \$500 million; (j) a resources information center for nutrition supported by the Office of Education; (k) a nutrition education act to promote nutrition education in the schools; (l) establishment of a federal-state advisory commission on nutrition; (m) increased food production in developing countries; (n) a reduction in the world's rate of population growth; and (o) lower consumption of meat in the United States.

Excellent summaries of the Select Committee Hearings have been published in the *Journal of Nutrition Education* (27) and in *Nutrition Today* (2). While it is impossible to summarize the recommendations of each panel, the recommendations made by the Panel on Nutrition and Health are of particular interest and have implications for the dairy industry should they form the basis of a National Nutrition Policy (26). The theme of this panel's recommendations is that the diseases of the American population with associated nutritional causes are primarily due to dietary affluence—coronary heart disease, high blood pressure, diabetes mellitus, obesity, dental caries, and liver disease—and that a few simple changes in the American diet and habits of life could greatly reduce the number of people who acquire these diseases and who may die from them. The Panel made the following recommendations:

(a) "The development of the 'alternate diet' concept, which is a gradual and attractive approach to a different lifestyle of eating. The 'alternate diet' is designed to prevent disease and, at the same time, is nutritionally adequate. Because it is largely but not completely derived from legumes, grains, vegetable, and fruit products, it is less expensive to produce in terms of resources than the present American diet based much more on food products derived from animals. It has this additional feature of ecological soundness at a time of world food shortages. The 'alternate diet' involves the reduction of dietary cholesterol intake.

(b) "Reduction of dietary cholesterol intake. This basically means that consumption of animal food products must be drastically curtailed. These include chiefly meat, milkfat, high-fat cheeses, and egg yolk. It should be emphasized that a low cholesterol diet is what most of the world's less affluent populations consume at the present time. This diet comes closer to the kind of a diet which people have eaten for most of the time that civilization has been in existence.

(c) "Decreased saturated fat intake. Since animal foods which contain dietary cholesterol are also high in saturated fat content, the same foods mentioned above as containing dietary cholesterol in high quantities must also be restricted to lower the intake of saturated fat.

(d) "Reduction in total caloric intake. If the foods derived from animals which are concentrated in calories and if large quantities of sugar are avoided in the diet, it is probable that the problem of obesity would be largely controlled, as well as the problem of adult-onset diabetes, the form of diabetes which afflicts most Americans.

(e) "A reduction in dietary salt intake. This can be accomplished by the avoidance of salting of foods and by not including sodium chloride in manufactured food products as is so commonly done at the present time."

Specific recommendations regarding a National Nutrition Policy on Coronary Heart Disease embraced such areas as: nutrition education, food production and marketing, health maintenance, establishment of a National Nutrition Council and National Nutrition Institute in the U.S. Department of Health, Education, and Welfare and primary prevention of coronary heart disease in the community. An "alternate diet" for prevention of atherosclerotic heart disease was also presented. The basic philosophy of the "alternate diet" plan is to move people gradually away from foods containing saturated fatty acids and cholesterol. This plan will be implemented in 3 phases. "Phase I—The first phase will be to advise people to decrease gradually the amounts of meat, egg yolks, and certain dairy products eaten to avoid food items extremely high in cholesterol, saturated fat, and total fat and to use substitute products, i.e., margarine for butter, vegetable oils and shortening for lard, skim-milk cheeses for whole-milk and cream cheeses, and egg whites for whole eggs. Phase II—In phase II people will be encouraged to

change their habitual diet further by the incorporation of the recipes developed in 'alternate diet product development laboratories.' Phase III—Phase III will be to develop directly the philosophy of the alternate diet."

Basically, the American population is being encouraged to increase its consumption of legumes, vegetables, grains, oils, fruits and lowfat animal products. I would agree that many people are not choosing foods wisely on the basis of nutrients received per calorie ("nutrient economics") and that emphasis in nutrition education needs to be placed on attaining energy balance and desirable body weight through a wide selection of foods. However, there is no evidence that the "alternate diet" as proposed by this Panel will prevent, mitigate or cure coronary heart disease, decrease overall morbidity, or improve lifespan in the general population.

NDC has been responsive to this Panel's far-reaching recommendations. We prepared a documented review of the subject which we submitted to the Select Committee (22).

POLICY ON HEART DISEASE

In our commentary to the Select Committee, NDC recommended that should a National Nutrition Policy be developed on coronary heart disease, the following points be considered.

(a) *Any National Nutrition Policy should assure adequate nutrient intake and promote overall health*

Diets which contain a variety of foods representing all the food groups (15, 19) would assure intake of all needed nutrients. Any diets which tend to exclude certain foods or put excessive emphasis on any one source of nutrients run the risk of not providing adequate levels of all essential nutrients. Thus, a combination of animal and plant food sources is useful. Further support for animal products in the human dietary is provided by the findings of the U.S. Department of Health, Education, and Welfare 10-State Nutrition Survey, 1968-1970 (4). Of the nutrients found to be consumed in less than desirable amounts, animal products represent reliable sources of all of them except vitamin C. Dairy foods are particularly good sources of high quality protein, vitamin A, riboflavin, vitamins B₆ and B₁₂, niacin equivalents, and calcium.

(b) *Any National Nutrition Policy on coronary heart disease should consider all aspects of the question*

Fact should be distinguished from hypothesis. Factors which are high-risk on a population basis may not be so on an individual basis, and vice versa. It should be recognized that the effectiveness of suggested diet changes is only speculative at this time. Perhaps intervention programs such as MRFIT will shed new light on the hypothesized relationship of diet and coronary heart disease.

(c) *Any National Nutrition Policy should encourage and support research to determine the true causes of coronary heart disease*

Every effort should be made to get scientific facts as a basis to support dietary recommendations. "In the absence of conclusive proof on the diet-heart question, any dietary advice to the American public will always lack authenticity and authority, will be conducive to half-measures, and will meet opposition which cannot be effectively countered" (1).

(d) There are many risk factors for coronary heart disease

Coronary heart disease is a disease with a great number of contributing factors. Three major risk factors are: high blood pressure, elevated serum cholesterol level, and smoking. Persons at risk should control as many risk factors as possible.

(e) By physical examination and individual screening, persons at risk of coronary heart disease would be identified

Physicians should evaluate the risk profile of individuals and, if necessary, the individual should take steps to reduce those factors which tend to elevate his risk profile.

(f) Recognition of an interdependence among several factors as the best public health approach to coronary heart disease

The American public should rely on a nutritionally balanced diet that does not compromise the intake of essential nutrients, on sensible weight control, regular exercise, and routine physical examinations, including measurements of plasma lipid profile, as the best public health approach to coronary heart disease.

Finally, although we have already published a position statement on coronary heart disease (20) and a realistic chart on food cholesterol (21) we have revised our booklet on coronary heart disease (12) for use by Dairy Council staff with national leaders and consumers.

NUTRITION RESEARCH

As we witness a movement to develop and implement a National Nutrition Policy, it is essential that someone define how dairy foods will fill a vital nutritional role in carrying out this Policy. This is the only way to assure a continuing market for dairy foods. But who is going to do this and how will it be done?

I now would like to dwell more specifically on how the NDC Nutrition Research Program relates to a National Nutrition Policy. National Dairy Council is a scientific-educational institution supported by all segments of the dairy industry. For the past 60 years, Dairy Council nationwide has directed a Nutrition Research, Nutrition Education, and Nutrition Communications program emphasizing the nutritional value of dairy foods and their role in the attainment of optimal health to leaders throughout the country—and through them, to the consumers of America.

The NDC Nutrition Research Program serves as the foundation for the dairy industry's total marketing concept. Think for a moment of NDC acting as a nutritional spokesman within the scientific community, working on behalf of the dairy industry to achieve better

nutrition for all Americans, and in the process increasing the consumption of dairy foods. Thus we serve our industry as well as the community!

Nutrition research is important in that it extends the knowledge of nutrient requirements to the nutritional value of foods and their relationship to health. Nutrition research provides the foundation, as well as pointing the way to what a National Policy should be. Certain nutrition research topics are of particular interest to the dairy industry and these should be pursued vigorously by NDC. With the recent decline in federal support of research in general, and of research pertaining to nutrition and dairy foods in particular, the dairy industry must take the initiative to fund research relative to its specific needs.

NDC Staff have presented to the dairy industry nutrition research topics needing greater investigation. These need to be evaluated in the context of a National Nutrition Policy and then given sufficient funding priority to achieve their objective. Never before has interest in nutrition been so widespread and intense. Never before have we had the close attention of the consumer regarding the nutritional value of our foods. We need to grasp this unique opportunity firmly and head-on.

Nutrition research topics needing greater investigation by the dairy industry include: (a) What is the role of milkfat in the diet?—are the saturated fatty acids and cholesterol consumed in recommended daily amounts of dairy foods related to coronary heart disease? Is dietary cholesterol needed early in life for optimal development? (b) What is the tolerance of white and non-white people to lactose consumed in recommended daily amounts of dairy foods and is there an effect on nutrient utilization? (c) What is the role of calcium, phosphorus, vitamin D, and perhaps other milk nutrients in the prevention, mitigation, and cure of bone disorders such as osteoporosis and periodontitis? (d) Are there interactions between the components of milk which facilitate its nutritional value? Is the whole better than the sum of its parts? (e) What is the nutritional value of products which resemble and purport to imitate traditional dairy foods? These are just some of the nutritional and health concerns consumers have about dairy foods. Such concerns can influence the National Nutrition Policy and will affect governmental feeding programs which now include dairy foods. The belief of consumers as to whether dairy foods are fattening or adversely affect their health in some way undermines the effectiveness of other industry programs such as advertising and product development. Research is the key to resolving consumer health concerns about dairy foods.

The more we know about the nutritional value of dairy foods and their role in the attainment of optimal health the better Dairy Council will be able to serve the dairy industry. This knowledge is acquired only through a continuous and progressive Nutrition Research Program. A clear delineation of what is known and what is not

known in these respective areas is essential if the dairy industry is to remain consistent with a National Nutrition Policy and concomitantly meet the marketing challenges of the future. Acquisitions of the latest scientific knowledge in these areas and translation of their significance to professional leaders who influence consumer attitudes and purchasing behavior is an efficient and effective aspect of the dairy industry's total marketing concept.

The three fronts of Nutrition Research are Grants-In-Aid, Professional Contacts and Conference Support, and Library Research. The three are integrally related to our efforts to *discover, educate, and answer*. We look for opportunities to show the nutritional benefits of dairy foods, and we try to anticipate future health concerns about those foods. But we must not stop there, for to truly serve the dairy industry, nutrition research must strive to educate all levels of society. Our work involves influencing opinion leaders, informing consumers, and educating health delivery personnel. In addition, we answer for the dairy industry to combat inaccurate and false nutrition and health information about dairy foods.

We have recently developed a brochure describing the value of nutrition research to the dairy industry. It is entitled *Milk Still Makes the Difference* (23). This brochure provides an insight into what we are doing and how we are influencing a National Nutrition Policy in our subtle, effective manner.

Discovery

Acting as a tool for DISCOVERY, The Grant-In-Aid Program *investigates* the nutritional value of dairy foods as well as *anticipates* future health concerns about our foods. In addition, inasmuch as we are the spokesman in nutrition for the dairy industry, we must have research facts to support our viewpoint. There are a handful of nutrition professionals who set the tone regarding National Nutrition Policy. They are the leaders who sit on the Food and Nutrition Board, National Academy of Sciences-National Research Council; or the American Medical Association Council on Foods and Nutrition; or the American Academy of Pediatrics Committee on Nutrition; or the American Heart Association Committee on Nutrition, and now the National Nutrition Consortium. They act in accordance with their knowledge and experience. The NDC Nutrition Research Staff work closely with all these groups and keeps them informed of the latest research pertaining to the nutritional value of dairy foods and their role in the achievement of optimal health.

As we review the past and present NDC Grant-In-Aid Program, it is evident that our research efforts have been "right on." Our 1975 Program consists of 19 research projects in the areas of Nutritional Importance of Milk Sugar, Coronary Heart Disease, Nutrition and Bone Health, and Nutrition and Health. I would like to cite an example or two of how specific research projects are fulfilling the needs of the dairy industry.

As you are no doubt well aware, coronary heart disease is one of the major causes of death in the United States. Milkfat has been implicated in the disease process and this is affecting the sale of milk. The exact cause of coronary heart disease is unknown. The role of diet remains a scientific controversy. We need to know whether diet, and in particular dairy foods, is in any way related to this disease and these data need to be considered in the development of a National Nutrition Policy.

For the past five years, Dr. Meyer Friedman, a cardiologist in San Francisco, has been studying the role of diet and stress (behavior pattern) in the development of coronary heart disease under NDC sponsorship. Thus far he has studied 2500 men. The data to date have shown no relationship between diet and blood fats or incidence of coronary heart disease. Furthermore, this researcher has shown that stress (behavior pattern A) as exemplified by the hard-driving, aggressive executive with an extreme sense of time urgency, is an important risk factor in coronary heart disease. Before NDC support, the role of stress in coronary heart disease was not well-documented or accepted by the scientific community. During the past five years Dr. Friedman and his colleague, Dr. Rosenman have presented their research findings to the medical and scientific community through numerous lectures and formal publications regarding the role that stress plays in the development of coronary heart disease. NDC has been particularly aggressive in communicating these data to national leaders through the Dairy Council Digest, Nutrition News, Food Writers' Conferences, a film on coronary heart disease, and many other similar activities. Some of you may have seen Dr. Friedman recently on the Barbara Walters Show (NYC) "Not for Women Only." Dr. Friedman is also planning to publish a pocketbook edition of his views on stress and coronary heart disease, following up on the success of the best seller he and Dr. Roseman authored early in 1974, *Type A Behavior and Your Heart*.

Another example I want to share with you is in the area of lactose intolerance. Lactose intolerance is the inability of some people to adequately digest milk sugar. The potential problem of lactose intolerance and its significance to the dairy industry was identified during the late 1960's. Funds were inadequate to investigate the situation and as a result only one side of the story was told. Many leaders were questioning the use of milk in domestic and foreign feeding programs. Only after much adverse publicity was NDC able to initiate studies in this area. We are now zeroing in on better methods of detecting lactose intolerance, establishing accurate figures of occurrence, and furthering our understanding of the nutritional role of lactose in the diet. We are defining the difference between lactose intolerance and milk intolerance. Our research is revealing that subjects believed to be intolerant to lactose can consume nutritionally useful quantities of milk without undue

symptoms developing and that the traditional method of determining lactose intolerance grossly exaggerates the practical problem. These data also have been extensively communicated to leaders by NDC. Dr. Michael Latham, Cornell University, one of NDC's grantees in this area, recently published his findings regarding lactose intolerance and milk consumption (29). This paper was widely interpreted to national leaders. Last, the 1974 NDC Annual Nutrition Research Conference completely reviewed the state-of-the-art on lactose tolerance and provided guidelines for future research and ultimately the National Nutrition Policy.

Education

EDUCATING all levels of society embraces *influencing* influentials, *informing* consumers, and *educating* health delivery personnel. The credibility and hence acceptability of Dairy Council in the scientific community, particularly with those professionals and societies who will play a prime role in the development and implementation of a National Nutrition Policy, speaks for itself. Policy makers and key leaders routinely look to Dairy Council for reliable, accurate nutritional information about dairy foods. Our ability to marshal those resources which support sound programs in nutrition, including dairy foods, will not only influence a National Nutrition Policy but also will have a marked impact on milk's position in an extremely competitive market.

Total involvement in the professional community provides a hotline to and from NDC relative to issues of national concern which influence the dairy industry. Through its program of Professional Contacts and support of Medical and Scientific Conferences, NDC remains immersed in the scientific milieu. We attend key strategic conferences of leading researchers—47 major national meetings in 1974 wherein we presented 24 speeches relative to the nutritional value of dairy foods and their role in health. We visit the laboratories of the men whose data will provide the input for tomorrow—72 different laboratories in 1974. And we sponsor scientific meetings which bring investigators on the forefront together—six in 1974. This keeps us where the action is and thus better informed to serve the dairy industry. Very importantly, we not only learn, but we teach. We hear what others have to say, and influence key leaders in our beliefs.

Sponsorship of medical and scientific conferences and symposia with national professional societies enables NDC to have controversial issues in nutrition and health put into proper perspective as these leaders meet annually to assess current knowledge in these areas. Collectively, these societies, either directly or indirectly, are involved in the National Nutrition Consortium, have had an impact on the U.S. Senate Select Committee's National Nutrition Policy Study/Hearings this past June and will be primarily responsible for setting the objectives of, as well as implementing, a National Nutrition Policy. It is through these organizations that

NDC can have its greatest impact on future nutrition policy.

One symposium of particular interest is the one NDC cosponsored with the Institute of Food Technologists at its Annual Meeting, May 1974. It was entitled "Nutritional Perspectives and Atherosclerosis." Three of the four participants were NDC grantees. The objective of the symposium was to review for the food industry new knowledge relative to the basic dietary components—fats, proteins, and carbohydrates (including fiber) as well as genetic-diet interactions and their relationship to coronary heart disease. The communication of these data to key leaders as well as their publication in the scientific press, placed the role of diet and its components into perspective as regards coronary heart disease. In addition, in 1974 NDC also worked in a similar fashion and developed five other symposia and conferences with leading national professional societies.

Speaking for the industry

ANSWERING for the dairy industry involves *battling* misinformation, *reacting* to governmental programs and legislation, and *interpreting* research findings for the dairy industry. How many of you have read a newspaper or magazine article containing misleading information about milk such as "Don't cry over spilt milk, it's not good for you anyway!" "Drinking milk is worse for you than smoking," "Milk socks it to you right in the heart" or the *Consumer Reports* article "Milk—Why is the quality so low?" and felt—I wish someone would respond to that writer! Well, that someone is Dairy Council. You can turn to Dairy Council to set the record straight with scientific evidence. Efforts such as these establish Dairy Council as a reputable and reliable resource in nutrition.

The key to our ability to answer is professional credibility and the NDC Library. The library at NDC is one of the very best sources of current information about the nutritional value of dairy foods in the country. It is the resource center for published scientific information necessary to document the Dairy Council program and its educational materials. It enables us to answer nutritional questions regarding dairy foods received regularly from key national leaders. We are pleased with our library not so much in terms of "look what we *have*," but rather, "look what we can *do*."

Another primary responsibility of Nutrition Research is to serve as a resource in nutrition to the entire dairy industry. In 1973, for example, position papers were prepared by Nutrition Research on the following subjects: (a) Background in New Legislation Affecting Child Nutrition Programs (Competitive Foods, Summer Meals, Special Milk). (b) A letter to the U.S. Department of Agriculture questioning the scientific basis on which the USDA on June 4, 1973 proposed changes in the type of milk served under the Child Nutrition Programs. (c) A detailed and extensively documented commentary regarding the nutritional aspects of the U.S. Food and Drug Administration proposed regulations pertaining to a common or usual

name for filled milk products. A standard of identity for filled milk products has not yet been promulgated by FDA. If and when they are, we hope they will reflect the recommendations made by NDC. (d) An alternate resolution to the American Dietetic Association resolution on fat in the diet. The ADA resolution was drafted to support the American Heart Association stand on fat in the diet.

Already in 1974 we have: (a) developed a summary of compositional analysis of Dairene product, an imitation milk, as compared to whole milk (13), (b) developed a similar summary of compositional analysis of Vitamite, another imitation milk, as compared to milk; this information is useful not only to the dairy industry but also to the professional community; a few years ago the Committee on Nutrition, American Academy of Pediatrics published a position statement on filled milks, imitation milks, and coffee whiteners utilizing information on some of these products supplied by NDC (5), (c) sent a letter to the U.S. Department of Agriculture on its proposed regulation to allow cheese alternate products in the National School Lunch Program and Special Food Service Program for Children, (d) submitted a statement to the U.S. Senate Select Committee on Nutrition and Human Needs on "Coronary Heart Disease: Risk Factors and the Diet Debate" (22).

SUMMARY

I have devoted most of this discussion to what Dairy Council is doing at the national level through its Nutrition Research Program to define the nutritional value of dairy foods and their role in the attainment of optimal health. Acting as a tool for discovery, answering for the dairy industry, and educating all levels of society are the basic components of this effort. It is this kind of a national effort which sets policies and programs into action. Many leaders within the professional community believe that the United States should have a National Nutrition Policy. A National Nutrition Policy has little effect unless it is reinforced in communities throughout the United States. A strong grass roots program is fundamental to the success of any national program. And so it is with Dairy Council.

We at NDC are acting as a nutritional spokesman for the dairy industry at the national level. The Dairy Council staff throughout the country must act as a nutritional spokesman at the State and Community level. Working together, we can achieve an effective nationwide program in Nutrition Research, Nutrition Education and Nutrition Communications. Educating the leaders who influence consumer attitudes and buying habits is the foundation of the dairy industry's total marketing concept. I am reminded of a quotation by Emerson. *Changing Times* quotes him as saying, "This time like all times, is a very good one if we but know what to do with it." This quotation puts the problems and opportunities of the dairy industry into perspective. Our

future success is dependent on effective implementation of today's short—and long-range goals and objectives.

It is evident that Nutrition Research does have a primary role in the development and implementation of a National Nutrition Policy. The Dairy Council Nutrition Research Program in particular does have a significant impact on this policy and thus will be one effective way of assuring the continued recognition and use of dairy foods in fulfilling national objectives in nutrition and health.

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REFERENCES

- Ahrens, E. J., Jr. et al. 1969. Mass field trials of the diet-heart question. An assessment of seven proposed experimental designs. Amer. Heart Ass. Monograph No. 28. Amer. Heart Ass., New York, New York.
- Anonymous. 1974. Hearings of the McGovern committee on nutrition and human needs. Nutr. Today 9:22.
- Borgstrom, G. 1972. The hungry planet, 2nd ed. Collier Books, New York, New York.
- Center for Disease Control, U.S. Dept. of Health, Education and Welfare. 1972. Ten-state nutrition survey, 1968-1970. Pub. No. 72-8134, Atlanta, Georgia.
- Committee on Nutrition, American Academy of Pediatrics. 1972. Filled milks, imitation milks, and coffee whiteners. Pediatrics 49: 770.
- Food and Drug Administration, U.S. Dept. of Health, Education and Welfare. 1973-1974. Food labeling. Federal Register 38:2124, 6950, 20702; 39:20878.
- Goldsmith, G. A. 1973. A national nutrition policy and program, Amer. J. Clin. Nutr. 26:901.
- Goldsmith, G. A. 1973. For a national nutrition policy. Nutrition Today, July/August.
- Hearings of the Select Committee on Nutrition and Human Needs of the U.S. Senate. 1969. Part I, Problems and prospects. U.S. Gov. Printing Office.
- Hegsted, D. M. 1973. The development of a national nutrition policy, J. Amer. Dietet. Ass. 62:394.
- Hegsted, D. M. 1974. Food and nutrition policy—Now and in the future, J. Amer. Dietet. Ass. 64:367.
- Hursh, L. M. 1975. Coronary heart disease: Risk factors and the diet debate. National Dairy Council.
- Huston, R. L., and E. W. Speckmann. 1974. Filled milk claims are found inaccurate. Hoards Dairyman 119:196.
- Kline, O. L. 1973. Toward a national nutrition consortium. AIN Nutrition Notes 9:4.
- Leverton, R. M. 1974. Fats in food and diet. USDA Ag. Info. Bull. No. 361.
- Mayer, J. 1972. Toward a national nutrition policy, Science 176: 237.
- Mayer, J., (ed). 1973. U.S. nutrition policies in the seventies. W. H. Freeman Co., San Francisco.
- McGovern, G., et al. 1974. National nutrition education act of 1974, S3864, July 31.
- National Dairy Council. 1971. A guide to good eating.
- National Dairy Council. 1972. A declaration of inter-dependence.
- National Dairy Council. 1973. Have you ever seen a realistic chart on food cholesterol?
- National Dairy Council. 1974. Coronary heart disease: Risk factors and the diet debate. Submitted to the U.S. Senate Select Committee on Nutrition and Human Needs. July 26.
- National Dairy Council. 1974. Milk *still* makes the difference.

24. National Dairy Council Nutrition Education: An Idea Whose Time has Come. 1974. Submitted to U.S. Senate Select Committee on Nutrition and Human Needs, June 20.
25. National Nutrition Consortium, Guidelines for a National Nutrition Policy, prepared for the U.S. Senate Select Committee on Nutrition and Human Needs. 1974. U.S. Gov. Printing Office.
26. Panel on Nutrition and Health. 1974. Recommendations regarding a national policy on nutrition and health. Submitted to the U.S. Senate Select Committee on Nutrition and Human Needs, June 21.
27. Phillips, M. C. 1974. The hearings of June, 1974: In perspective. *J. Nutr. Education* 6:ii.
28. Report of the President's Science Advisory Committee. 1967. The world food problem. U.S. Gov. Printing Office.
29. Stephenson, L. S., and M. C. Latham. 1974. Lactose intolerance and milk consumption: The relation of tolerance to symptoms. *Amer. J. Clin. Nutr.* 27:296.
30. U.S. Department of Agriculture. 1956. Food consumption of households in the United States. Household food consumption survey 1955. U.S. Gov. Printing Office.
31. U.S. Department of Agriculture. 1968. Food consumption of households in the United States, Household food consumption survey 1965-66. U.S. Gov. Printing Office.
32. White House Conference on Food, Nutrition and Health. 1970. Final report. U.S. Gov. Printing Office.
33. White House Conference on Food, Nutrition and Health. 1971. Report of follow-up conference, Williamsburg, Va.

Certification of Food Service Managers—Why and How?^{1,2}

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ABSTRACT

As an apparent consequence of recent scares concerning botulism and generally increased public concern for environmental quality, there is widespread interest in comprehensive programs of education food service industry management personnel in food protection. Most often these efforts are justified on epidemiologic grounds. Foodborne illness experience does not support this position.

The program initiated by the Ohio Department of Health in 1972 and funded by the Food and Drug Administration during 1973-1974 is the most prominent example of such a program. Examination of a report submitted at the June 1974 National Environmental Health Association conference reveals that this program is quite costly, excessive in the scope of its curriculum, and most probably places an undue academic burden on food service management people. Apparently heavy emphases are placed on foodborne disease, microbiology of principal foodborne etiologic agents, epidemiology, food service establishment plan and equipment review, exploration of the organization of official health agencies concerned with food protection, and itinerant and temporary food service operations. Most of these are topics the average food service manager has neither the need nor the ability to effectively understand. It is contended that food service manager training in code requirements and interpretation, the concept of self-inspection and regulation, and the rudiments of food protection practice is sufficient.

Voluntary participation in a program embodying academic excesses is only wasteful. However, potentially serious problems could result if legal requirements were adopted making satisfactory testing performance in such a program mandatory. A situation could eventuate wherein people lacking academic prowess would be deprived of the opportunity to pursue a vocation they have successfully and safely engaged in for years. Environmentalists are challenged to remember that environmental technology is only a tool and not their master and to serve the public with this view in mind.

Repercussions are reverberating throughout the nation's food service industry and official environmental health circles as a result of the recently intensified efforts to educate the industry in the imperatives of food protection. This thrust is aimed at the management/supervisory levels of industry and the program is termed: Food Service Manager Certification.

Perhaps the most widely heralded such program is the one initiated by the Ohio Department of Health in 1972. It has received considerable notoriety apparently because of its scope and the publicity associated with the financial support accorded the program by the U.S. Food and Drug Administration (FDA) during 1973-74. The FDA support was provided to obtain "technical

information which could be used to implement a similar program on a national perspective" (7).

Judging by the facts that the National Environmental Health Association conducted a special workshop on this topic during its June, 1974 meeting, and that there is widespread interest in it among professional environmentalists, it seems possible that many other jurisdictions may be inclined to board this bandwagon. Before this occurs, it is our purpose to sound a cautioning note and establish a perspective on the effort.

WHY FOOD PROTECTION EDUCATION?

Traditionally, the "raison d'être" for an official food control program and its collateral formal educational effort has been the protection of the public from foodborne illness. In the Ohio report this is affirmed several times as the basic justification for this training/certification endeavor. Likewise, in the foreword of the new Center for Disease Control (CDC) training manual (4) Bryan declares that "... before the food borne disease problem will be significantly reduced, food service supervisors and managers must become aware of the factors that contribute to foodborne disease outbreaks, and they must be motivated to require appropriate preventive measures as routine practice in the operations that they supervise. Formal training assists these supervisors and managers in gaining such awareness and motivation."

Clearly these premises are predicated on the assumption that we are confronted by a significant problem with foodborne illness, principally those involving bacterial agents of the genera *Staphylococcus*, *Clostridium*, and *Salmonella*. Let us examine this assumption for apparent validity.

In the "Slide #1-Narration Guide" in the CDC Training Kit (4) is a graph on which are plotted food-, water-, and milk-borne disease outbreaks for the 1940-1972 period, as reported to the CDC. The curves show water- and milk-borne outbreaks dropping off sharply, but the number of foodborne outbreaks held fairly constant at around 300 per year. In view of the nation's substantial population growth and disproportionately great increase in dining out habits of the country, the absence of a dramatic increase in the number of outbreaks must be reckoned as a significant success in food protection. (It is noted, parenthetically, that a foodborne "outbreak" is any episode in which more than one person becomes ill).

¹Views expressed in this paper are personal in nature and are not to be construed as reflecting the official current or projected policy of the authors' employing agency.

²EDITOR'S NOTE: This paper presents a viewpoint different from that commonly held by many persons concerned with the public's health. Readers wishing to comment on the contents of the paper are invited to prepare and submit "Letters to the Editor."

Exploring the statistical aspects of the allegedly significant public health problem further, Slide #2 narrative stipulates that only an estimated 10% of all investigated (by state and local agencies) outbreaks are reported to the CDC. Considering the high esteem and prestige that the CDC enjoys among epidemiologists, this rank disregard of their program requirements seems improbable. Notwithstanding the possibly questionable nature of that estimate, accepting it for discussion purposes results in an estimated 3000 outbreaks per year. Proceeding further to Slide #5 narrative, which deals with "Place Where Illness Was Acquired," we find that 37% of the outbreaks occurred in food service establishments, with the balance occurring in homes, at picnics, and in other non-commercial operations. Thus we find that there are approximately 1100 ($3000 \times .37$) reported outbreaks in food service establishments annually in this country. Comparing this figure with the estimated number (600,000) (3) of food service establishments in the United States, we arrive at a frequency of one per 545 establishments per year.

In view of the preceding analysis of data, is it any wonder that environmental health specialists suffer from a credibility gap in attempting to sell food protection to the industry primarily on the basis of foodborne disease potential? What does the food sanitarian do when the establishment operator honestly responds to exhortations to effect corrections on the basis of food-borne illness potential that he has "been in business for over 20 years and hasn't had a problem yet?" Does he waggle a threatening finger with the warning that he has just been lucky . . . so far?

CONSTRAINTS ON FOODBORNE ILLNESS

Why are we confronted by this dilemma or good fortune? In part, the answer lies in the microbiological and chemical dynamics involved in foodborne disease outbreaks caused by the "big three:" *Staphylococcus aureus*, *Clostridium perfringens*, and *Salmonella* species.

S. aureus causes illness by production and discharge of a heat-stable enterotoxin into a potentially hazardous food before its ingestion. *S. aureus* is a very weak competitor. Consequently, if it is introduced into a raw food which is held a sufficient period at a favorable growth temperature, it will probably be overgrown by saprophytes resulting in spoilage of the food and the production of no *S. aureus* toxin. Therefore, if the *S. aureus* is not to be subjected to such competition, the food would have to be cooked to destroy competitors or be salted or sweetened (like ham or custard) to suppress competition. If it is a cooked food, the *S. aureus* inoculum would have to be introduced through poor handling practice after cooking. The food would have to be mishandled by storage at an improper temperature for a sufficient period to permit logarithmic multiplication and production of the exotoxin. Moreover, the product would have to be sufficiently salted or sweetened or the contaminating inoculum would have to

be an almost pure culture of *S. aureus*, lest the feared pathogen suffer the adverse affects of competition. In view of these constraints and the coincidental parameters that must be satisfied for a *S. aureus* foodborne intoxication to transpire, it is hardly surprising that outbreaks are relatively rare.

Let us now consider the factors involved in an outbreak of *C. perfringens* foodborne gastroenteritis. Interestingly, for some years this had been deemed an infection. This was apparently inferred from the usually protracted incubation period of 8 to 22 h (2). However, recent studies (6) have demonstrated that the gastroenteric symptoms are mediated by liberation of a heat-labile enterotoxin "in vivo" from the cellular cytoplasm during sporulation.

C. perfringens is an anaerobic, spore-former with thermophilic tendencies. The strains of types A and F which produce the enterotoxin of concern favor a high protein medium and produce spores of variable heat resistance. In an epidemiologic context, the reservoirs (sources) of this microorganism are usually considered to be the intestinal tracts of men and animals and the soil. Its presence on the surface of meat supplies coming into food establishments is readily demonstrable (5) and presumably results from gut content contamination during slaughter and dressing of the carcass.

This product contamination can be minimized by good handling/processing technique and thorough flushing with water. Being an anaerobe, the raw meat surface contaminant exists in a static, non-reproductive phase. Normal cooking will prove lethal to vegetative cells; however, such treatment may serve only to heatshock spores and stimulate their germination and multiplication if the meat/juice product is held at optimum growth temperatures (100-115 F). Holding an inoculated gaseous oxygen-depleted meat product at a favorable temperature for several hours can result in development of a sufficient number of cells to cause gastroenteritis, if the product is ingested. Since the ingestion of a large number of cells is demanded if illness is to ensue (6), reheating such a product to a sufficient temperature (165 F) would assure destruction of these cells and render the product safe.

In terms of customary operating practice it seems apparent that the greatest danger of *C. perfringens* foodborne illness is associated with holding and serving large cuts of beef (5) where high temperature holding would impair quality in terms of "doneness." In such instances, the practice of good hygienic technique and strict control of the time (microbial incubation) parameter are essential. Notwithstanding this primary area of potential problems, we see once again that an intricate combination of poor practices is coincidentally required for an outbreak to occur.

Turning briefly to the last leg of the "big three," food borne illnesses caused by several of the salmonellae, we find that we are dealing with far less fastidious microorganisms than are the other two. Salmonellae will reproduce on almost any moist food which does not

embody an adverse factor of pH, salt, etc. These are mesophilic facultative anaerobes and do well in gaseous oxygen-depleted cooked food. While they proliferate more readily on the usual "potentially hazardous foods," there are indications that they can be transmitted on food as innocuous seeming as tossed salad.

Of the three primary etiologic genera, salmonellae are the most serious in terms of impact on the foodborne illness victim. Causing disease by enteric infection, severe dehydration, localization in specific organs, abscesses or septicemia can result from foodborne salmonellosis. In cases where the victim is immunologically impaired, very old or otherwise debilitated, such episodes are too often fatal.

Reservoirs (sources) of these microbes are readily available in foods of animal origin or asymptotically infected food service personnel. Fortunately, these are heat-sensitive microorganisms and involve no heat resistant factors such as the exotoxin of *S. aureus* or the spore of *C. perfringens*. Therefore, exclusion of *Salmonella* carriers or frankly ill people as food handlers, thorough cleaning of fruits and vegetables to be eaten raw, thorough cooking of foods of animal origin, and proper temperature control of prepared food will effectively prevent salmonellosis. Again, the requirements for a salmonellosis outbreak include the coincidence of a number of deficient practices.

In view of the above outlined natural constraints, the total transition to mechanical refrigeration/freezing equipment, and industry awareness resulting from decades of intensive public health activity, it would be truly amazing and to the discredit of everyone involved if we did have a significant problem with foodborne illness.

CURRENT PROMOTIONAL TRENDS-OHIO'S PROGRAM

Yet we persist in "beating the epidemiologic drums loudly" in encouraging proper food protection. Would it not be more credible and accurate to speak of esthetics, good general sanitation and cleanliness, legal requirements, minimization of food spoilage, superior product quality, consumer expectations, and, ultimately, if we do many things wrong, we can create an instrument of harm to others? Perhaps these prosaic considerations lack sufficient technological elegance for environmentalists to comfortably address. What ever the reason, we feel that we are over playing the public health aspects of the matter.

Another unfortunate trend is the basis on which we promote good public health practice. This is typified by the Slide #6 narrative in the CDC training kit (4) which indicates that an outbreak opens a Pandora's Box of problems for the establishment, including, but not limited to: loss of customers and sales; loss of prestige and reputation; legal suits resulting in lawyer and court fees; increased insurance premiums; lowered employee morale; absenteeism of employees; need for retraining employees; and embarrassment. The slide's title is "Economics-Cost of Foodborne Illness to the Food Industry." There was a time when we would promote

concerns of public health in terms of preventing injury, illness, or death of potential victims. Could this shift in emphasis of concern from others, to self, be part of the problem?

The Ohio report (7) correctly indicates that one of its program's goals is to foster the ability and attitude of self-inspection and in-house training of subordinates. This is a worthwhile goal and for many sanitarians has been the goal of the field inspection program for many years. Certainly, formal classroom instruction is a valuable adjunct to the field program, since the field inspection operates primarily on a negative and self-limiting format and the classroom permits more comprehensive, impersonally directed instruction.

Another stated goal of the Ohio program is to reduce the cost to the taxpayer for the ever-burgeoning regulatory program. The desire is expressed to "reverse the present trend which in effect compels state and local government to add another 10 to 12 thousand dollars to the public payroll every time another two hundred or so food service operations or vending machine locations are established in Ohio." Further, the summary statement reads: "In summary the food service manager certification program was initiated to upgrade food protection and public health in Ohio by lessening the work load of local health departments by providing a more highly educated professional food service manager, allowing the local sanitarian to spend his time in problem areas where most needed." If there is the need to protect the public health thru improved food protection and averting foodborne illness outbreaks, where is the local sanitarian more needed than in this program?

Desiring to reduce the burden on the taxpayers is a legitimate goal. Therefore, the assumption that "manager certification can very well be the way to do this" should be briefly examined in light of the Ohio experience. The FDA funded this program for exactly one year, from March 1973 thru March 1974 at a total cost of \$114,053.00. This provided the initial 4-day training (24 h in classroom plus homework) for the certification candidates in 15 classes. As best can be inferred from the report, 25 students participated in each class, resulting in a total of 375 (25 x 15) trainees. Relating the total program cost of the total number of trainees, we find that it cost the taxpayers in excess of \$300 per trainee for just the initial phase of the certification program. Ongoing program costs for the same group of trainees continue for at least 2 years in conducting or monitoring the "self-improvement program meeting established educational requirements and participating in a self-inspection program." The plan provides that: "failure to meet these standards results in forfeiture of one's certificate." It is inconceivable that satisfactory performance of a self-inspection program can be measured or verified without field inspection. Additionally, there are, of necessity, concealed administrative overhead costs on the part of FDA officials and state and local health people.

The previously cited hope of abating an added

\$10-12,000 per annum personnel cost for each 200 new businesses needs to be compared with the foregoing. Disregarding the potentially large indirect and unprojected costs, the initial direct training cost for the 200 new operators would be \$60,000 (200 × \$300). This sum would fund the \$10-12,000 field surveillance/education cost for at least 5 years.

It may be proposed to pass this cost directly on to the operators rather than drawing on general tax funds. But would not this be the equivalent of a tax levy? First the industry is assessed; then they pass it back to the consuming (taxpaying) public in higher costs.

The point of this analysis of fiscal aspects is to indicate that we should avoid committing ourselves to any such self-deluding hypotheses, however attractive they may be. If they stand up, we deceive our legislative (funding) people and public constituency; if they don't our profession is discredited.

Why play semantical games with the cost-benefit relationship of such a program? If it is determined that some type of comprehensive educational program (certification) is compellingly needed, let us forthrightly acknowledge that it is going to cost and then sell the program on its projected programmatic merits.

EDUCATIONAL CONTENT — THE OHIO PROGRAM

In turning to a consideration of the scope and sufficiency of the Ohio curriculum for the initial training/certification phase, it must be remembered that any educative program should be tailored to the needs and capabilities of the students. If anyone were to suggest that elementary calculus or nuclear physics be included in this program, we would be unanimous in our response that, "They don't need to know that." Precisely! Let us examine the Ohio Program in light of the "need to know" criterion. Briefly, the 24-h program can be categorized on the basis of topic, time, and percentage of time allocated in accordance with the following tabulation.

1. Introduction and examinations	2.25 h (9.3%)
2. Laws, regulations, and responsibilities	1.00 h (4.2%)
3. Microbiology and foodborne disease	3.50 h (14.6%)
4. Safety and accident prevention	2.00 h (8.3%)
5. Laws, regulations, and industry self-inspection	3.00 h (12.5%)
6. Procedures for training food handlers	2.00 h (8.3%)
7. Plan and equipment review	2.50 h (10.5%)
8. Your local health department	.75 h (3.1%)
9. The "hidden part" of the food service industry	1.00 h (4.2%)
10. Food handling practices	3.25 h (13.5%)
11. Food-disease-health-handling relationships	1.00 h (4.2%)
12. Group problem solving	1.25 h (5.2%)
13. Role of certified food service managers (by class)	.50 h (2.1%)

Topic #2 deals with the administrative structures, procedures, and responsibilities of state and local health departments and some official boards in Ohio. Do food service management people need to know this or can they utilize the information? If the business is regulated by a local health function, it is the manager's need to know how to contact that agency or his sanitarian, not how the department is organized and how it interfaces with other segments of officialdom. It is probable that many health

officials in Ohio do not possess a complete understanding of this official hierarchy and would learn this if and as they had to deal with it.

Topic #2 coupled with #8 (Your Local Health Department) would appear to constitute a fairly comprehensive orientation to official regulatory health functions having jurisdiction in food protection. Collectively, 7.3% of the training effort time is invested in these areas.

Topic #7, "Plan and Equipment Review," consumes over 10% of the educative effort. Professional sanitarians involved in plan review spend many days agonizing over plans and specifications trying to learn how to correlate architectural, mechanical, and electrical prints; decipher books of details and specifications; read equipment plans and schedules; cope with finish schedule codes; evaluate equipment in terms of National Sanitation Foundation criteria; assess product flow in terms of cross-contamination potential; size hot water heating requirements and thus judge the adequacy of hot water generating equipment; or evaluate the adequacy of a local exhaust ventilation system. Would the food service establishment manager be his own designer or his own reviewer or both? Obviously, these skills are not to be acquired in 2½ h of classroom work. Then why present such information beyond informing operators of their responsibility to submit plans before construction?

Topic #9 deals with the control of such "hidden" food service operations as vendors, caterers, mobile services, and carnivals. By implication, the manager certification trainees are not involved in these operations, and, simply stated, it is not their concern or need to understand the health departments' problems with such operations. Should questions arise during discussion, they can be briefly and adequately handled without a curriculum section.

Topic #12 dealing with "Group Problem Solving" is apparently designed to initiate trainees to the value of "brain-storming" problems. If this involves role playing with hypothetical problems, it is probably so contrived as to be more entertaining than educational. Such group problem solving is probably already practiced at restaurant association meetings among managers and in individual establishments among staff members. If not, it is improbable that a manager can become a devotee and practitioner of this management technique in 1¼ h

Topic #13 is an imponderable as the report does not elucidate it beyond being a program slot. Is this a 60-sec feedback by all 25 trainees of the important things they have learned? Or does one represent the whole group in demonstrating conversance with the sanitarian's jargon?

So far we have commented on five program sections comprising more than 25% of the allotted instruction time. Bluntly, we feel that this represents an utter waste and we are at a loss to fathom the motive for their inclusion in the program.

Let us now consider the scope of some of the other more relevant curriculum topics. Topic #3 is a necessary ingredient but the question remains as to how it should

be developed. The Ohio report indicates that it deals with the microbiology and control of the principal food borne bacterial agents, chemical food poisoning, and foodborne disease outbreak investigation procedures accompanied by an epidemiological exercise as a homework assignment. This seems strongly reminiscent of the itinerant CDC course in foodborne disease epidemiology. The CDC course is designed to challenge the understanding of professional sanitarians, epidemiologists (M.D.), and environmental health administrators.

Under usual circumstances a small alleged foodborne disease outbreak investigation may be handled locally by the sanitarians and health director. However, when an apparently significant outbreak occurs, the local health authority usually engages the assistance of professional epidemiologists from the state health department, CDC, or other resource agency. What is the justification for attempting to teach food service establishment managers the skills of an epidemiologist?

Does a restaurant operator need to master such Greek terms as "staphylococcus," "aureus," or "clostridium?" Does he need to know that salmonellosis causes fever and staphylococcosis a depression of body temperature? Does he need to remember which illness results from an infective process and which from a toxic effect? Does he need to know variations in incubation periods? Does he need to know which bacterium is a spore former and which is not? Does he need to know the technical names of the organisms which are common to beef, poultry, eggs, human noses, human intestines, etc?

Would it not be sufficient for him to know that there are several germs which can come from foods of animal origin or from the human body and, if introduced to cooked potentially hazardous foods, can cause intestinal illness (or death) if permitted to multiply, through improper temperature control? These elements, properly developed and emphasized with adequate prevention and control information, are all the restaurant operator needs to know. It is probably also all the average operator can comfortably cope with.

This brings us to the areas of excellence in the Ohio curriculum, topics #5 and 10. These have to do with a study of the code and its interpretation, food handling practices (prevention), and self-inspection. Understanding of the code and what constitutes good practice automatically equips the operator for self-inspection. Encouraging this self-critical approach and attitude is laudable. Regrettably, these two topics are accorded little more than 25% of the instructional time of the program. We believe that they should constitute 80-90% of the endeavor.

By way of summary comment on the Ohio program, we can not help but observe that, if a person can demonstrate even reasonable mastery of the several educational topics, any official health agency should be pleased to hire him as a professional food sanitarian.

NEED FOR MODERATION—RISKS IN EXCESS

In 1947, Adams (1) reported on the operation of a

number of training programs for food handlers. He encouraged the implementation of such programs by health departments on a much more moderate and relevant basis. While most training efforts were inadequate, much success in food protection has been achieved since 1947, as attested to by the previously cited epidemiological statistics. We must remember that these managers are not sanitarians, epidemiologists, microbiologists, or food technologists. Food protection and compliance with sanitation codes represent just one of many concerns the restaurant operator has. He must deal with purchasing, inventory control, staff hiring and training, supervision, plant maintenance, tax and accounting procedures, advertizing, merchandising, preparing tasty dishes, customer relations, and probably many other areas of interest. As environmentalists, we do not understand most of these areas, and nobody expects us to. Should we not show the same consideration to restaurant operators?

It is noted that the Ohio program is only voluntary and appointments are made on the basis of health department recommendations and demonstrated high motivation. This provides a built in bias for success of a pilot program.

To this point we have urged avoidance of excess in these training activities. Other than a waste of time, effort, and money, the primary danger we see is such a voluntary program is the possible implication being conveyed to the public that the non-certified manager is somehow less capable of preparing and serving safe food. Moreover, this impression would tend to be endorsed by all levels of government. This seems contrary to the role and duty of governmental agencies which exist to serve all segments of the public.

The real risk we see in this is the situation wherein such a program acquires the full force and effect of law. This could transpire where a legislative jurisdiction might ordain that all managers and supervisors be trained and certified in food protection and the administering agency proceeds to use the Ohio program as a model. Here the industry would be confronted by a situation wherein industry personnel would be required to pass what is admittedly a college level program (4, 7) to legally pursue their chosen vocation. The food service industry has long represented vocational opportunity to the educationally disadvantaged in a technologically oriented society. In many such cases, the food industry has been a chance to successfully "go into business." Would this program erase such an opportunity?

Already we have many marginally educated and foreign speaking people owning, managing, and supervising food establishments. It is highly probable that many of these could not pass such a college level course under any circumstances. Are we to tell them that they can no longer earn a living?

In this vein, it would be our recommendation to any legislative body contemplating such a legal requirement that it specifically retain the prerogative of legislative review of any administratively proposed academic

criteria. This would serve to protect the interests of the people who could find themselves in difficulty without knowing what happened.

CORRELATION OF GOALS AND METHODS

Environmentalists, we should remember that we are people first, public (people) servants second, and happen to use the tools of environmental technology. It appears that at times we need to back-off and regain our perspective lest we permit the technology to run the man. This is one of those times. Come, let us reason together.

REFERENCES

1. Adams, H. S. 1947. Milk and food sanitation practice. Harvard University Press, Cambridge, Massachusetts, p. 232-242.
2. American Public Health Association. 1970. Control of commu-

ble diseases in man. 11th ed., American Public Health Association, Washington, D.C., p. 92-93.

3. Anonymous. 1974. Food service sanitation—proposed uniform requirements. Federal Register 39(191, II): October.
4. Bryan, F. L. 1974. Control of foodborne diseases in the food service industry—Narration guide, Training kit. U.S. Department of Health Education and Welfare, Center for Disease Control, Atlanta, Georgia.
5. Bryan, F. L., and E. G. Kilpatrick. 1971. *Clostridium perfringens* related to roast beef cooking and storage in a fast food service restaurant. Amer. J. Public Health 61:1869-1885.
6. Hauschild, A. H. W. *Clostridium perfringens* enterotoxin. J. Milk Food Technol. 34:596-599.
7. Ohio Department of Health. 1974. History of the Ohio Department of Health food service manager certification program. Paper presented by D. Clingman at a National Environmental Health Association workshop, June 24, 1974. Cincinnati, Ohio.

News and Events

Samuel J. Crumbine Award For 1975

The award this year will be given for the most creative, innovative and effective use of . . . evaluation methods in justifying current appropriations . . . for food and beverage sanitation.

Inflation, dwindling tax dollars, rising costs of local government and competition for available tax dollars has made the funding of local food and beverage sanitation programs more difficult each year.

At the same time, public administration and management of tax funds has become more sophisticated.

Health officials seeking funds for expansion, for continuation of existing programs, and particularly for new programs need to be skilled in methods of showing specifically in what ways the consumer and the community will be protected. They need to demonstrate what results will be achieved in return for tax dollars spent.

Statements of good intent, personal opinions that certain services are necessary for consumer protection, and pleas for continuation of existing activities are no longer sufficient to justify expenditure of tax dollars.

Such traditional yardsticks as number of activities, man hours spent and other work load data are challenged as not being a true measure of the protection the public is asked to buy with its tax dollars for food and beverage sanitation.

Hence, in acknowledgement of the importance of self-evaluation, the Crumbine Consumer Protection Award for 1975 will be given to the local governmental agency which demonstrates the most creative, innovative and effective use of significant evaluation methods in justifying its current appropriation of tax funds for food and beverage sanitation.

Instructions

Each entry is to be in narrative form with supporting data. The narrative is to be limited to five pages, plus such supporting exhibit materials as is necessary to the presentation.

An additional one page community profile showing general characteristics of the community and specific data relating to food and beverage sanitation is to be included.

The above presentations should be entered in duplicate, double-spaced on one side of 8-1/2 x 11 paper and carefully identified with name and address of entrant.

The narrative should show what evaluation methods and criteria are being used in the current year to evaluate the food and beverage sanitation program.

It should show how you justify the expenditure of your current appropriation for food and beverage sanitation to the community and should give the rationale for expending tax funds for this purpose.

Creativeness and innovation in evaluation of programs and in justification of use of tax funds to the community should be stressed in the application.

Each presentation statement becomes the property of the Single Service Institute and will be returned only if requested. Material contained in the entries may be published in the Institute's periodical, *Environment News Digest*.

Entries must be submitted to the Crumbine Jury on or before May 1, 1975. Mail your completed entry to:

The Crumbine Jury
c/o Environment & Health Committee
Single Service Institute, Inc.
250 Park Avenue, New York, NY 10017

News and Events

Dr. Bernard J. Liska Promoted



Dr. Bernard J. Liska

West Lafayette, Ind., Jan. 9. Dr. Bernard J. Liska, associate director of the Indiana Agricultural Experiment Station at Purdue University, will become director and associate dean of agriculture July 1.

Dr. R. L. Kohls, Purdue's dean of agriculture, made the announcement in preparation for the impending retirement of Dr. Herbert H. Kramer, who has been director and associate dean since Jan. 1, 1967. He will continue as associate director and associate dean.

Dr. Liska is a widely recognized authority on food chemistry, food bacteriology and chemical residues in food. He has been director of Purdue's Food Sciences Institute since its establishment in 1968, a post he has continued to fill since his appointment as associate director of the Agricultural Experiment Station two years ago.

A professor of food science, he recently organized, prepared and coordinated a three-year research program, funded by Lilly Endowment, to study improved animal and human nutrition. The program, which will continue until 1977, involves staff members of the Schools of Agriculture and Home Economics.

Dr. Liska's professional activities include the vice-chairmanship of the Institute of Food Technologists' expert panel on food safety and nutrition and the secretaryship of the North Central Regional Agricultural Experiment Station Directors Association. He also is scientific editor of the *Journal of Food Science*.

After receiving the B.S., M.S. and Ph.D. degrees in dairy and food science from the University of Wisconsin, Dr. Liska served on the staff at the University of Florida. He joined the Purdue agricultural staff in 1959 as an assistant professor of food science. He was promoted to associate professor in 1962 and to professor three years later.

Officers Elected at Annual Meeting of Evaporated Milk Association

Bob L. Hall, General Manager, O-At-Ka Milk Products Cooperative, Inc., Batavia, New York was reelected President of the Evaporated Milk Association at its annual meeting in Chicago today (January 30).

Elected to serve a second term as Vice President was Ray Morris, President, Grocery Products Division, Pet Incorporated, St. Louis. Joseph M. Carson Jr., President, United Dairy, Inc., Martins Ferry, Ohio was reelected Treasurer.

Reelected to serve with the officers as the Association's Board of Directors were: Henry C. Arnest, Carnation Company, Los Angeles, John Campbell, Westerville Creamery, Covington, Ohio, and William A. Diehl, The Defiance Milk Products Company, Defiance, Ohio.

Organized in 1923, the Evaporated Milk Association is based in Washington, D.C. J.C. Flake, Ph.D., is the Association's Executive Vice President.

The Evaporated Milk Association is supported by all processors of evaporated milk in the United States, and a number of associate members.

ISI® Schedules Tour Program for Bicentennial Years

Philadelphia, Pennsylvania, February 3, 1975—The Institute for Scientific Information (ISI®) has announced that it will offer tours of its facilities to the many librarians, information scientists, and scientific and technical people of all types expected to come to Philadelphia during 1975-1976 for the Bicentennial. Located at 325 Chestnut Street, a block away from Independence Hall and the Liberty Bell, ISI is in the center of Philadelphia's historical area.

The Institute for Scientific Information is a company that provides a variety of computer-based services to help professionals keep up with the current journal literature and search the past literature more effectively. Well-known ISI services include *Current Contents*® and the *Science Citation Index*®.

Visitors at ISI will view a prize-winning orientation film on the information explosion and the growth of ISI. Then, with ISI personnel acting as guides, they will tour important work areas to see how the various ISI services are produced. A question-and-answer period will follow.

Tours will start at 2 p.m. every Tuesday and Thursday (except holidays) beginning April 1, 1975. They are designed primarily for adults with college-level educations and are not appropriate for anyone below high-school age. Since the number of places on each tour must be limited, tours will be run on a *reservation only* basis.

To make reservations or for more information, contact Jean Sprissler at (215) 923-3300, Ext. 359, or write her at the Institute for Scientific Information, 325 Chestnut Street, Philadelphia, Pennsylvania 19106.

Spring Meeting of 3-A Sanitary Standards Committees

The 3-A Committees will hold the regular spring meeting on April 8, 9 and 10, 1975 at Hunt Valley Inn, Hunt Valley, Maryland.

There are approximately 14 standards, amendments and revisions to be considered at this meeting.

The Hunt Valley Inn is located outside of Baltimore about five miles from the Baltimore Beltway.

National Restaurant Association Supports Education Fund of American Culinary Federation

In appreciation of the outstanding display of culinary talent demonstrated at last year's NRA Restaurant, Hotel-Motel Show, and in continued recognition of this vital aspect of the industry, the National Restaurant Association contributed a \$1,500 check to the Education Fund of the Chefs de Cuisine Association of Chicago.

NRA President Henry W. Bolling is shown presenting the check to Amato Ferrero, President of the American Culinary Federation and the Chefs de Cuisine Association. "One objective of the National Restaurant Association is to provide national leadership in education for the foodservice industry. NRA strives for continuous liaison with educational endeavor and recognizes excellence in the field with such rewards," Bolling added.

The 56th NRA Restaurant, Hotel-Motel Show, May 18th-21st, 1975, at Chicago's McCormick Place, is the one and only marketplace where you can attend a variety of exciting and stimulating educational programs, visit



Amato Ferrero and Henry Bolling

hundreds of exhibits, and talk with operators from across the United States.

From all indications, the 1975 NRA Show will be as large as 1974, with over 90,000 registrants. Exhibiting companies already number 714.

3rd International Livestock Waste Conference to Meet at the University of Illinois

St. Joseph, Michigan . . . The American Society of Agricultural Engineers and 18 cooperating organizations will sponsor a conference of worldwide importance: the 3rd International Livestock Waste Symposium and exhibition, April 21-24 at the University of Illinois, Urbana-Champaign, Illinois.

The conference is expected to draw well over a thousand scientists, and engineers, federal and state regulatory and environmental agency personnel, livestock producers, farm owners and managers, and farm building contractors. Symposium participants will focus their attention on the problems of waste

management system designs and the effects of waste products on the environment.

Specific topics to be covered during the four day event span the interests of every group involved in livestock wastes.

A feature of the symposium will be an exhibition of scientific and waste handling equipment. The exhibition will be held at the Assembly Hall on the university campus, April 22-23. The indoor and outdoor exhibits and demonstrations are free to the public.

A free copy of the complete program is available on request from ASAE.

Cheese Seminar Set for May 12, 13

"Put a smile in your profits, say cheese," is the theme of the 1975 National Cheese Seminar to be held in Milwaukee's new MECCA convention center May 12 and 13.

According to Clark Squires of Lake to Lake Dairy, first vice president of the Seminar, the 1975 program is carefully balanced to provide food retailers with how-to workshops on the merchandising of cheese as well as recognizing their customers' preferences and expectations and dealing affectively with them.

"We will complete arrangements with recognized authorities on the economy, government and imports to achieve greater depth than ever before in our program," Squires said.

The National Cheese Seminar began in 1964 as the Wisconsin Cheese Seminar and attracted only a handful of people. Attendance steadily increased, however, as word of its excellence spread. The 1974 Seminar was presented to nearly 1,500 in Milwaukee.

The Seminar operates in cooperation with the Wisconsin Department of Agriculture and major producers of cheese.

Milton J. Mayer, vice president-marketing of Purity Cheese Company, is president and W. T. Reese of the Wisconsin Department of Agriculture is executive secretary.

Report of the Editor Journal of Milk and Food Technology 1973-1974

REVIEW OF VOLUME THIRTY-SIX

The 36th volume of the *Journal of Milk and Food Technology* was completed when the December, 1973 issue was published. Volume 36 was one of the largest ever published and was exceeded in number of papers and pages only by the record-breaking Volume 35 of 1972.

In 1973 we published 108 papers as compared to 132 in 1972, 102 in 1971, and 64 in 1967. Of the 108 papers in Volume 36, 60% reported research findings, 28% were technical general interest papers such as reviews, and 12% were devoted to non-technical topics of general interest. Fewer pages in Volume 36 than in Volume 35 were devoted to equipment standards and news and events. In contrast, association affairs occupied more pages in Volume 36 than in the preceding volume. Complete details about Volume 36 and other recent volumes are in Table 1.

As with other volumes, numerous topics were discussed on the pages of Volume 36. Approximately 57% of the papers discussed non-dairy foods or topics related to such foods, 32% were devoted to dairy foods and related subjects, and 11% considered environmental or other topics. This marks the first volume that contained considerably more papers which dealt with non-dairy foods than with dairy foods. This is to be expected since currently more research efforts are being expended on non-dairy foods rather than on dairy foods and related areas. Hence, it is possible that this trend will continue in the future.

PRESENT STATUS OF VOLUME THIRTY-SEVEN

The first six issues of Volume 37 consisted of 376 pages, including

the covers. This compares with 408 pages for the first six issues of volume 36 and 264 pages for similar issues of Volume 30 (1967). These six issues of Volume 37 contained 32 research papers, 17 technical general interest papers, and 7 non-technical general interest papers. This compares with 36, 19, and 6 papers in the same categories for the first six issues of Volume 36.

On July 1, 1974 there was a backlog of 38 research papers and 4 general interest papers awaiting publication. In addition, there were 19 research papers and 1 general interest paper being reviewed or revised. This backlog is somewhat greater than that reported a year ago. Nevertheless, we can still assure prompt (usually in less than 6 months after submission) publication of research and other papers.

REVIEW PAPERS

Review papers provide readers with up-to-date information in an area with which they may not be particularly familiar. The *Journal* continues to be a source of these valuable papers. Authors are encouraged to prepare review papers and such papers will be published promptly. Prospective authors of such papers are encouraged to contact the Editor if they have questions about the suitability of their material for publication.

EDITORIAL BOARD

The Editorial Board consists of 42 scientists in industrial, governmental, or university laboratories. Many of the persons on the Editorial Board voluntarily devote numerous hours to the review of

TABLE 1. Summary of contents of the Journal of Milk and Food Technology, 1967-1973

Item	Volume 30 (1967)	Volume 31 (1968)	Volume 32 (1969)	Volume 33 (1970)	Volume 32 (1971)	Volume 35 (1972)	Volume 36 (1973)
1. Total pages, including covers	512	540	624	688	728	832	752
2. Total papers published	64	62	87	104	102	132	108
3. Research papers							
a. Number	30	32	47	66	67	78	65
b. Pages	137	142	205	280	288	317	284
c. Percent of total pages	26.7	26.3	32.9	40.7	39.5	38.1	37.7
4. General interest papers- Technical							
a. Number	11	16	14	18	24	35	31
b. Pages	47	74	87	99	150	242	208
c. Percent of total pages	9.2	13.7	12.2	14.3	20.6	29.1	27.7
5. Equipment standards							
a. 3-A, pages	9	22	12	44	40	23	17
b. E-3-A, pages	—	—	7 ^a	16	30	15 ^b	—
c. Percent of total pages—all standards	1.7	4.1	3.0	8.7	9.6	4.5	2.2
6. General interest papers-Non-technical							
a. Number	23	14	26	20	11	19	12
b. Pages	72	65	91	64	46	76	49
c. Percent of total pages	14.1	12.0	14.6	9.3	6.3	9.1	6.5
7. Association affairs							
a. Pages	64	68	62	49	45	47	84
b. Percent of total pages	12.5	12.6	9.9	7.2	6.3	5.6	11.2
8. News and events							
a. Pages	51	42	36	23	17	7	4
b. Percent of total pages	9.9	7.8	5.8	3.4	2.3	0.8	0.5
Percent of pages-technical material, including standards	37.6	44.1	48.1	63.7	69.7	71.7	67.6
Percent of pages-non-technical material	36.5	32.4	30.3	19.9	14.9	15.5	18.2
Percent of pages—covers, adds, index, etc.	25.9	23.5	21.6	16.4	15.4	12.8	14.2

^aThese were Baking Industry Equipment Standards.

^bIncludes 1 page of Baking Industry Equipment Standards.

papers that ultimately appear in the *Journal*. Their help is acknowledged and appreciated.

In addition to regular members of the Editorial Board, other scientists are sometimes invited by the Editor to review papers. Thus far in 1974 31 persons have voluntarily served as ad hoc reviewers. Included are: C. H. Amundson, J. H. von Elbe, R. L. Bradley, Jr., G. S. Torrey, D. H. Kropf, H. W. Walker, W. S. LaGrange, Ruth Dickie, J. Garver, D. W. Mather, N. F. Olson, T. Kristoffersen, D. M. Irvine, P. J. Pace, L. H. Schultz, Mary Mahaffey, J. M. Goepfert, T. E. Minor, F. F. Busta, J. V. Peary, W. Dyal, J. A. Koberguer, J. T. Peeler, O. R. Fennema, D. B. Lund, H. E. Calbert, E. Todd, A. H. W. Hauschild, and R. C. Lindsay. Their help is acknowledged and appreciated.

Dr. W. G. Walter, Montana State University has resigned from the Editorial Board because he has been assigned additional responsibilities at the University. He will be replaced with a scientist from another university.

NEW PRINTER

For the last 18 or so years the *Journal* has been printed by Roeder's Franklin Printing Company in Franklin, Indiana. Effective with the

January, 1975 issue, the *Journal* will be printed by Heuss Printing and Signs, Inc. in Ames, Iowa. The change in printer was prompted by relocation of the headquarters for the association when Mr. E. O. Wright became the Executive Secretary of IAMFES and Managing Editor of the *Journal*.

Heuss Printing and Signs, Inc. has equipment so that composition of the *Journal* will be done by computer. This will mean: (a) use of a new type face, (b) use of more bold-face type for headings in articles, (c) a redesigned "table of contents" page, (d) a complete journal citation above the title of each article, and (e) authors will receive page proofs rather than galley proofs. The *Journal* will be printed on an offset press and publication will be somewhat earlier each month than now so that a given issue is in the hands of readers during the month that the particular issue is dated. The planned changes should make the *Journal* more attractive both to readers and authors.

E. H. MARTH

Editor

Journal of Milk and Food Technology

Association Affairs

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Sanitarian Award Notice

In 1973 there was no SANITARIAN AWARD made due to lack of sufficient, properly documented nominations. This Award, if made, would have been made to a State or Federal Sanitarian.

When the 1974 Awards Committee was considering nominees they inadvertently made the Sanitarian Award to a most deserving recipient. However, his affiliation was with a State Health Department.

Being aware of these facts when organizing the Award selection for 1975, the most consistent action was judged to follow the 1974 State Award with the 1975 Award to a municipal or local Sanitarian.

The rotation of this Award indicated by the last two years will be followed in the future. 1976 Sanitarian Award will therefore be to a State or Federal employee; followed again in 1977 by a local or municipal Sanitarian.

Walter F. Wilson, Chairman
 Awards & Recognition Committee

Report of Executive Secretary, 1974

A considerable amount of effort was put forth to revive affiliate organizations that had become inactive. With the aid of Harold Heiskell two affiliates have become active. A new affiliate was organized in Canada and there is a possibility of another unit in Canada as well as Mexico.

Several affiliates were visited at the time of their annual meetings with the Executive-Secretary discussing programs and objectives of the IAMFES. Through these visits many things have been suggested that will become part of the program for IAMFES future programs.

The executive office has been moved to Ames, Iowa and on January 1, 1975 publishing of the *Journal of Milk and Food Technology* will be in Ames. We employed a full time secretary and two part time student secretaries that carry out the office work. The office is located in a remodeled bank building now called *The Executive Office Building* located in downtown Ames at 413 Kellogg Avenue.

This office also includes the office of the 3-A Sanitary Standards Administrative Council.

This has been a trying year for the Executive Office, but I can now state that the routines have been worked out and materials are now being handled in an efficient routine manner.

Many thanks to "Red" Thomasson for his guidance and untiring efforts that help make the transition of the Executive office a success.

Respectfully submitted,
 E. O. Wright

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Report of the Applied Laboratory Methods Committee, 1973-1974

The two subcommittees comprising the Applied Laboratory Methods Committee are the subcommittee on Laboratory Methods for the Examination of Water and other Environmental Samples and the subcommittee on Laboratory Methods for the Examination of Milk and Milk Products. The first subcommittee does not have a report at this time. The report of the subcommittee on milk and milk products is presented here.

The two studies reported last year in the interim report were completed and written up as papers for eventual submission to the *Journal of Milk and Food Technology*. Comparison of distilled water and phosphate buffer as diluents for raw milk in determining the standard plate count showed no advantage for incorporating phosphate in the dilution blanks and the committee recommends that the use of phosphate be discontinued unless evidence for its usefulness is presented.

The second study reported on last year involved the comparison of 45 and 50 C as temperatures for pouring agar. Counts with agar at 50 C were significantly lower and care should be taken that this temperature is not used. A second part of this study was a determination of the equilibration times of freshly autoclaved agar or water in similar vessels. The agar showed only a slightly longer equilibration time. The most important factor in attaining the recommended 45 C temperature for agar at pouring is the degree of loading of the water bath. Under extreme loading conditions almost 1 h was needed for the agar to reach temperature. The subcommittee suggests that a 1-h minimum equilibration time be used.

Two other studies have been completed by the subcommittee. One involved comparison of dilution blanks at 20, 25, and 30 C for raw milk bacteria. There did not appear to be any significant difference in the counts obtained at the three temperatures according to preliminary examination. A second study involved the use of 30 and 32 C as incubation temperature with two and three day incubation times for the standard plate count. Results are now being analyzed.

Several members of the subcommittee are participating in the revision of the 13th edition of *Standard Methods for the Examination of Dairy Products*. Members of the subcommittee are: William L. Arledge, Earl W. Cook, C. B. Donnelly, Roy E. Ginn, J. J. Jezeski, Donald I. Thompson, James Messer, F. E. Nelson, Don Pusch, H. E. Randolph, Edmond L. Sing, H. Michael Wehr, and W. S. LaGrange.

Respectfully submitted,
C. N. Huhtanen

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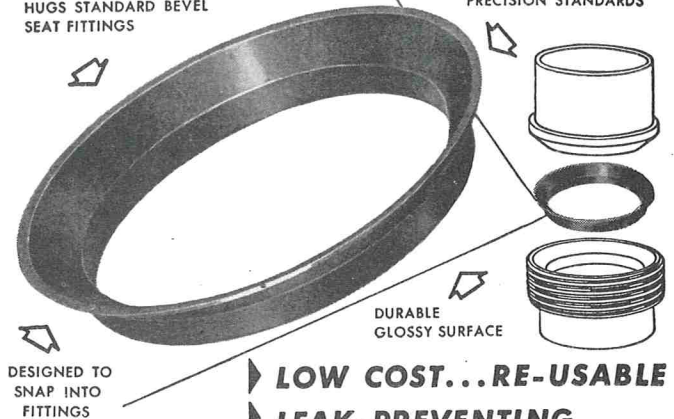
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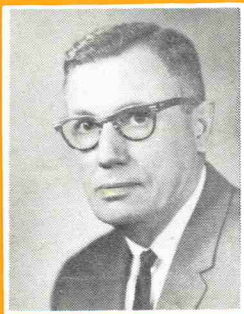
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Ralph Bonewitz, Extension Specialist
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What questions should a dairyman ask before expanding or modernizing?

Here are some of the most basic questions I believe dairymen should ask themselves before they begin a program of modernization or expansion:

What about my future in dairying? Will the changes I make be profitable in the long run? Will the changes be feasible in the short run?

Long run profitability refers to a period of eight to ten years or more. It is usually studied through the use of budgets. In the budgeting process, capital expenditures are prorated over the life of the assets by arbitrary depreciation methods.

Short run feasibility refers to the income-generating ability of a business in a short period of time. It is usually studied through the use of a projected cash flow.

Watch your cash flow

Projected cash inflow and outflow during the period are compared, reflecting payment requirements from credit agencies as well as all normal expenditures. Some business changes are capable of being profitable in the long run *but they are not capable of meeting short run demands for cash, particularly when payment requirements for capital expenditures are concentrated in the early years of an investment.*

Management must expand as herds get larger. More failures are due to lack of management than any other one thing. Hours spent thinking and getting facts will pay off and the manager or owner must assume this responsibility. A manager must have the ability to get the right things done at the right time.

Here are some more questions:

Will my expansion or modernization plan improve the chances and ease of producing a higher quality

product? Will it increase the ease of the key jobs associated with dairying? Will it increase the efficiency of labor, investment and/or equipment? Will the modernized set-up provide the minimum movement of men, animals and material? Can this modern dairy farm compete with nonfarm occupations for good labor or manpower?

Do you as a manager or owner have a concern for production, people, quality milk and a desire to make the dairy more profitable? Will you develop a good milking program? One that obtains high production per cow, controls mastitis, produces clean excellent-flavored milk and uses a minimum amount of labor?

Check this planning list

Tomorrow's profitable dairy farm can be expected to be a planned operation. Here are some of the things you will want to consider during the planning phase: 1) Size of herd to be accommodated; 2) Dairy breed; 3) Climate conditions; 4) Topography of farmstead, slope, drainage and exposure; 5) Size and productivity of the farm; 6) Feeding program as related to feed storage and equipment for feeding; 7) Existing buildings and equipment that will fit into long range plans; 8) Availability of labor; 9) Capital available for investment; 10) Sanitary regulations or codes or present and potential milk markets; 11) Personal preference of the owner; 12) Water and air pollution regulations.

Planning with pencil and paper prior to the start of construction permits you to analyze combinations of equipment and building arrangements without any expenditure. Visit as many farms as possible and incorporate the good points seen at these farms into your facilities. Use university people and private consulting people.

Unless a dairyman regularly tests production, a pipeline milker can be the best friend that a cull cow ever had. The cull cow strolls in with the good producers, gives only enough milk to color the line, eats almost as much feed as the best cows, and then goes her merry way. A dairyman needs profitable production from every cow. You will call the correct signals and build a profit-winning dairy team if you use production records.

Feeding practices important

Constant attention to feeding practices, breeding for production and herd health during expansion are very important. A well designed, properly installed milking system is essential to proper milking. You can't afford an inadequate or poorly maintained milking system.

Productivity must be the key

The productivity of a resource depends on the amount and kind of other resources with which it is combined. As an example, when capital is substituted for labor, it requires fewer hours of labor per cow. However, unless production increases or more cows can be handled, the machinery and equipment cost will offset the savings in labor. Productivity of a resource then depends on the kind and quality of the resource with which it is combined. Modern technology is closely related then to the substitution of capital for labor and land. It increases the demands on management, emphasizes financial management and increases technical requirements of hired labor.

Finally, all of this modernization should help make dairying more pleasant, as well as more productive for you and your family.

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