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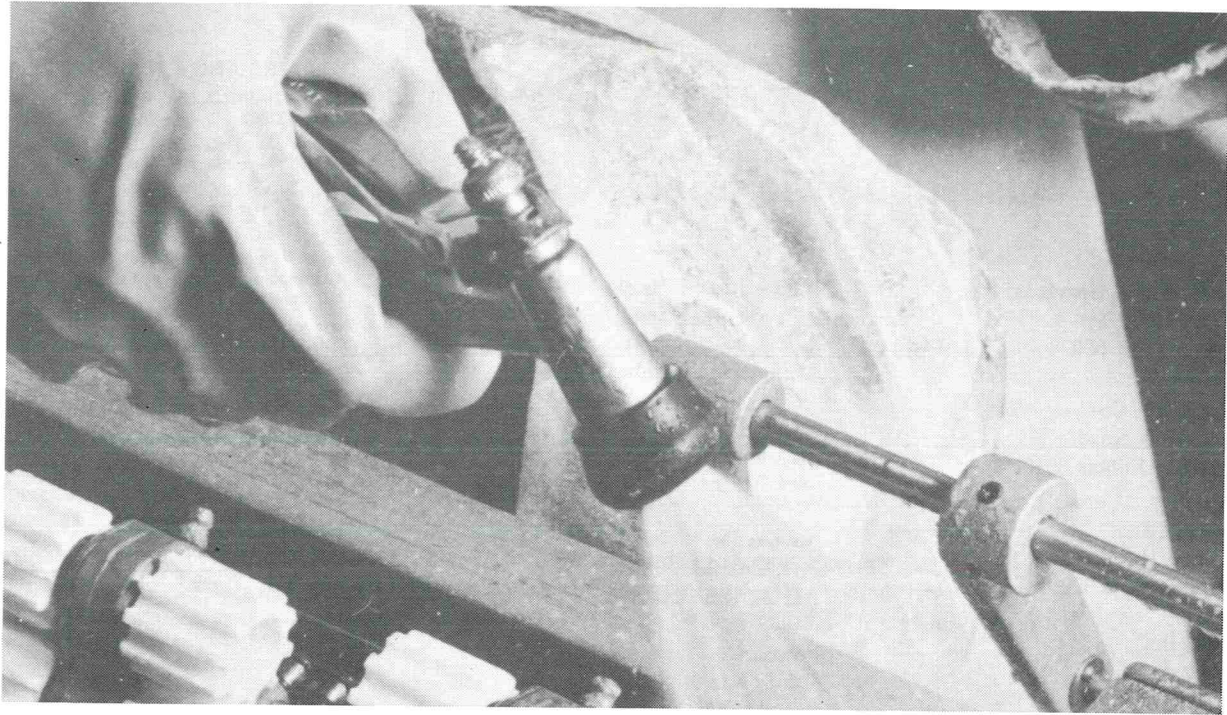
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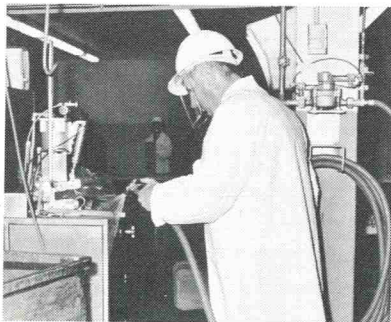
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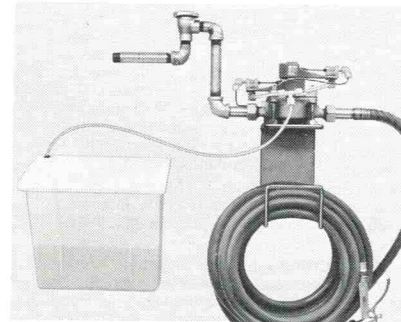
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## A Comparison of the Mojonnier and Roese-Gottlieb Methods for Determining Milkfat Content of Ice Cream

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(Received for publication January 30, 1978)

### ABSTRACT

Twenty-two samples of commercial ice cream were analyzed for milkfat content by the Mojonnier and Roese-Gottlieb methods. These samples were tested in duplicate by two analysts and results were compared. The Roese-Gottlieb method gave consistently lower results on the same sample than did the Mojonnier method. There was a wide variation in test results from the two methods. The Roese-Gottlieb test results ranged from 0.10 to 0.30% less than those of the Mojonnier test on the same samples, the Roese-Gottlieb results averaging 0.16% lower than those of Mojonnier method. These variations are highly significant and are attributable to the different amounts of alcohol used for fat extraction.

The Roese-Gottlieb method is the official method of the Association of Official Analytical Chemists to determine the fat content of milk and its products and was incorporated in the laws of many states (1). The Mojonnier method was adopted as the official method for fat analysis of ice cream by some states (8). The Mojonnier method has been considered an official procedure in the dairy industry and its accuracy is well documented in the literature (3,5,9,13). The Mojonnier test was also used as a standard for comparison of various methods of testing dairy products for milkfat (3,4,6,13). Sometimes the names of these two tests were used interchangeably even though the Mojonnier analysis is a modification of the Roese-Gottlieb method (8,10,11,14,15). Information is lacking on the results obtained with the Roese-Gottlieb method when applied to ice cream. Thus, this experiment was conducted to compare the Roese-Gottlieb and Mojonnier methods in testing ice cream.

### MATERIALS AND METHODS

Twenty-two half gallons of plain commercial ice cream were obtained from various supermarkets in the midwest and transported to our laboratory in insulated containers by ice cream trucks. These samples were kept frozen in our hardening room until the tests were done. The A.O.A.C. procedure was not followed in preparation of samples because of the possibility of fat separation or churning of fat before weighing samples. Goss indicated that melted ice cream churns easily upon mixing, usually resulting in low test results (5). Thus, the procedure

used in this experiment was as follows. Approximately 65 g of the ice cream were taken from the center of the package and placed into a 4-oz. Mason glass jar. The sample jar was placed in a water bath (13-16 C) and its contents were mixed thoroughly with a stainless steel spatula. Excessive stirring was avoided. Ice cream samples (4.8-5.3 g) were weighed immediately into the Mojonnier fat extraction flasks once they were thoroughly mixed. Four samples of ice cream from the 4-oz. jar were weighed on a Sartorius analytical balance directly into the Mojonnier flasks, when two were tested by the Mojonnier method and two by the Roese-Gottlieb method. Weighing directly into the Mojonnier flask has been shown to give a more accurate result (7).

Extraction of fat was done according to methods described by the Mojonnier Instruction Manual (9) and the A.O.A.C. (2). In the Roese-Gottlieb method the following procedures were done in the same manner as the Mojonnier procedures, with the exception of the shaking time, as explained in (a).

(a) Fat extraction flasks were shaken as illustrated in the Mojonnier manual (Fig. 43), but for different lengths of time; the Roese-Gottlieb and Mojonnier samples were shaken for the times specified in the respective manuals.

(b) Centrifuged the fat extraction flasks, 30 turns taking 30 sec. (Roese-Gottlieb method calls for 600-rpm centrifuge, or allowing solution to stand until upper liquid is practically clear. The centrifugation process as used ensured this clarity.)

(c) Added distilled water to raise the dividing line and obtain sharper separation of ether and nonether solutions in the last extraction (Mojonnier, 2nd extraction; Roese-Gottlieb, 3rd extraction) to enable complete decanting of the fat-ether solution, and that only.

(d) Dried the aluminum fat dish in the vacuum oven at 135 C for 5 min with 23 inches of vacuum. (Roese-Gottlieb method suggests alternative oven temperatures but the stated result required is constant weight, and this was achieved.)

(e) Cooled the dish in the cooling desiccator for 7 min. (The Mojonnier procedure was followed here because the Roese-Gottlieb method does not specify cooling time or temperature to be reached.)

(f) Weighed the dish plus fat rapidly and recorded weight of fat. (The Roese-Gottlieb method calls for weighing the dish after removal of fat instead of before addition of fat, but careful application of either method could be expected to produce the same net results.)

Blank determinations were made to prove the purity of the reagents, and the results were satisfactory: 0.0002 and 0.0003 g. Before every use, all fat extraction flasks, aluminum fat dishes, and corks were thoroughly cleaned and rinsed with alcohol and ethyl ether to remove any trace of fat residue. The fat dishes were placed in the vacuum oven for 5 min at 135 C. They were then transferred to the cooling desiccator and left for 7 min before weighing. Each of these two methods were done in duplicate by two analysts.

## RESULTS AND DISCUSSION

Data in Table 1 show that the fat content of 22 commercial ice creams, as determined by the Mojonnier method, did not correspond to values determined by the Roese-Gottlieb method. Tests results varied considerably, the Roese-Gottlieb results being consistently lower than those of the Mojonnier method. Results from the work of the two analysts did not vary appreciably. Fat content according to the Roese-Gottlieb method ranged from  $-0.10$  to  $-0.30\%$  of the Mojonnier results, with the average fat content being  $0.16\%$  lower (Analyst A,  $-0.17\%$ ; Analyst B,  $-0.15\%$ ). When the samples were tested in duplicate by each of the methods, Mojonnier test results between paired samples corresponded more closely than did the paired Roese-Gottlieb results (Table 1). Results using the Mojonnier method varied from  $0.0$  to  $0.08\%$  for both analysts, whereas results with the Roese-Gottlieb method varied from  $0.0$  to  $0.13\%$  (Analyst B) and from  $0.0$  to  $0.17\%$  (Analyst A). Four possible reasons for low readings from the Roese-Gottlieb method were investigated. Only one seemed likely to be a major contributing factor. (a) Insufficient shaking. The fat extraction flask was shaken gently, as opposed to vigorously, for 1 min. (b) Alteration of centrifugation time and rate. The fat extraction flask was centrifuged 90 turns for 1 min as opposed to 30 turns for 30 sec. (c) Not altering the dividing line. The ether solution was poured off without adding water as opposed to pouring it off after adding water to raise the dividing line. Methods tried included adding water in the second extraction, third extraction and in both. (d) Carrying out the extraction with or without alcohol. Five ml of alcohol were added in the second extraction of the Roese-Gottlieb method, as opposed to the addition of none.

The first three alterations in the method did not appreciably affect test results. The fourth resulted in a narrowing of the differences in final readings of fat content. The amount of alcohol used in the first extraction was the same in both methods. However, the Roese-Gottlieb procedure does not call for any alcohol in the second or third extraction whereas the Mojonnier analysis employs 5 ml of alcohol in the second extraction. In six trials addition of 5 ml alcohol in the second extraction of the Roese-Gottlieb method brought values for fat content into close agreement with those of the Mojonnier method. The average test results of these trials were  $10.14\%$  with the Roese-Gottlieb method and  $10.13\%$  with the Mojonnier. Our findings are somewhat in agreement with those of previous workers (5,9). These workers explained that too little alcohol could not completely recover the fat trapped in gelatinous precipitate upon adding ether. Goss also suggested that 5 ml of alcohol in the second extraction will bring the dividing line about half way up on the narrow portion of the Mojonnier flask to make easy and accurate pouring of the ethers (5). Sommer indicated that alcohol makes extraction possible by helping to destroy the emulsion and by making the sample more miscible with ether (12). Ice cream contains, in a more concentrated form, not only the fat and serum solids found in milk, but also added sugar, corn syrup, emulsifiers, stabilizers and sometimes eggs. All of these constituents make the emulsion of ice cream more difficult to break than that of milk. Therefore, it might be necessary to employ additional alcohol in the second extraction of the Roese-Gottlieb method for ice cream analysis whereas this may not be necessary for milk analysis.

Our findings raise some important questions concerning the methodology of the Roese-Gottlieb (A.O.A.C.)

TABLE 1. Milkfat content of ice cream as determined by the Mojonnier and Roese-Gottlieb methods.

No.	Analyst A (Fat %)					Analyst B (Fat %)				
	Mojonnier method		Roese-Gottlieb method		Variation from Mojonnier	Mojonnier method		Roese-Gottlieb method		Variation from Mojonnier
1	10.09	10.09	9.92	9.81	-0.22	10.07	10.05	9.87	9.83	-0.21
2	10.08	10.08	9.92	9.95	-0.14	10.05	10.05	9.92	9.85	-0.16
3	10.21	10.22	9.99	10.02	-0.21	10.19	10.20	10.01	10.03	-0.18
4	9.92	9.89	9.70	9.68	-0.22	9.88	9.90	9.78	9.76	-0.12
5	9.92	9.91	9.70	9.78	-0.18	9.90	9.87	9.77	9.76	-0.12
6	9.89	9.90	9.72	9.73	-0.17	9.88	9.87	9.66	9.79	-0.15
7	10.06	10.04	9.88	9.90	-0.16	9.97	9.96	9.83	9.83	-0.14
8	10.07	10.07	9.91	9.90	-0.16	9.96	9.97	9.83	9.80	-0.15
9	10.05	10.03	9.72	9.88	-0.24	10.00	10.08	9.86	9.89	-0.16
10	9.87	9.83	9.69	9.72	-0.14	9.78	9.78	9.65	9.71	-0.10
11	10.18	10.18	10.04	10.00	-0.16	10.16	10.14	9.98	10.03	-0.14
12	10.15	10.13	9.97	9.91	-0.20	10.13	— <sup>a</sup>	9.88	9.93	-0.22
13	9.99	10.07	9.81	9.86	-0.19	9.97	—	9.85	9.88	-0.11
14	9.95	9.87	9.63	9.80	-0.19	10.11	—	9.80	9.81	-0.30
15	10.05	10.02	9.88	9.88	-0.16	10.02	—	9.92	9.91	-0.10
16	9.93	9.99	9.88	9.83	-0.10	10.00	—	9.86	9.90	-0.12
17	9.83	9.78	9.58	9.70	-0.17	9.83	—	9.69	9.66	-0.15
18	9.86	9.86	9.73	9.79	-0.10	9.89	—	9.79	9.78	-0.10
19	10.03	10.05	9.88	9.92	-0.14	10.14	—	10.00	10.00	-0.14
20	9.75	9.78	9.62	9.64	-0.13	9.78	—	9.67	9.68	-0.10
21	10.16	10.14	9.93	9.95	-0.21	10.15	10.15	9.96	9.92	-0.21
22	10.12	10.09	9.92	9.85	-0.21	10.10	10.09	9.90	9.85	-0.21
			Mean		-0.17			Mean		-0.15

<sup>a</sup>—Duplicate test not done.

and relationship to the results of the milkfat content of ice cream in commercial practice. According to the Federal Standard of Identity, ice cream must contain at least 10.0% milkfat (1). However, whereas an official method of fat determination is prescribed for other dairy products (1), none is prescribed for ice cream. This lack of official standardization of testing procedure gives rise to some potentially troublesome anomalies. For instance, the data in Table 1 indicate that most of the commercial ice creams tested were illegal (less than 10.0% fat) by the Roese-Gottlieb method while the ice creams were legal according to results of the Mojonnier method. For some time the ice cream industry has been using the Mojonnier instead of the Roese-Gottlieb method, and the industry generally maintains a close tolerance on milkfat (+0.10 to +0.15%) in the ice cream mix formulation. However, this amount of milkfat is inadequate to satisfy legal standards when the Roese-Gottlieb test is required. On the basis of our findings it should be realized that results from these two methods are not in mutual agreement when milkfat content of ice cream is measured. Since Roese-Gottlieb testing results in lower milkfat readings, official evaluation of milkfat content of ice cream by this method could cause problems for manufacturers who determine ice cream formulas on the basis of Mojonnier readings. The current situation, where some states accept Roese-Gottlieb findings while others accept Mojonnier findings, could carry potential legal implications for interstate commerce.

In conclusion, our results indicate the need for a review of the methodology used by the ice cream industry and by regulatory agencies for determination of milkfat in ice cream.

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## Relation of *Enterobacteriaceae* Counts to *Salmonella* Contamination of Market Broilers

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### ABSTRACT

We determined the *Enterobacteriaceae* counts and the *Salmonella* status (positive or negative) of 20 individual birds in each of 12 groups of broiler carcasses. The overall logarithmic mean *Enterobacteriaceae* count for the 240 carcasses was 2.7 with group means ranging from 1.8 to 3.6. One hundred and twenty three (51.2%) of the 240 carcasses were *Salmonella*-positive. The number of *Salmonella*-positive carcasses within groups ranged from 0 to 18. No relationship was found between *Enterobacteriaceae* counts and presence of *Salmonella* in broiler carcasses.

Use of an *Enterobacteriaceae* count as an index of the hygienic quality of processed raw broiler carcasses has been proposed by a number of European investigators (6,7,12). Mean counts of 300 (6) or 365 (7) *Enterobacteriaceae* per ml of whole-carcass rinsing fluid (13) have been suggested as an appropriate bacteriological standard for frozen broilers. Leistner (7) stated that *Salmonella* and enteropathogenic *Escherichia coli* are less likely to occur on such carcasses if the *Enterobacteriaceae* count is low. Van Schothorst et al. (12) advocated determination of the *Enterobacteriaceae* count in pieces of ventral, lateral, and breast skin for evaluation of hygiene during processing.

Levels of *Enterobacteriaceae* on unfrozen, ready-to-cook market broilers and their relation to the presence of salmonellae have not been reported. Therefore, we thought that such information would be important in assessing the reliability of an *Enterobacteriaceae* count as an index of *Salmonella* contamination.

### MATERIALS AND METHODS

During a 3-month period, we obtained a total of 12 groups of 20 unfrozen broiler carcasses each from two processing plants and two retail stores. At the laboratory, a 12.3-cm<sup>2</sup> area of the lower back skin of each broiler was rubbed for 30 sec with a calcium alginate swab. An earlier study in our laboratory (4) showed that *Enterobacteriaceae* counts were slightly higher ( $p < .05$ ) for the back area than for the breasts or thigh areas. Appropriate serial dilutions of the swab, in 1% sodium citrate, were plated in duplicate with double poured Violet Red Bile Agar (Difco) containing 1% glucose (9) and incubated at 35 C for

24 h.

The *Salmonella* contamination status of each carcass was determined by examining each of two pieces of neck skin and the whole carcass (rinse technique) for the presence of salmonellae. We classified a carcass as *Salmonella*-positive if *Salmonella* was detected in at least one of the three samples. Details of sampling procedures and of methods for isolating and identifying salmonellae are presented elsewhere (3).

Analysis of variance procedures were used for statistical analysis of the data.

### RESULTS AND DISCUSSION

Means and ranges of *Enterobacteriaceae* counts for the 12 groups of broilers sampled and the number of *Salmonella*-positive carcasses in each group are given in Table 1. The overall count (mean  $\pm$  standard deviation) for the 240 carcasses was  $2.7 \pm 0.4$ ; group means ranged from 1.8 to 3.6.

The number of *Salmonella*-positive carcasses within a group ranged from 0 to 18. Of the 240 carcasses sampled, 123 (51.2%) were positive for *Salmonella*. The percentage of *Salmonella*-positive carcasses within a group bore little relationship to the mean *Enterobacteriaceae* count. *Enterobacteriaceae* counts per 12.3 cm<sup>2</sup> ranged from 1.5

TABLE 1. *Enterobacteriaceae* counts and incidence of *Salmonella* in groups of ready-to-cook broiler carcasses.

Group <sup>a</sup>	Log <i>Enterobacteriaceae</i> count/12.3 cm <sup>2</sup>		No. <i>Salmonella</i> -Positive carcasses
	Mean	Range	
1	2.2	1.5-3.2	15
2	2.7	2.2-3.0	18
3	2.9	2.6-3.4	13
4	2.9	2.5-3.6	17
5	2.5	1.7-3.9	4
6	3.6	2.7-4.4	3
7	1.8	1.0-3.1	0
8	2.9	2.3-3.7	18
9	2.9	2.4-3.2	16
10	2.6	2.1-3.5	3
11	2.9	2.3-3.4	9
12	2.1	1.3-2.8	7
All carcasses	$2.7 \pm .4^b$	1.0-4.4	123

<sup>a</sup>20 carcasses in each group.

<sup>b</sup>Standard deviation.

to 3.8 for *Salmonella*-positive and from 1.0 to 4.4 for *Salmonella*-negative birds. Corresponding means for the two groups (2.7 and 2.6, respectively) were not significantly different at the 1% level. An obvious example of the poor relationship between *Enterobacteriaceae* level and incidence of *Salmonella* contamination is the finding of only three *Salmonella*-positive carcasses in the group with the highest mean *Enterobacteriaceae* count, (3.6).

Fifteen serotypes were isolated from the carcasses (Table 2). Within groups, there was no apparent relationship between the number of positive carcasses and the number of serotypes isolated. For example, six different serotypes were isolated from the nine positive carcasses in group 11, but only one serotype (*S. typhimurium*) from the 18 positive carcasses in group 2. Although a single serotype was usually isolated from an individual positive carcass, in one instance three different serotypes were isolated from one carcass.

TABLE 2. *Salmonella* serotypes isolated from each group of broiler carcasses.

Group	Serotypes
1	<i>S. heidelberg</i> , <i>S. montevideo</i> , <i>S. worthington</i>
2	<i>S. typhimurium</i>
3	<i>S. derby</i>
4	<i>S. californica</i> , <i>S. heidelberg</i> , <i>S. infantis</i> , <i>S. kentucky</i> , <i>S. typhimurium</i> var. <i>Copenhagen</i>
5	<i>S. montevideo</i>
6	<i>S. typhimurium</i>
7	None
8	<i>S. bredeney</i> , <i>S. californica</i> , <i>S. heidelberg</i> , <i>S. infantis</i> , <i>S. kentucky</i>
9	<i>S. agona</i> , <i>S. newington</i>
10	<i>S. anatum</i>
11	<i>S. worthington</i> , <i>S. bornum</i> , <i>S. newport</i> , <i>S. anatum</i> , <i>S. californica</i> , <i>S. infantis</i>
12	<i>S. anatum</i> , <i>S. infantis</i>

Expressed arithmetically, the average number of *Enterobacteriaceae* per cm<sup>2</sup> of back skin was about 40; about 95% of the counts fell in a range of about 10 to 300, levels similar to those reported by Cox et al. (2) and Thomson et al. (14) for the breast skin of freshly processed (immersion chilled) broilers. The similarity suggests that *Enterobacteriaceae* are uniformly distributed over the entire skin surface. Van Schothorst et al. (12) reported mean *Enterobacteriaceae* counts of pericloacal (3.4/g) breast (3.1/g), and neck skin (3.5/g) pieces from thawed frozen broilers. When converted to a per cm<sup>2</sup> basis [1 g skin/10 cm<sup>2</sup>, Barnes and Shrimpton (1)] these values are about 1 log greater than those in our study. This difference may be attributed to differences in types of carcasses and to the more efficient removal of bacteria by blending excised skin rather than by swabbing the skin surface (5). Regardless of sampling method used, it would appear that *Enterobacteriaceae* counts of broiler carcasses, processed in a similar manner, fall within a particular, relatively consistent range, and according to our data, do not differ significantly between *Salmonella*-positive and *Sal-*

*monella*-negative carcasses. The most likely explanation for this finding is that levels of salmonellae on *Salmonella*-positive carcasses are extremely low, e.g. 1 to 30/carcass (13), an average of 17/100 g of skin (11), and less than 100/100 g of skin (10). Presence of so few salmonellae on a carcass would obviously have little or no effect on the magnitude of the *Enterobacteriaceae* count.

The results of this study indicate that an *Enterobacteriaceae* count is not a reliable index of the presence of *Salmonella* on broiler carcasses and therefore can not be substituted for the direct detection of this pathogen. Our results also support the general concept, espoused by Mossel (8) that use of *Enterobacteriaceae* as an indicator is of greater value in processed than in raw foods.

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## Effect of Major Spices in Lebanon Bologna on Acid Production by Starter Culture Organisms

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### ABSTRACT

The effect of a Lebanon bologna spice mixture and its major component spices, black pepper, allspice, and nutmeg, on acid production by a mixed starter culture containing *Lactobacillus plantarum* and *Pediococcus cerevisiae* was studied in a liquid medium. These spices stimulated acid production by the starter culture organisms although some Lebanon bologna component spices are known to have antimicrobial properties. The spice mixture stimulated *L. plantarum* more than *P. cerevisiae* when each organism was cultured singly. Stimulation of acid production could not be attributed solely to differences in bacterial numbers as defined by plate counts.

The microbiology of spices used in sausages and other meat products has been studied primarily from a viewpoint of their contribution to the contaminating microflora of a product or their inhibiting effects on organisms of public health significance which might be present in a food product. Jensen et al. (5) implicated contaminants from coriander and white pepper in spoilage of canned chopped hams. Castell (2) reported that 20 samples of spices which he examined were heavily contaminated with aerobic thermophiles. In a more comprehensive study of the role of spices in pickled-food spoilage, Fabian et al. (3) found bacterial plate counts in whole and ground spices ranging from 0 to  $6.7 \times 10^7$  per g, with only cloves and ground cinnamon inhibiting bacterial growth. As food processing techniques advanced and the importance of other organisms of public health significance (*Vibrio parahaemolyticus*, *Bacillus cereus*) was recognized, spices came under renewed scrutiny. Powers et al. (8), reporting on the microbiology of spices procured by the military, found *Clostridium perfringens* in 15% of 115 samples of the seven different spices analyzed. In a later study, Powers et al. (9) found *B. cereus* in 53% of 110 samples of seven different spices. Farbood et al. (4), in a study of the bacteriostatic and bactericidal effects of rosemary spice extractive (RSE) on microbes associated with mechanically deboned poultry

meat, turkey breast, and beef, reported that 0.1% RSE exerted a definite bactericidal effect on *Staphylococcus aureus*. Julseth and Deibel (6) reported inhibition of growth of *Salmonellae* by allspice, cassia, onion, and oregano, and Beauchat (1) found dried oregano and thyme to be highly toxic to *V. parahaemolyticus*.

Lebanon bologna probably evolved from sausage formulations brought to the Lebanon, Pa., area by the earliest Moravian and Palatine German settlers. Factors involved in production of this highly spiced and smoked fermented sausage are currently under investigation in our laboratory (7,11). We observed (10) that acid production by lactic acid bacteria during fermentation of Lebanon bologna decreased when spices were omitted from the sausage formulation. This indicated that spices might play a role beyond that of exerting germicidal effects or contributing a different microflora in the processing of Lebanon bolognas and similar fermented sausages.

This paper describes our research on the effects of Lebanon bologna spice mixture and its major component spices — black pepper, allspice, and nutmeg — on acid production in a liquid medium by a starter culture containing both *Lactobacillus plantarum* and *Pediococcus cerevisiae*.

### EXPERIMENTAL

#### Spices

Purified spices (Griffith Laboratories, Inc., Union, N.J.) were used throughout the experiment. A Lebanon bologna spice mixture was prepared according to the formulation of Palumbo et al. (7): black pepper, 25.0 g; nutmeg, 12.5 g; allspice, 12.5 g; red pepper, 6.2 g; cloves, 6.2 g; cinnamon, 6.2 g; ginger 6.2 g; mustard, 6.2 g; and mace 0.2 g. Total aerobic plate counts of the purified spices determined by conventional plate count methods were less than 100 cells/g.

#### Liquid medium

Beef extract (Difco Labs, Detroit, Mich.) 3 g; tryptone (Difco), 5 g; sucrose, 20 g; and glucose, 20 g; were dissolved in 1 liter of distilled water. The pH of the solution was adjusted to 6.4 with 0.1 N H<sub>2</sub>SO<sub>4</sub> to give a post-sterilization pH of 5.8-6.1. Aliquots of 250 ml of the medium

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were dispersed into 500-ml Erlenmeyer flasks and sterilized for 15 min at 15 psi.

#### Starter culture

The starter culture used in our fermentation work was Lactacel MC (Merck and Co., Inc., Rahway, N.J.) containing *L. plantarum* and *P. cerevisiae*. In some experiments the individual organisms were used: *P. cerevisiae* (Lactacel, Merck and Co.) and *L. plantarum* (Lactacel DS, Merck and Co.).

#### Fermentation

Purified spices were added aseptically to flasks of sterile medium to provide concentrations of 4, 8, and 12 g/l, respectively, and 2.5 ml of commercial starter culture diluted with 0.5% peptone water was then added to each flask and to a control containing no spice to give an initial bacterial population in the range of  $1.0\text{--}5.0 \times 10^4$  cells/ml. The flasks were incubated for 4 days at 35 C. Samples for bacterial counts and titratable acidity were taken at 24-h intervals.

#### Bacterial counts

Bacterial counts were made by conventional pour plate techniques with tryptone glucose extract agar (Difco). Plates were incubated for 48 h at 35 C before counting.

#### Titratable acidity

Titratable acidity was expressed as ml of 0.1 N NaOH required to titrate to pH 7.0 a 10-ml aliquot of the liquid medium after centrifugation and dilution with 50 ml of distilled water.

## RESULTS AND DISCUSSION

The liquid medium was devised to provide a broth in which production of lactic acid by the starter culture organisms could be measured without competition from the naturally occurring microflora found in meat. Lebanon bologna formulae differ so widely that a satisfactory model cannot be devised, but the test medium was made to provide pH value and sugar concentrations in the ranges found in these products, and the range of Lebanon bologna spice mixture concentrations tested encompassed the amounts of spice mixture used in bologna manufacture.

Titratable acidity data (Table 1) show a definite increase in acid production in all samples containing spice compared to the control sample without spice. However, increases in titratable acidity in spice-

containing samples were not commensurate with increasing spice concentration. Maximum acid production was obtained in samples containing black pepper, allspice, and the Lebanon bologna spice mixture at the 12 g/l level. With nutmeg, maximum production of acid was obtained at the 8 g/l level. Possibly, an increased concentration of this spice beyond the 12 g/l concentration might lead to inhibitory effects on the starter culture organisms.

The extent to which acid production was enhanced in the liquid medium depended on the spice used. For example (Table 1), after 96 h of fermentation, starting with an initial titratable acidity of 0.66 ml, the control reached a value of 4.15 ml; black pepper, 6.53 ml; allspice, 6.84 ml; nutmeg, 7.66 ml; and the spice mixture, 9.65 ml when 8 g/l of spice was used. The bacterial counts for the control and the spice containing samples were in a very narrow range,  $1.4\text{--}2.0 \times 10^8$  cells/g. The high titratable acidity found in the broths containing the spice mixture might be attributed to effects of spices present in lesser quantities in the spice mixture, or it might be due to synergistic or additive effects of spices on the starter culture organisms.

To examine the effect of spice on growth of and acid production by the individual organisms, flasks with the liquid medium containing 8 g/l of Lebanon bologna spice mixture were inoculated with *L. plantarum* or *P. cerevisiae*, incubated and sampled for analyses as for the mixed culture. Initial counts were  $2.6 \times 10^4$  cells/ml for *L. plantarum* and  $1.8 \times 10^4$  cells/ml for *P. cerevisiae*. The results of the analyses are presented in Fig. 1. As with the mixed culture, bacterial count data showed that the spice mixture did not stimulate bacterial growth significantly. The spice mixture evoked a definite stimulation of acid production by both organisms, but *P. cerevisiae* did not produce an increase in titratable acidity as strongly as *L. plantarum*. After 96 h of incubation in the presence of 8 g/l of the spice mixture the titratable acidity values were 4.24 ml for *P. cerevisiae* and 10.27 ml for *L. plantarum* cultures, while the control values were 1.70

TABLE 1. Effect of black pepper, allspice, nutmeg, and lebanon bologna spice mixture on growth of and acid production by a mixed starter culture (*L. plantarum* and *P. cerevisiae*).

Spice,	g/l	Incubation time at 35 C							
		24 h		48 h		72 h		96 h	
		TA <sup>a</sup>	count <sup>b</sup> /ml	TA	count/ml	TA	count/ml	TA	count/ml
Control		2.08	$4.1 \times 10^8$	3.00	$3.5 \times 10^8$	3.70	$4.9 \times 10^8$	4.15	$1.5 \times 10^8$
Black pepper	4	2.91	$6.6 \times 10^8$	4.74	$8.8 \times 10^8$	5.73	$3.3 \times 10^8$	6.48	$2.2 \times 10^8$
	8	3.17	$7.5 \times 10^8$	5.00	$4.3 \times 10^8$	6.04	$1.9 \times 10^8$	6.53	$1.8 \times 10^8$
	12	3.10	$6.5 \times 10^8$	4.92	$6.4 \times 10^8$	6.30	$3.1 \times 10^8$	7.00	$1.7 \times 10^8$
Allspice	4	2.20	$2.1 \times 10^8$	3.59	$2.5 \times 10^8$	4.95	$1.6 \times 10^8$	6.07	$1.4 \times 10^8$
	8	2.25	$1.8 \times 10^8$	3.84	$3.2 \times 10^8$	5.52	$2.4 \times 10^8$	6.84	$1.4 \times 10^8$
	12	2.15	$1.8 \times 10^8$	4.10	$2.5 \times 10^8$	5.97	$1.7 \times 10^8$	7.30	$1.6 \times 10^8$
Nutmeg	4	2.39	$5.0 \times 10^8$	4.40	$5.5 \times 10^8$	5.75	$3.2 \times 10^8$	7.02	$9.0 \times 10^7$
	8	2.45	$5.0 \times 10^8$	4.87	$6.5 \times 10^8$	6.38	$2.3 \times 10^8$	7.66	$1.5 \times 10^8$
	12	2.88	$4.7 \times 10^8$	5.00	$4.8 \times 10^8$	6.30	$2.5 \times 10^8$	7.23	$1.0 \times 10^8$
Mixture	4	3.60	$5.5 \times 10^8$	6.09	$9.5 \times 10^8$	7.59	$5.0 \times 10^8$	8.82	$2.0 \times 10^8$
	8	3.78	$6.6 \times 10^8$	6.80	$7.7 \times 10^8$	8.50	$9.0 \times 10^8$	9.65	$2.0 \times 10^8$
	12	3.67	$6.6 \times 10^8$	7.01	$1.5 \times 10^9$	8.29	$8.4 \times 10^8$	10.05	$2.4 \times 10^8$

<sup>a</sup>TA = Titratable acidity. The initial titratable acidity for the control samples was 0.66 ml. The values for the spice containing samples were within 0.05 ml of the control value.

<sup>b</sup>The initial bacterial count was  $3.0 \times 10^4$  cells/ml.

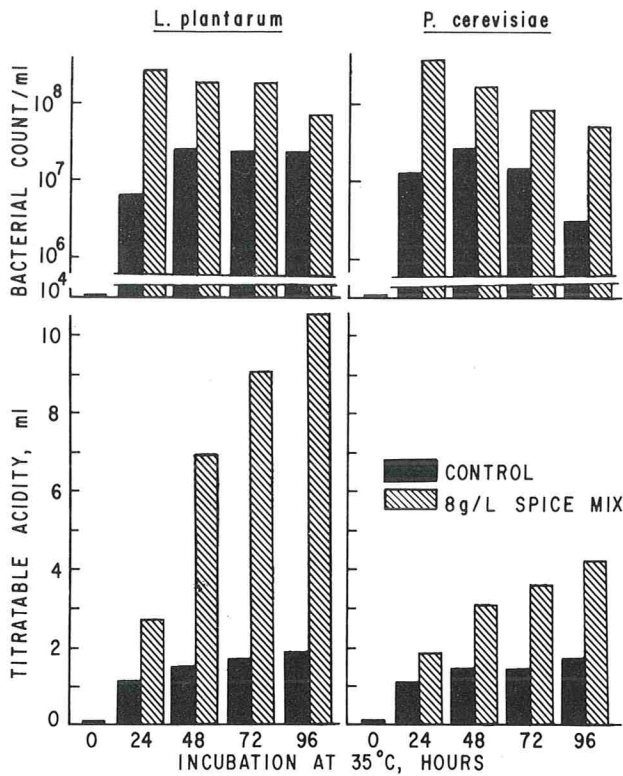


Figure 1. Effect of 8 g/l of Lebanon bologna spice mixture on growth of and acid production by *L. plantarum* and *P. cerevisiae*.

and 1.88 ml, respectively.

It can be concluded from this work that black pepper, allspice, nutmeg, and lebanon bologna spice mixture do not stimulate population growth of starter culture organisms, but do stimulate production of acid by these bacteria. Moreover, the multi-component spice mixture exerts a greater stimulatory effect on acid production by the starter bacteria than do the individual spices. Increasing concentrations of spice from 4 to 12 g/l brings about a slight increase in acid production except with

nutmeg which showed optimum stimulation of acid production at the 8 g/l concentration. Production of acid by both *L. plantarum* and *P. cerevisiae* was stimulated by all spices used, but acid production by *P. cerevisiae* is very low in comparison with that of *L. plantarum*.

#### ACKNOWLEDGMENTS

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## A Microbiological Assay for Penicillic Acid<sup>1</sup>

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### ABSTRACT

Six bacterial cultures were studied in a search for an organism sensitive to penicillic acid suitable for use in a quantitative bioassay of this mycotoxin. A vegetative culture and a commercially prepared spore suspension of *Bacillus subtilis* were both sensitive to as little as 1 µg of penicillic acid and exhibited a linear relationship between 1 and 100 µg. The bioassay method was comparable in accuracy to thin layer chromatographic assay. The procedure was used to verify the biological activity of sample extracts, as well as to quantitate penicillic acid concentration in samples of liquid media and corn. The bioassay is sensitive, rapid (15-17 h), simple and inexpensive.

Use of microbiological assay techniques to confirm the presence of mycotoxins and supplement results of thin layer chromatography (TLC) detection has been employed by several workers. Burmeister and Hesseltine (4) reported that of 392 different microorganisms surveyed for sensitivity to aflatoxins, *Bacillus megaterium* NRRL B-1368 was most sensitive. Clements (5) later used this organism in developing a rapid confirmatory test and quantitative bioassay for aflatoxin B<sub>1</sub>. *B. megaterium* NRRL B-1368 has also been reported to be sensitive to ochratoxin A (6) and a confirmatory test for ochratoxin A using this organism has been reported (16). Broce et al. (3) reported a quantitative bioassay and confirmatory test ochratoxins A and B, using *Bacillus cereus* var. *mycoides* LSU (Louisiana State University). Stott and Bullerman (17) reported that *B. megaterium* NRRL B-1368 was also sensitive to patulin and was a suitable test organism for an accurate quantitative bioassay of the toxin. Reiss (14) also developed a sensitive bioassay for patulin using a spore suspension of *B. subtilis*.

Penicillic acid, first isolated in 1913 by Alsberg and Black (2), is produced by numerous mold species commonly found in foods and feeds. In previous work, gram-positive and gram-negative bacteria have been

found to be sensitive to penicillic acid (1). In those studies, the activity of the compound was reported in terms of the highest dilution required to prevent growth using the streak plate method with *Escherichia coli*, *Staphylococcus aureus* and *Bacillus subtilis* (7). The cylinder plate method was used with *S. aureus* and *E. coli* (8). Tube dilution methods have also been used to assay penicillic acid with *S. aureus*, *E. coli* and *Salmonella typhi* (11,12). This method has also been used quantitatively, with *B. subtilis* (8 µg/ml), *E. coli* (64 µg/ml) and *S. aureus* (16 µg/ml) by Kavanagh (9). With these methods either quantitative results were not always reported, or sensitivity was poor.

The objective of this study was to develop a more sensitive quantitative bioassay for penicillic acid that could be used as a sensitive, rapid, simple and inexpensive means of detecting biological activity in sample extracts.

### MATERIALS AND METHODS

#### Cultures

Cultures of *E. coli*, *S. aureus* and *B. subtilis* were obtained from the Department of Food Science and Technology culture collection. *B. megaterium* NRRL B-1368 and *B. cereus* var. *mycoides* (LSU) were obtained previously for bioassay work with patulin and were maintained in our laboratory. A commercially prepared *B. subtilis* spore suspension (Difco) was also used. These organisms were selected to test for sensitivity to penicillic acid because they had either been reported in the literature to be sensitive to penicillic acid or had been reported to be sensitive to patulin which is believed to have a mode of toxicity similar to that of penicillic acid. Cultures were maintained on nutrient agar and stored at refrigerated temperatures.

#### Mycotoxin standard

Crystalline penicillic acid was diluted with reagent grade chloroform to give a concentration of 1 µg/ul. The purity and concentration of the solution were confirmed using ultraviolet absorption spectrophotometry and thin layer chromatography (10,15).

#### Media and inoculum preparation

Tryptone-yeast extract-glucose (TYG) broth and agar (17) were used for this assay. The cultures were prepared by inoculating a tube of TYG broth with the appropriate microorganism and incubating at 35-37°C for 15-20 h until approximately 70% transmittance was obtained as

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measured at 520 nm in 1-cm cell (Bausch and Lomb Spectronic 20 spectrophotometer). Transmittance was adjusted with sterile water when necessary. Two ml of the inoculum preparation was added to each 100 ml of melted and tempered (50 C) TYG agar when assaying with *S. aureus*, *E. coli*, *B. megaterium*, and *B. cereus* var. *mycooides*; 1 ml/100 ml TYG agar was used for *B. subtilis* and the *B. subtilis* spore suspension. After the inoculum had been added, the TYG agar was swirled to mix the solution to insure uniform distribution, and 10 ml of the seeded agar was aseptically pipetted into sterile glass petri dishes (15 × 100 mm) and allowed to solidify.

#### Assay procedure

Blank antibiotic discs (6.35 mm in diameter, No. 740, Schleicher and Schuell, Keene, NH) were placed upon a wire mesh support to insure that the disc absorbed all the solvent that was delivered to it. To determine sensitivity limits and linear response of each microorganism studied, discs were prepared containing 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50 and 100  $\mu\text{g}$  concentrations of penicillic acid standard solution. Discs containing 5 and 20  $\mu\text{l}$  of solvent control were also prepared. Solvent control and standard toxin solutions were slowly applied to discs dropwise using a microliter syringe. The discs were allowed to dry approximately 10 min and then four discs (impregnated side down) were evenly spaced on the agar surface of each prepared plate. The plates were then inverted and pre-incubated at 5 C for 30 min to allow uniform diffusion into the agar. After preincubation, plates were incubated overnight (15-17 h) at 35-37 C. The inhibition zones were then measured with vernier calipers to the nearest 0.1 mm; the diameter of the paper disc (6.35 mm) was subtracted to obtain the adjusted inhibition zone. Assays were done in quadruplicate.

## RESULTS AND DISCUSSION

Table 1 gives the lowest concentration of penicillic acid that caused a measurable zone of inhibition with each of the microorganisms tested. *B. megaterium* NRRL 1368 and *B. cereus* var. *mycooides* LSU were the least sensitive to penicillic acid, and *S. aureus* and *E. coli* were equally sensitive to intermediate amounts of the mycotoxin. Vegetative cultures and the commercial spore suspension of *B. subtilis* were the most sensitive to penicillic acid, with inhibition occurring with as little as 1  $\mu\text{g}$  of the compound. The chloroform control discs gave no inhibition.

When the penicillic acid concentration ( $\mu\text{g}/\text{disc}$ ) was plotted on the y-axis and the corresponding average corrected zone of inhibition on the x-axis of semi-logarithmic graph paper, standard curves for penicillic acid inhibition of the various cultures were obtained. The standard curve obtained with *B. subtilis* spores is shown in Fig. 1.

Regression analysis of the two variables for the curve gave a correlation coefficient of 0.986, which is indicative of a strongly positive linear relationship between the

TABLE 1. Minimum concentration of penicillic acid ( $\mu\text{g}$ ) giving a detectable zone of inhibition.

Microorganism	Penicillic Acid ( $\mu\text{g}$ )
<i>S. aureus</i>	3-5
<i>E. coli</i>	3-5
<i>B. megaterium</i> NRRL B-1368	8-12
<i>B. cereus</i> var. <i>mycooides</i> LSU	12
<i>B. subtilis</i>	1
<i>B. subtilis</i> (spore suspension)	1

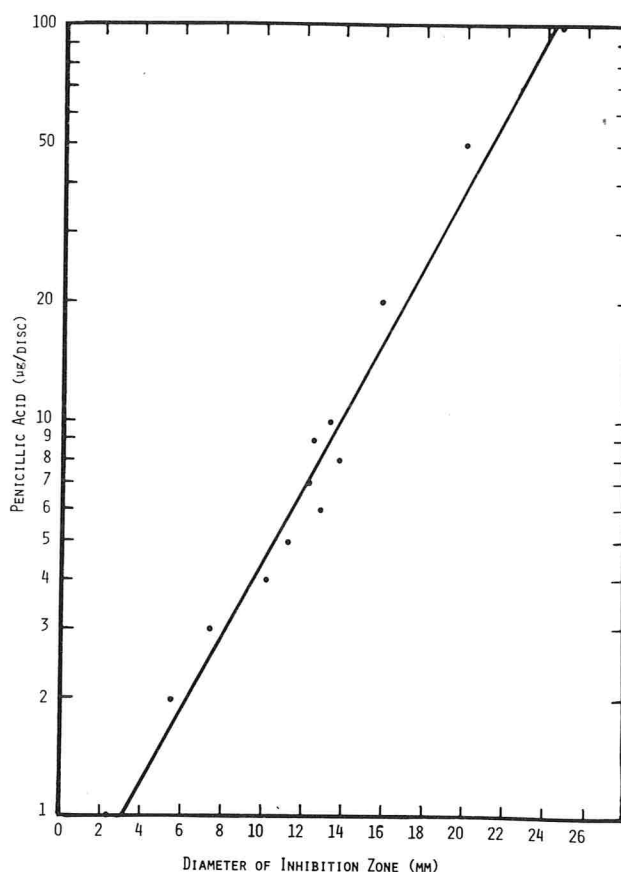


Figure 1. Standard curve for bioassay of penicillic acid using *Bacillus subtilis* spores.

variables and is statistically significant ( $P = 0.1$ ). The line was determined by linear regression analysis of the data which gave a coefficient of determination ( $r^2$ ) of 0.974 and determined the slope of the line ( $b = 0.093$ ) and the y intercept ( $a = 0.272$ ). Thus, the equation for the line is  $y = -0.272 + (0.093) X$ . The standard curve maintained a linear relationship up to a concentration of 100  $\mu\text{g}/\text{disc}$ . Upon repeated trials the slope of the line and inhibition zone size varied slightly, but 1  $\mu\text{g}$  of the mycotoxin was always readily detectable and the standard curve maintained its linearity. The results obtained using vegetative cultures of *B. subtilis* were similar, indicating that either spores or vegetative cultures could be used.

The quantitative bioassay separately using vegetative cultures and spores of *B. subtilis* was compared to quantitative measurement of penicillic acid by TLC using visual estimation of concentration after derivatization with phenylhydrazine (15). Twelve chloroform extracts of several liquid media cultures of a penicillic acid producing *Penicillium* sp. were quantitated by the two methods. For the bioassay 1-, 5-, 10- and 20- $\mu\text{l}$  volumes were also spotted. The value obtained by TLC quantitation was the average of three independent observations for each sample. The results were compared statistically by the analysis of variance method. There

was no significant difference ( $P = 0.01$ ) between the chemical and biological quantitation methods. The bioassay was also compared with TLC using an extract obtained from corn that had been inoculated with a known penicillic acid producing *Penicillium* sp. The corn was extracted by the method of Pohland and Allen (13). The bioassay and TLC quantitations showed no significant differences. Again, there was very little difference in sensitivity to penicillic acid between vegetative cells and spores of *B. subtilis*.

The work reported here clearly indicates the suitability of *B. subtilis* for a quantitative bioassay of penicillic acid. A definite linear relationship existed between the concentration of penicillic acid and the zone of inhibition of *B. subtilis* when using the disc plate technique of microbiological assay. This method was more sensitive than those previously reported (7,9) and is comparable to the sensitivity reported for microbiological assays of other mycotoxins.

The accuracy and quantitative capability of this bioassay method compare favorably with quantitative thin layer chromatography. The technique, using commercial *B. subtilis* spore suspensions, offers a simple, rapid, inexpensive confirmatory and quantitative method that can be used to supplement TLC in determining the presence and concentration of penicillic acid in sample extracts.

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## Lettuce Salad as a Carrier of Microorganisms of Public Health Significance<sup>1</sup>

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### ABSTRACT

Culture, distribution, and preparation of lettuce for salad offers opportunities for contamination with and growth of microorganisms. Protection and preservation methods, even when appropriate, may likewise be favorable for the contaminants. Fresh lettuce, as commercially available, was studied to determine the magnitude of contamination and the nature of representative contaminants. Specific contaminants of public health interest were added to test portions to determine their fate during storage of lettuce as a salad at room temperature. Storage of lettuce in bowls on ice resulted in very little cooling of most of the lettuce. Microbial plate counts on fresh lettuce commonly were over  $10^5$ /g and the diversity of the microflora indicated a generally favorable microenvironment for many types of bacteria. Inocula of *Salmonella typhimurium*, *Escherichia coli*, and *Staphylococcus aureus* fared well on lettuce salad and were able to grow at room temperature storage. Commercial "whitener" added to lettuce to preserve freshness reduced the total microflora and indicator organisms of public health significance.

Food preparation for consumption outside the home is a rapidly growing segment of the food industry, and most reported foodborne illnesses are attributed to this segment (1). The growing complexity of mass production of meals away from home presents new challenges in food protection (16). Lettuce is an example of food products undergoing changes in preparation and storage methods. There is increasing use of central processing to provide ready-to-serve forms of lettuce. Under any system, lettuce is a fresh raw vegetable, which is subjected to a wide spectrum of exposure before reaching the food preparation area. The common regimen of production has inherent opportunities for contamination from such sources as manure for fertilizer, contaminated irrigation water, wild animals, and personal contact in the harvesting process. However, Dunlop and Wang (2) found surprisingly few pathogens on lettuce irrigated with sewage. At the time of harvesting, lettuce is cooled for its protection which arrests growth but provides protection for contaminants.

When lettuce reaches the food preparation area, there are various opportunities for contamination through mechanical equipment and human contact. Scheduling to maximize use of labor may involve holding lettuce or salads at room temperature, thereby allowing growth of pathogenic organisms if they are present.

Lettuce as prepared for salads by traditional methods and evaluated immediately may carry a total microbial load of millions per gram (3-6). Some of these organisms may grow during storage under refrigeration (14). More rapid growth would be expected with lettuce in warmer conditions up to room temperature.

Preparation of lettuce for serving involves creation of new surfaces and a new, unstudied microenvironment which may be more favorable for microbial growth (14). An integral step in preparation is washing, which provides residual moisture for growth of contaminating organisms. Furthermore, the physical nature of lettuce provides a high surface area to unit weight and ample protection of the microbial contaminants.

Where there is human contact there is a possibility of contamination with pathogens of human origin. Hall and Hauser (7) found 6.4% of healthy workers to be carriers of enteropathogenic *Escherichia coli*.

The purpose of this work was to determine the magnitude and nature of the microflora of lettuce and to obtain more information on lettuce as a carrier of pathogens.

### METHODS

#### Cultures

For observations on the fate of pure cultures, *Salmonella typhimurium*, *Staphylococcus aureus*, and *E. coli* were used. They were propagated in m-Plate Count Broth (PCB; Difco) at 25 C for approximately 48 h and used in this state or held at 5 C for further propagation and use. Cultures were diluted in phosphate buffer (8), for the contamination experiments.

#### Evaluation of microflora

The general procedures were those outlined in *Recommended Methods for the Microbiological Examination of Foods* (15) and *Standard Methods for the Examination of Dairy Products* (8). Total aerobic plate counts at 32 C were made on Plate Count Agar (PCA; Difco). Coli-

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form counts were made by plating with Violet Red Bile Agar (VRBA; Difco). Staphylococcal counts were made on Staphylococcus Medium 110 (S110; Difco). *Salmonella typhimurium* counts were made on Brilliant Green Agar (BGA; Difco).

To study the nature of the microflora occurring naturally on commercial lettuce, 10 colonies were picked by random design from the countable plates used to determine the total microbial count. The colonies were inoculated into litmus milk and streaked on PCA containing skim milk. After growth, isolates were further observed for gram reaction, morphology, spore formation, proteolysis of casein, catalase, oxidase, appearance on EMB Agar, and gas production in Brilliant Green Lactose Bile Broth. The organisms were then grouped according to major factors of interest to the food industry (12,13).

#### Lettuce

Head lettuce was obtained fresh as needed from local supermarkets. Lettuce for institutional use was prepared in a central operation and distributed to a restaurant where it was obtained for this work. An 11-g sample was blended in 99 ml of phosphate buffer (8) in a Waring blender for 1 min after which serial dilutions were made in phosphate buffer for plating.

Various portions of lettuce heads were sampled to determine the general magnitude of contamination. First, the entire edible portion of head lettuce was torn by hand into serving-size pieces, mixed and an 11-g sample was removed for plate counts. To determine the location of contamination, the aesthetically unacceptable leaves were removed and discarded. Then one to three leaves were taken for a microbial sample of extreme outer portion, and the results were noted as "outside leaves." For counts on the "inside," leaves were taken from the very center of the head.

#### Contamination of lettuce

Fresh edible leaves of lettuce were washed in tap water to provide representative test samples of 50 g each. The culture to be studied as a contaminant was diluted 1:1000 in phosphate buffer. With disposable single-service gloves, hands were submerged to the second knuckle, removed and shaken. With the contaminated gloved hands a 40 g sample was torn into bite-size pieces and tumbled 24 times. Sub-samples of 11 g were placed in a petri plate and held at room temperature (23-25 C). Periodically, a sub-sample was blended for plate counts on a selective medium appropriate for the test contaminant being studied.

#### Chemical treatment of lettuce

A commercial product "Tater White" (L. K. Baker and Co., Columbus, Ohio) containing sodium meta-bisulfite, sodium citrate, and sodium erythrobratate was used. Lettuce was treated according to directions with 15 g/gal of wash water and a treatment contact time of 1 1/2 min.

#### Temperature measurements

Localized temperature and heat transfer in salad bowls was measured with a Honeywell recording potentiometer with a copper-constantan thermocouple. Dimensions, of the salad bowls were: (a) wood (14.5 cm diameter, 3.5 cm deep), (b) plastic (12.5 cm diameter, 5 cm deep), (c) glass (12.5 cm diameter, 5 cm deep).

## RESULTS

#### Microflora of commercial lettuce

The magnitude of the total microbial load and counts on selective media, based on an average of at least three trials with duplicate plating, are shown in Table 1. It was apparent that most of the microorganisms were on the outer leaves, as counts on the inner parts were very low. The extreme outer leaves, the total blend of the heads, and the institutional prepared products contained approximately the same magnitude of microbial load. Apparently blending and disruption of colonies offset the very low count on the inner parts of the lettuce head.

TABLE 1. Plate counts on commercial lettuce for salads.

Fraction observed	Plating medium		
	PCA	S110	VRBA
Head lettuce	$1.6 \times 10^5$	$6.3 \times 10^3$	$5.6 \times 10^3$
Outside leaves	$6.3 \times 10^4$	$5.0 \times 10^2$	$1.3 \times 10^3$
Inside leaves	$3.2 \times 10^1$	< 10	< 10
Institutional (prepared)	$4.2 \times 10^5$	$2.9 \times 10^4$	$8.3 \times 10^3$

Also, the microenvironment of the extreme outer leaves may be less favorable than further into the head. Results on total blended heads of lettuce were in agreement with previous reports by Ercolani (3) and Fowler and Foster (4). The presence of indicator organisms as shown by the counts on VRBA and S110 indicate lettuce is an acceptable environment for microorganisms of public health significance.

The nature of the microflora of head lettuce and prepared institutional lettuce was studied by making isolates from the above countable plates. The results (Table 2) indicated there was a broad spectrum of microorganisms, which further indicated that the microenvironment would support many types of contaminants of public health significance. A total of 480 isolates from various parts of lettuce were studied and the results indicated those from head lettuce and institutional lettuce were similar.

TABLE 2. Nature of the microflora of lettuce.

Type of organism	Percentage	
	Head lettuce	Prepared institutional lettuce
Sporeformers	2	7
Gram +, catalase + asporogenous, non-proteolytic rods	17	7
Gram +, catalase -, rods	2	3
Gram -, rods, proteolytic	18	27
Gram -, rods, non-proteolytic	47	33
Coliforms	0	2
Gram + cocci, catalase negative	0	10
Gram + cocci, catalase positive	2	0
Coccobacilli, catalase positive	8	3
Gram +, rods, catalase +, proteolytic	5	8
	101%	100%

#### Fate of contaminants of public health significance on lettuce

Test cultures of *E. coli*, *S. typhimurium*, and *S. aureus* individually were added to lettuce and stored uncovered at 23-25 C. The numbers were determined by periodic plating on VRBA, BGA, and S110, respectively. Counting of colonies on the selective media was based on known appearance of inoculum added for study. Results of an average of three trials are shown in Fig. 1. These data indicated there was a lag of approximately 2 h after which there was some growth. Triplicate experiments also were done with one change in procedure, which included covering the lettuce with thin polyethylene film. The results were essentially the same as those with uncovered lettuce.

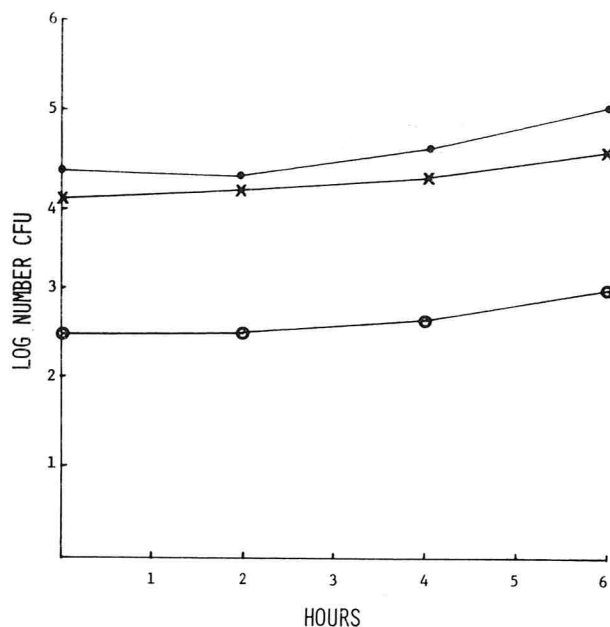


Figure 1. Fate of contaminants of public health significance on lettuce expressed as colony forming units per gram. Dots represent *E. coli*; crosses represent *S. aureus*; open circles represent *S. typhimurium*.

#### Temperature of lettuce as a salad presented in a cafeteria-like environment

Salad bowls of wood, plastic, or glass were filled with torn lettuce and placed on finely crushed ice and held at room temperature. Temperature measurements within a bowl were made in three locations: (a) within 2 mm of the bottom center with a lettuce leaf between the bottom and the thermocouple, (b) near the side and approximately halfway between the bottom and rim of the bowl, and (c) top center with a lettuce leaf covering the thermocouple. The temperature pattern over a 6-h period in a glass bowl is shown in Fig. 2. Temperatures indicated by the thermocouples on the side and top were essentially the same and these data were combined for presentation in Fig. 2. Construction material of the salad bowl or minor changes in configurations as exemplified by measurements of these bowls had no apparent effect on the temperature of the lettuce during the period of study. Covering the lettuce and bowl with a thin polyethylene film did not have a significant effect on the temperature profile. The data indicate that most of the lettuce is far warmer than might be implied by the temperature of storage on ice.

#### Effect of "whitener" on the microflora of lettuce

A commercial source of whitener was used to treat lettuce leaves according to the recommended procedure in prepared systems for preserving fresh appearance. The results in Table 3 show a comparison of treated and untreated halves of the same head of lettuce after 48 h at 5 C. Immediately after treatment, the counts were lower than on the untreated lettuce and the difference was even greater after 48 h. Thus the chemical treatment

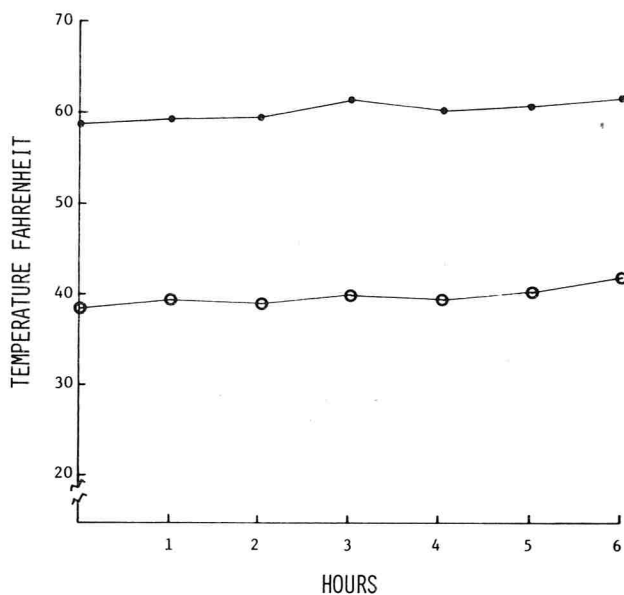


Figure 2. Temperature measurements of lettuce in bowls stored on ice. Dots represent top and side measurements. Open circles represent near bottom measurements.

TABLE 3. The effect of "whitener" on the numbers of microorganisms on lettuce.

Plating medium	Control		Whitener	
	0 h	48 h	0 h	48 h
PCA	$1.3 \times 10^5$	$1.0 \times 10^6$	$3.5 \times 10^4$	$8.1 \times 10^4$
S110	$6.8 \times 10^3$	$1.3 \times 10^3$	$3.0 \times 10^5$	<10
VRBA	< 10	< 10		

preserved the appearance of the lettuce and reduced microbial activity.

#### DISCUSSION

There are numerous microorganisms on fresh lettuce as indicated in this work, as well as reports by others. More important, however, than numbers is the great diversity of types proliferating on lettuce. The microenvironment is favorable for microorganisms with the same requirements as common microorganisms of public health significance.

Since the microenvironment is favorable for microorganisms of public health significance, contamination should be avoided. Microorganisms can grow on lettuce as it is prepared and presented for selection in institutional feeding systems. The regimen of preparation and service should not allow such practices for banquets as place setting of salads at room temperature long before consumption. The motivation is full labor utilization, but the restraint is overwhelmingly in favor of public health protection.

Covering of lettuce base salads for presentation in a cafeteria-type service has aesthetic appeal, affords some protection against airborne contamination but has little effect on maintaining properly refrigerated conditions. This equilibrium of cooling and heating is quite different from the protective effect provided by cooling hot foods

where water vaporization is a major factor (12). Warm lettuce at room temperature, though in a bowl on ice, showed little temperature change in hours. Presentation of bowls on ice is mostly aesthetic as the patron feels the cold bowl, but cooling is insignificant for most of the lettuce.

The practice of using whiteners, which possess a preservative, not only preserve the fresh appearance but reduce the numbers of microorganisms. There is also a residual effect up to 48 h as observed in this work. The merits or acceptability of such a practice are beyond the scope of this work, which was solely to observe the effect on total load and some microorganisms of public health significance. Further and more detailed work, however, should be done to determine which fraction of the microflora is suppressed and the significance of outgrowth of those remaining.

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## Enumeration of *Lactobacillus acidophilus* with the Agar Plate Count

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### ABSTRACT

Higher plate counts on MRS agar were obtained under anaerobic conditions for three of four strains of *Lactobacillus acidophilus* and commercially prepared nonfermented acidophilus milks (products A and B) made with two of the strains. Average values for aerobic counts of products A and B were 87 and 60%, respectively, of those for corresponding anaerobic counts. Incubation of plates poured with MRS agar for  $72 \pm 3$  h at 37 C was sufficient for maximal counts. Two strains and the nonfermented acidophilus milks gave highest counts on Standard Methods Agar (SMA). Greatest numbers of bile-resistant colonies were indicated by MRS agar (with 0.2% oxgall). The average of plate counts for products A and B determined on MRS agar with oxgall was 65% of that for corresponding plate counts determined on MRS without oxgall. Buffered distilled water, 0.9% NaCl, and 1% peptone each served satisfactorily as diluent. Overlaying MRS agar in poured plates with additional medium was not advantageous. Plate counts of samples that had been frozen and stored at -26 C or in dry ice were as high as those of duplicate samples that had been stored at 1.7 C.

This study was undertaken to determine medium and conditions for determining maximal numbers of *Lactobacillus acidophilus* with the agar plate count. Three or more different strains of *L. acidophilus* presently are available for use in commercial preparation of nonfermented acidophilus milks, and some states have established regulations requiring that such products comply with minimal plate count standards. The minimal standard in California is 2 million colonies per milliliter.

### MATERIALS AND METHODS

#### Media

Six different media were used for enumerating *L. acidophilus*. APT agar, LBS agar, and Tomato Juice agar (TJ) were obtained from BBL, Cockeysville, MD; Elliker agar (EA), Standard Methods agar (SMA), and MRS agar (MRS broth plus 1.5% agar) were from Difco Laboratories, Detroit, Michigan. Oxgall (dehydrated beef bile) was from Difco Laboratories.

#### Cultures

Initially four strains of *L. acidophilus* were studied. Two (A and B) were commercial frozen concentrated cultures that are used extensively for preparing nonfermented acidophilus milks. Two (C and D) were lyophilized cultures of *L. acidophilus* that presently are not used extensively. Eventually, commercially prepared nonfermented acidophilus milks were purchased as needed and tested. Product A was made

with culture A; product B was made with culture B.

Neither frozen nor lyophilized cultures were propagated before plating. Frozen cultures were cut into small pieces (in a cold room), put into screw-capped test tubes, and stored at -26 C. For each experiment one test tube was removed from the cold room, the culture was allowed to melt, and the appropriate dilution was made. The dilution was adjusted from experiment to experiment to obtain 30-300 colonies per plate. These adjustments make comparison of counts from one experiment to another inappropriate. For plating lyophilized cultures, 0.1 g was diluted.

#### Plating

Except where indicated otherwise, procedures were as follows. Cultures were diluted in buffered distilled water, made according to *Standard Methods for the Examination of Dairy Products*, 13th ed. Plates were poured with 12 to 15 ml of agar and incubated at 37 C for 3 days ( $72 \pm 3$  h). A sufficient number of plates was poured so that there were duplicate plates for each variable studied. Colony counts are average values for two plates, unless indicated otherwise. Normally, plates were incubated aerobically and anaerobically, with and without 0.2% oxgall, which normally was sterilized separately and added to sterile media at the time of plating. Anaerobic conditions (about 7% CO<sub>2</sub>, according to the BBL Manual) were accomplished by using Gas Pak 100 Anaerobic Systems (BBL).

### RESULTS AND DISCUSSION

#### Frozen or lyophilized cultures

Cultures A and B were plated with six different media with and without 0.2% oxgall, and incubated aerobically and anaerobically. Separate pairs of plates were incubated for 2, 3, or 5 days. Subsequently, four cultures were used in additional comparisons of MRS with APT and SMA.

Anaerobic conditions were necessary for maximal counts of cultures B, C, and D (Tables 1, 2, and 3). Three or four of the six media tested served satisfactorily for cultures A and B when the plates were incubated anaerobically 3 days or longer (Table 1). Comparison of MRS with APT (Table 2) showed that anaerobic counts of cultures A and D were higher on MRS, that those of culture B were about the same on the two media, and that counts of culture C were higher on APT. Comparison of MRS with SMA (Table 3) showed that anaerobic counts of cultures A and B were higher on

MRS and that counts of cultures C and D were higher on SMA. APT and LBS (with oxgall added) indicated that cultures B and D contained bile-resistant colonies, but the largest number of bile-resistant colonies for each of the strains was indicated by MRS (Tables 1, 2, and 3). Two sets of plates received SMA and MRS agars containing 0.25% sodium thiosulfate to determine if use of sodium thiosulfate would enhance colony formation under aerobic conditions. Results were inconsistently

negative (Table 3).

#### Commercial products

Commercially prepared nonfermented acidophilus milks were obtained and plated on three media (Table 4). Subsequently, several modifications of the plating procedure (with MR agar) were studied (Tables 5 to 10). All plates were incubated  $72 \pm 3$  h, because longer incubation at 37 C was unnecessary for maximal counts

TABLE 1. Influence of agar medium and incubation time on the plate count of *Lactobacillus acidophilus*.

Agar	Colonies/plate					
	No oxgall			0.2% Oxgall		
	2 days	3 days	5 days	2 days	3 days	5 days
	Culture A-Aerobic					
MRS	280	350	350	35	44	50
SMA	200	250	280	<1	<1	<1
APT	120	240	270	<1	<1	<1
EA	110	150	280	<1	<1	<1
LBS	<1	170	200	<1	<1	<1
TJ	<1	<1	<1	<1	<1	<1
	Culture A-Anaerobic					
MRS	250	320	310	21	29	68
SMA	180	300	280	<1	<1	<1
APT	110	93	120	<1	<1	<1
EA	220	220	290	<1	<1	<1
LBS	220	270	230	<1	<1	<1
TJ	<1	13	69	<1	<1	<1
	Culture B-Aerobic					
MRS	29	51	36	30	38	49
SMA	<1	58	150	<1	<1	<1
APT	<1	47	48	<1	<1	<1
EA	<1	130	170	<1	<1	<1
LBS	<1	<1	<1	<1	<1	<1
TJ	<1	56	51	<1	<1	<1
	Culture B-Anaerobic					
MRS	170	170	190	140	140	150
SMA	210	200	230	<1	<1	<1
APT	210	180	190	20	25	40
EA	140	160	180	<1	<1	<1
LBS	140	160	160	<1	70	58
TJ	100	90	90	<1	<1	<1

TABLE 2. Comparison of plate counts on MRS and APT agars incubated aerobically and anaerobically with and without oxgall.

Agar	Colonies/plate					
	No Oxgall			0.2% Oxgall		
	2 days	3 days	5 days	2 days	3 days	5 days
	Culture A-Aerobic					
MRS	104	127	129	<1	10	12
APT	52	112	143	<1	<1	<1
	Culture A-Anaerobic					
MRS	115	142	126	9	14	22
APT	58	60	122	<1	<1	<1
	Culture B-Aerobic					
MRS	37	34	36	31	35	38
APT	30	38	43	<1	<1	<1
	Culture B-Anaerobic					
MRS	142	160	178	110	132	110
APT	162	168	167	33	27	35
	Culture C-Aerobic					
MRS	27	49	39	<1	<1	<1
APT	4	20	24	<1	<1	<1
	Culture C-Anaerobic					
MRS	101	115	127	<1	19	20
APT	112	143	147	<1	<1	<1
	Culture D-Aerobic					
MRS	81	93	84	64	63	65
APT	80	84	84	5	<1	10
	Culture D-Anaerobic					
MRS	123	133	122	79	87	84
APT	97	98	104	3	4	4

TABLE 3. Comparison of plate counts on MRS and SMA incubated aerobically and anaerobically with and without oxgall (0.2%).

Agar	Colonies/plate <sup>a</sup>		
	Aerobic	Aerobic (.25% sodium thioglycollate)	Anaerobic
	Culture A-No oxgall		
MRS	45	<1	64
SMA	52	67	47
	Culture A-Plus oxgall		
MRS	<1	<1	<1
SMA	<1	<1	<1
	Culture B-No oxgall		
MRS	17	<1	127
SMA	<1	14	91
	Culture B-Plus oxgall		
MRS	<1	<1	83
SMA	<1	<1	<1
	Culture C-No oxgall		
MRS	80	96	210
SMA	330	137	470
	Culture C-Plus oxgall		
MRS	<1	<1	110
SMA	<1	<1	<1
	Culture D-No oxgall		
MRS	164	160	141
SMA	130	151	189
	Culture D-Plus oxgall		
MRS	110	121	99
SMA	5	<1	<1

<sup>a</sup>Plates here and for subsequent tables were incubated 72 ± 3 h.

TABLE 4. Comparison of MRS, SMA, and APT agars for plating commercial nonfermented acidophilus milks.

Agar	Colonies/plate		
	Aerobic	No oxgall Anaerobic	0.2% Oxgall Anaerobic
	Product A		
MRS	271	268	166
SMA	265	332	5
APT	241	177	14
	Product B		
MRS	93	105	60
SMA	197	138	3
APT		132	5

on MRS agar (Tables 1 and 2). (Were nonfermented acidophilus milks enumerated at 35 or 32 C, longer incubation likely would be required for maximal counts.) Normally, fresh products were obtained for each new experiment.

With nonfermented acidophilus milks made with cultures A and B, as with frozen cultures, colony counts on MRS (without oxgall) were higher when plates, especially those containing product B, were incubated anaerobically. The average of aerobic counts for product A (Tables 4 to 9) is 87% of the average for anaerobic counts. The average of aerobic counts for product B is 60% of that for anaerobic counts. Anaerobic counts for products A and B were higher on SMA than on MRS (Table 4). Using as little as 10 ml of MRS agar per plate was satisfactory (Table 5); overlaying the agar in poured plates with more MRS agar was unnecessary (Table 6); and there was little preference among the three diluents tested (Table 7). The low count obtained for product A in the repeat experiment with 1% peptone as the diluent is inconsistent.

TABLE 5. Influence of the amount of MRS agar/plate on plate counts of commercial nonfermented acidophilus milks.

Amount agar (ml)	Colonies/plate			
	No oxgall		0.2% Oxgall	
	Aerobic	Anaerobic	Aerobic	Anaerobic
	Product A			
10	116	136	100	90
15	115	136	84	82
20	123	150	51	83
	Product B			
10	87	134	5	65
15	46	124	32	114
20	68	105	6	76

TABLE 6. Influence on plate counts of nonfermented acidophilus milks of overlaying MRS agar in poured plates with additional MRS agar.

	Colonies/plate			
	No oxgall		0.2% Oxgall	
	Aerobic	Anaerobic	Aerobic	Anaerobic
	Experiment #1			
	Product A			
Not overlayed	100	123	114	68
Overlayed	60	116	128	75
	Product B			
Not overlayed	64	86	49	68
Overlayed	76	96	35	74
	Experiment #2			
	Product A			
Not overlayed	63	70	34	39
Overlayed	41	53	37	47
	Product B			
Not overlayed	56	88	42	52
Overlayed	47	77	33	41

TABLE 7. Influence of diluent on the plate counts of commercial nonfermented acidophilus milks.

Diluent	Colonies/plate <sup>a</sup>			
	No oxgall		0.15% Oxgall	
	Aerobic	Anaerobic	Aerobic	Anaerobic
	Product A			
.9% NaCl	67	87		
1% Peptone	84	86		
Buffered distilled water	64	86		
	Product B			
.9% NaCl	40	63		41
1% Peptone	29	70		40
Buffered distilled water	39	56		41
	Repeat; oxgall added before autoclaving			
	Product A			
.9% NaCl	79	81	44	32
1% Peptone	35	35	21	16
Buffered distilled water	55	66	6	8
	Product B			
.9% NaCl	60	99	57	98
1% Peptone	58	111	21	93
Buffered distilled water	45	96	31	90

<sup>a</sup>Average for four plates. The agar here and for subsequent tables was MRS.

Use of a selective medium for enumeration of *L. acidophilus* in refrigerated nonfermented milks should not be necessary, because psychrotrophic bacteria do not grow or grow poorly under anaerobic conditions at 37 C, which is the optimal temperature for culture A in MRS broth and below the optimum for culture B (unpublished data). Nevertheless, oxgall may be added to MRS for the

selective enumeration of *L. acidophilus*. The pH of MRS agar without adjustment is stated to be 6.5. Ours, determined after the addition of oxgall, was 6.4. Adjustment above 6.4 decreased the number of colonies formed in the presence of 0.2% oxgall (Table 8). Decreasing the oxgall concentration below .2% permitted an increase in the number of colonies (Table 9). The plate counts of products A and B with oxgall added to MRS agar averaged 65% of those obtained without oxgall (Tables 4 to 10).

Products A and B were dispensed into 3-oz. screw-cap bottles. Some were stored in a refrigerator at 1.7 C, some

TABLE 8. Influence of pH on the bile resistance of bacteria in commercial nonfermented acidophilus milks.

pH (after autoclaving and addition of 0.2% oxgall)	Product A		Product B	
	Aerobic	Anaerobic	Aerobic	Anaerobic
5.75	61	58	36	37
6.15	58	59	34	55
6.40	77	56	26	35
6.60	69	42	22	21
6.90	25	32	10	29

TABLE 9. Influence of amount of oxgall on plate counts of commercial nonfermented acidophilus milks.

Amount oxgall (%)	Colonies/plate <sup>a</sup>	
	Product A	Product B
None	267	105
.10	226	73
.15	179	70
.20	133	60

<sup>a</sup>Plates were incubated anaerobically.

TABLE 10. Influence of freezing and storage of commercial nonfermented acidophilus milks on plate counts run subsequently.

Storage (days)	Colonies/plate <sup>a</sup> after storage of product		
	At 1.7 C	At -26 C	In Dry Ice
	Product A		
1	120	120	113
3	101	108	96
5	96	96	97
7	97	99	97
	Product B		
1	118	109	100
3	94	105	111
5	98	104	117
7	108	110	113
	Recheck at later date		
	Product A		
None	63	63	63
1	67	66	56
	Product B		
None	56	56	56
1	51	54	56

<sup>a</sup>Plates were incubated anaerobically. Oxgall was not added to MRS agar.

in a cold room at -26 C, and some in dry ice (separated from the dry ice by cardboard to prevent breakage). Frozen samples were thawed at room temperature (about 45 min), and all samples were inverted rapidly several times before removal of portions for plating. The plate counts on frozen samples were as high as those for refrigerated samples (Table 10).

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## Oxidative Deterioration in Vegetable Oils: Health-Food Oils Versus Conventional Oils<sup>1</sup>

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### ABSTRACT

Storage stability of health-food and conventional vegetable oils was evaluated by determining oxidative deterioration during accelerated storage at 60 C of unused oils and room-temperature storage of unused and used (once-heated) oils. Oxidative changes were determined by peroxide value (PV), 2-thiobarbituric acid (TBA) test, measurement of weight increase, and sensory evaluation. Vegetable oils included were safflower and corn oils with (conventional oils) or without (health-food oils) added antioxidants. Health-food oils oxidized much faster by all measures than conventional oils, although composition of fatty acids was similar within each oilseed category. In addition, peak values of PV and TBA tests were higher for health-food oils than conventional oils. Differences between health-food and conventional oils increased steadily with the increase in storage time when unused oils were stored at room temperature; for used oils the steady increase was followed by a decrease after approximately 100 days. However, differences were greater with used oils than the unused within 100 days. As to the different oilseeds, safflower oils were more susceptible to oxidation than corn oils, the differences being widened by heating treatment before storage. The TBA test was more sensitive and correlated better with rancid odor development in these vegetable oils at early stages of oxidation, whereas peroxide value determination was generally more reliable for monitoring the oxidative deterioration over longer storage periods, up to certain limits.

In recent years the public has been increasingly interested in so-called health food, organic food, and natural food (5). The term "health food" is frequently used to be inclusive of organic and natural food. It is not unusual now to find separate health-food sections in the supermarket.

The available scientific reports on quality of health foods are limited to a small number of articles dealing with nutrient analysis and evaluation of eating quality (2,3,12). According to these reports, health foods are not better than conventional counterparts in the quality aspect studied. Health foods are, however, generally much more expensive than corresponding conventional foods (2). The growing concern in the public sector about

food additives and the rapid growth of the health-food market led us to conduct a study on storage stability of health food versus conventional food. Specifically, the present study was concerned with stability of vegetable oils without preservatives. The investigation has been focused on oxidative deterioration during storage, since autoxidation is the primary cause of the quality deterioration of vegetable oils. Refined, salad and cooking oils were chosen because they can be found both in health-food stores and in the supermarket, whereas crude vegetable oils are sold only in health-food stores. Storage conditions and/or treatments employed were oven storage of unused oils and room temperature storage of unused and once-used (for frying) oils.

### MATERIALS AND METHODS

#### *Materials*

Corn and safflower oils, processed as salad and cooking oils, were purchased from a local health-food store and a supermarket. All oils were of nationally known brands. The abbreviations to be used for the oils are CO-H (health-food corn oil), SF-H (health-food safflower oil), CO-C (conventional corn oil), and SF-C (conventional safflower oil). The purchase price of each health-food oil was twice as great as that of the conventional counterpart. CO-C contained isopropyl citrate and methyl silicone as additives and SF-C contained BHA, BHT, and citric acid. No additives were included in CO-H and SF-H according to label descriptions.

#### *GLC analysis*

Oils were converted to fatty acid methyl esters according to the AOAC (1) method. GLC analysis of methyl esters was done using a Hewlett-Packard Model 5710-A gas chromatograph equipped with a flame ionization detector. A stainless-steel column (6 ft × 1/8 inch) packed with 10% of 75%-cyanopropyl silicone on 100-120 mesh Chromosorb W was used. The trials were isothermal at 170 C and the carrier gas (helium) flow was 20 ml/min. Peak areas were measured with an electronic integrator. Peak identities and quantitative accuracy were determined from known standards for each fatty acid reported.

#### *Chemical analysis*

The peroxide value (PV) of oil samples was determined by the AOAC (1) method. The 2-thiobarbituric acid (TBA) test described by Tarladgis et al. (14) was slightly modified; 2 g of oil were emulsified with 0.2 g of Tween 20, and 5 ml of a 0.5% solution of propyl gallate and EDTA

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were added to the distillation mixture (16). TBA reagent was prepared in distilled water instead of an acidic medium (15).

#### Sensory evaluation

The oil samples stored at 60 C were evaluated for the intensity of rancid odor with a laboratory panel of 8-12 judges. Those judges who were found to be entirely insensitive to rancid odor during preliminary judging sessions were eliminated from evaluation. A six-point descriptive rating scale ranging from 6 (not detectable) to 1 (very strong) was used for sensory scores. The oils were not warmed for odor evaluation. The mean odor scores of samples were calculated to relate the sensory data with the chemical analysis data.

#### Oil storage

For oven storage, 11-g aliquots of oils from newly opened bottles were weighed into 100-ml beakers and stored at 60 C. The oil samples were periodically removed from the oven for chemical analyses and to determine the increase in oil weight. The remainder of each oil sample, after sampling for chemical analyses, was tightly covered and immediately placed in a freezer at -18 C until the following day for sensory evaluation. The oven storage lasted until the oils were completely polymerized as judged by visual observation of viscosity.

For shelf storage, a 150-ml aliquot of each oil was placed in a 450-ml glass storage bottle (6.5 cm I.D.) with lid and stored in the dark at room temperature (24-26 C). An amount necessary for chemical analysis was withdrawn from storage bottle at each sampling period.

To determine the stability of once-heated (used) oils, 120 g of flour-water mixture (1:6, wt/vol) were fried for 20 min in 450 ml of oil in an aluminum electric skillet. Oil was first added to the unheated skillet and heated to 191 C before introducing the flour-water mixture. The fried dough and small dough fragments were removed before the used oil was divided into 30-ml aliquots in 100-ml beakers and stored in the dark with a sheet of paper loosely covering the samples.

## RESULTS

#### Fatty acid composition of oils

Fatty acid profile of each health-food oil was nearly the same as that of the corresponding conventional oil. The fatty acid data (Table 1) of these oils were comparable with those of USDA (4).

#### Oven storage

The results of PV and TBA-number determinations are illustrated in Fig. 1. Health-food oils oxidized faster than conventional oils. In addition, the peak values of both chemical tests were higher for the health-food oil in each oilseed category. PV and TBA number increased faster with safflower oils (for both health-food and conventional) than with corn oils.

The relative rates with which rancid odor developed with these oils were: SF-H > CO-H, SF-C > CO-C. A high correlation was demonstrated between TBA number and odor score and between TBA number and PV during the earlier period (up to 12 days) of storage,

but the correlations decreased upon extending the storage period to 20 days (Table 2). The correlation between PV and odor score was also high, but changed little when the storage period was increased to 20 days. The weaker correlation between TBA number and odor score during the 20 days of storage was attributable to the two TBA value peaks observed with SF-H (see Fig. 1); we also have observed two TBA value peaks with soybean oils which usually contain considerably higher amounts of linolenic acid (unpublished data). The relationship between PV and TBA number was similarly influenced by the emergence of two TBA value peaks. No odor evaluation was made beyond 20 days of storage since all oils were moderately to strongly rancid by this time.

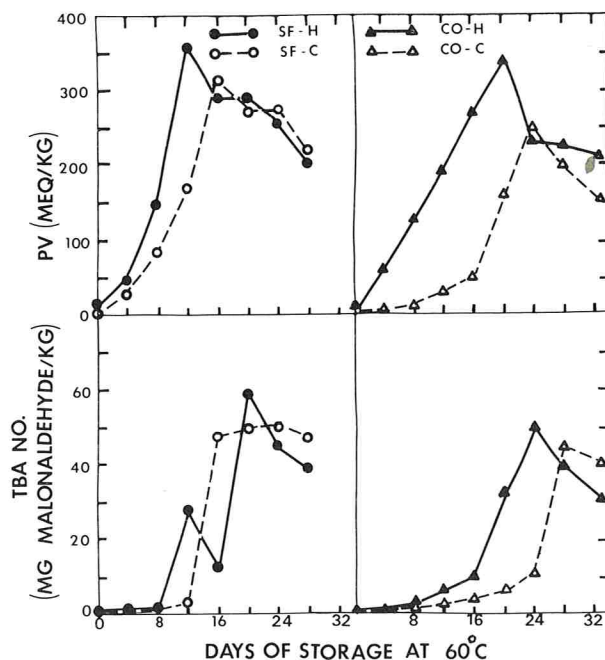


Figure 1. PV and TBA numbers during oven storage of health-food and conventional oils at 60 C.

TABLE 2. Overall correlation coefficients among PV, TBA number and odor score of all oils during storage at 60 C for 12 and 20 days<sup>a</sup>.

	12 days (N = 12)		20 days (N = 20)	
	PV	TBA Number	PV	TBA Number
Odor score	-0.875* * *	-0.924* * *	-0.838* * *	-0.737* * *
PV		0.875* * *		0.747* * *

<sup>a</sup>Results of six oils were pooled for computing correlation coefficients. \* \* \* Significant at p = 0.001.

TABLE 1. Fatty acid composition<sup>a</sup> by GLC analysis.

Oils	Saturated fatty acids (%)					Unsaturated fatty acids (%)				Total poly-unsaturated
	14:0	16:0	18:0	20:0	22:0	16:1	18:1	18:2	18:3	
Health-food oils										
Safflower	Trace	8.4	2.4	Trace	—	—	13.4	75.8	Trace	75.8
Corn	—	12.0	1.9	Trace	Trace	0.2	24.8	60.0	1.2	61.2
Conventional oils										
Safflower	—	7.7	2.5	Trace	—	—	13.9	76.0	Trace	76.0
Corn	—	12.4	2.1	—	—	—	24.8	59.5	1.2	60.7

<sup>a</sup>Calculated as percentage of total GLC peak area, as methyl esters.

Oil samples were also weighed at intervals to indirectly determine the amount of oxygen absorbed (9). Although the data are not presented in detail, the patterns of weight increment rate were similar to those of PV increase; the rate of weight gain was faster with health-food oils than conventional oils.

#### Room temperature storage

The results of PV determination showed that health-food oils were more susceptible to oxidation than conventional oils regardless of whether oils were used or unused. The rates of PV increase were: unused oils — SF-H > CO-H > SF-C > CO-C; used oils — SF-H > SF-C > CO-H > CO-C. The differences between health-food and conventional oils increased steadily with the increase in storage time for unused oils. For used oils the difference increased until about 100 days, followed by a decrease (Fig. 2). This indicates that the major part of oxidation occurred with health-food oils within 100 days of storage while conventional oils were still oxidizing after 100 days.

The differences between health-food and conventional oils were greater for used oils than the unused within 100 days. The opposite was observed in storage beyond this period — storing once-heated oils longer than 100 days is an unlikely practice in the use of vegetable oils. The differences between SF-H and CO-H and also between SF-C and CO-C were also widened by the heating treatment. It should also be noted that safflower oil *with* additives oxidized faster than corn oil *without* additives when the oils were once heated before storage.

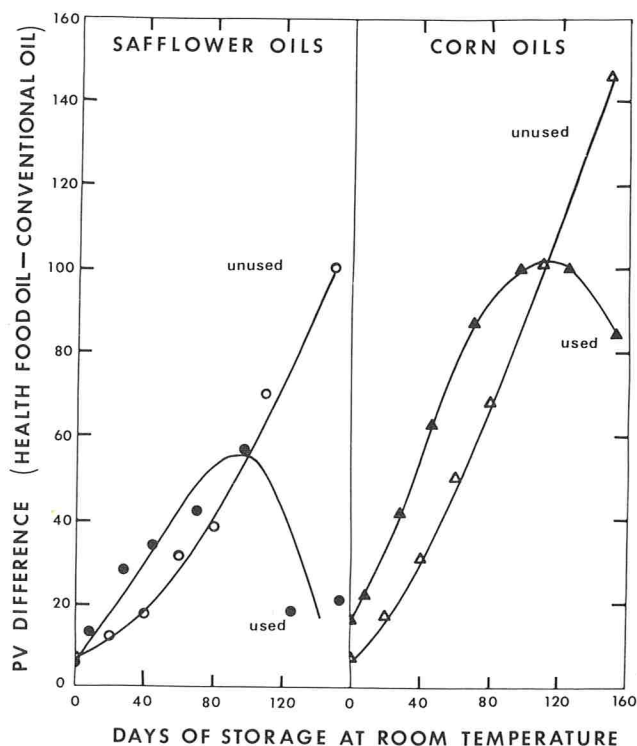


Figure 2. PV difference between health-food and conventional oils stored at room temperature: comparison of used (once-heated) and unused oils.

## DISCUSSION

PV determination is the most widely used chemical method to measure oxidative rancidity of fats and oils, whereas the TBA test is as widely used for meat products. Although the TBA test has not been adopted for the day-to-day quality control and product development in food industry, its usefulness for oil products has been indicated (7,18). The present study has demonstrated that the TBA test is more sensitive and correlates better with rancid odor development in vegetable oils at early stages of oxidation, whereas PV determination is generally more reliable for monitoring the oxidative deterioration over longer storage periods, up to certain limits.

Conventional vegetable oils had greater storage stability than health-food oils as evaluated by all measures. Safflower oils oxidized at a greater rate than corn oils as predictable from the high content of polyunsaturated fatty acid (mostly linoleic acid) in safflower oils. The widened gaps after heating treatment between health-food and conventional oils and also between safflower and corn oils have a practical implication in the use of these oils — whether to be used as salad or cooking oils, particularly for repeated use in frying. Safflower oil has been promoted as an ideal polyunsaturated dietary fat to alleviate problems encountered with consumption of saturated fats in connection with coronary diseases. Precautions should be exercised by dietitians and consumers in handling this vegetable oil.

The result of oxidative deterioration of vegetable oils does not end with development of rancid odor in the oils or in food products prepared with the oils. Loss of potency of the fat-soluble vitamins A, D, and E due to co-oxidation induced by lipid peroxides has been well established. Similarly, co-oxidation results in destruction of the water-soluble vitamins, pyridoxine, panthothenic acid, biotin, and ascorbic acid. Adverse effect of oxidizing lipids on the nutritive and biological values of proteins has also been suggested (6,10,11,17). Further, toxicity of oxidized lipids has been discussed (8).

Finally, it should be noted that the health-food users' rationale or reasons for consuming health-foods are directly or indirectly related to the health and nutritional aspects (13). The implication of this study is in contrast with their belief.

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## Comparison of Single and Multiple Stage Sieve Samplers for Airborne Microorganisms<sup>1,3</sup>

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### ABSTRACT

Single and multiple stage air samplers were evaluated under commercial conditions for enumerating airborne microbial particles in a plant in which swine were slaughtered and pork was further processed. Three volumes of air, 0.014, 0.028, (1 ft<sup>3</sup>), and 0.057 cu M were sampled in duplicate on each of 2 days (for airborne molds, yeasts, coliforms, and aerobic bacteria) in eight rooms where pork carcasses were handled and further processed. Unexpectedly, the microbial counts were low during this winter sampling. The single and multiple samplers yielded mean (log<sub>10</sub>) counts (n = 94) of 0.15 and 0.42; -0.23 and -0.36; 1.18 and 1.29; and -0.63 and -0.91 per 0.028 cu M; for molds, yeasts, aerobes and coliforms, respectively. The multiple sampler detected slightly greater numbers of molds and aerobic bacteria, but did not define the differences in aerobic bacterial numbers from among the various processing rooms as readily as the single stage sampler. Counts of coliforms were higher from the single than from the multiple stage sampler. The single stage sampler required only one petri dish per sample, as compared with six for the multiple stage sampler, so it required less medium and time for evaluating air for microorganisms.

The continuing effort to control microbial contamination of meat has focused on holding the numbers of bacteria on meat to a minimum during packing and on use of strict sanitation practices during carcass breaking and fabrication into retail cuts. In spite of fastidious care, retail meat occasionally exhibits bacterial counts that are inordinate in relation to days in storage. One potential source of bacterial contamination that has received minimal attention in the meat industry is airborne bacteria. Heldman (2) proposed that airborne microbial contamination could be controlled by isolating and eliminating the sources of such microorganisms, preventing their transport and by using some method for their localized control. Heldman (3) identified ventilation systems, floor drains and humans as sources for

generation of microbial particles in dairy plants. Data are not available for distribution of airborne microorganisms in meat packing plants and centralized distribution centers.

Recent procedures for enumerating airborne bacteria have centered on the gravity settling culture plate, Andersen multiple stage sieve sampler and the Cosella slit sampler (4,5,6,8). The multiple stage sieve sampler was superior to the gravity settling culture plate (5) and similar to the slit sampler (8) for enumeration of airborne microorganisms. Recently another air sampler, the Microban model AS-101 manufactured by Ross Industries, Inc. (Midland, VA) became available. This sampler has only a single stage and, therefore, would have potential advantages for ease of sampling if it could enumerate microorganisms as accurately as the multiple stage sampler.

The purpose of this study was to compare the effectiveness of a single and a multiple stage air sampler for enumerating microorganisms in a plant in which swine are slaughtered and pork is further processed.

### MATERIALS AND METHODS

The Andersen multiple stage air sampler, described by Sayer et al. (5) and the Microban single stage air sampler were compared. Both samplers have motors of standardized capacity to draw a fixed volume of air through the holes of a metal plate covering a petri dish containing medium. Bacteria in the air impinge upon the surface of the medium and, after incubation, produce visible colonies. The multiple stage sampler forces the air to cascade over the surfaces of six stacked petri dishes, each beneath a sieve plate. In the Andersen sampler each successive sieve plate has holes of smaller diameter than the preceding one, to allow segregation of particles on the basis of size.

About 15 ml of medium was placed in each petri dish and allowed to dry for 24 h at 22 C to remove excess surface moisture. Media and conditions for incubation are presented in Table 1. Air was sampled in the evisceration, offal, carcass cooler, carcass breaking, sausage stuffing, processed meat packaging, and sausage packing rooms, and the curing cellar of the swine slaughter and processing plant. Three volumes of air, 0.014, 0.028 (1 ft<sup>3</sup>), and 0.057 cu M, were used in each of the eight rooms sampled for each type of microorganism. Each air volume at each location was sampled twice on each of 2 days. Microbial counts were all converted to counts per 0.028 cu M for analysis of data, which were treated by analysis of variance (7) and the mean separation test (1).

<sup>1</sup>We thank ESKAY Meat Packing Company for facilities; Ross Industries, Inc. for the single stage sampler; and Mr. E. James Koch, ARS, USDA, for advice and assistance in analyzing the data.

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<sup>3</sup>Mention of trade names does not imply endorsement by the U.S. Government.

TABLE 1. *Conditions for incubating microorganisms.*

Microorganism	Media	Temp (C)	Time (h)
Aerobes	Plate count agar (Difco)	20	72
Coliforms	Violet red bile agar <sup>1</sup>	35	18-24
Molds and yeasts	Potato dextrose agar <sup>2</sup>	22-25	72-120

<sup>1</sup>With overlay<sup>2</sup>Acidified with tartaric acid to a pH of 3.5

## RESULTS

Counts differed significantly ( $P < 0.05$ ) between samplers for molds and aerobic bacteria but not for yeasts (Table 2). Sampler also affected ( $P < 0.001$ ) counts for coliforms. For all microorganisms, microbial counts differed ( $P < 0.01$ ) among the eight processing rooms. Absolute counts of airborne microorganisms within the processing locations were defined extensively in an evaluation (study in progress) of seasonal variations. The interaction of sampler  $\times$  location was significant ( $P < 0.001$ ) for aerobic and coliform bacteria. Thus, our need for dissimilar air samples with which to test the effectiveness of the single and multiple samplers was met.

From the multiple stage sampler, mean ( $\log_{10}$ ) counts ( $n = 94$ ) were 0.42, -0.36, 1.29 and -0.91 for molds, yeasts, aerobes and coliforms, respectively. The single stage sampler yielded counts of 0.15, -0.23, 1.18, and -0.63, respectively. Thus, the mold and aerobic counts were larger ( $P < 0.05$ ) from the multiple sampler, yeasts counts were similar and the coliform counts smaller than counts from the single stage sampler. The magnitudes of the differences were so small that they were of questionable importance. The numbers of molds, yeasts

and coliforms detected were so small that tabular data were restricted to aerobic bacterial counts (Table 3). Since the location  $\times$  sampler interaction was significant (Table 2), the data for that interaction are in Table 3. The variability in microbial counts for the volume of air sampled within each location was greater for the multiple than for the single stage sampler. Thus, data from the single stage sampler tended to be more precise.

The main effect of volume of air was significant ( $P < 0.05$ ) only when the multiple stage sampler drew in 0.014 cu M of air and the count was doubled to convert it to a count for 0.028 cu M. The magnitude of the difference in counts among various volumes of air was much greater for the multiple than for the single stage sampler. Thus, data from different volumes of air tended to be more reproducible from the single than from the multiple stage sampler.

The variance of data calculated across locations was 0.09 for the multiple and 0.78 for the single stage sampler. Since locations had been selected to introduce variability in numbers of airborne bacteria, the single stage sampler most accurately estimated the differences in numbers of aerobic bacteria among locations.

Under the conditions of our tests, the single stage sampler had more advantages than the multiple stage sampler because: (a) airborne counts, regardless of volume of air, were more reproducible within locations with the single stage sampler, and (b) the single stage sampler assessed differences among locations more accurately than the multiple stage sampler. Other advantages were: the single stage sampler required

TABLE 2. *Mean squares and their statistical significance obtained from analysis of variance of numbers of airborne microorganisms.*

Source	df	Molds	Yeasts	Aerobes	Coliforms
Sampler	1	1.75*	0.37	0.28*	1.88* **
Location (room)	7	2.75* **	1.44* *	3.06* **	1.26* **
Sampler $\times$ location	7	0.18	0.76	13.61* **	0.77* **
Volume	2	0.06	0.13	0.27*	0.33
Sampler $\times$ volume	2	0.36	0.06	0.15	0.02
Location $\times$ volume	14	0.39	0.51	0.09	0.20
Sampler $\times$ location $\times$ volume	14	0.19	0.14	0.06	0.09
Residual	48	0.31	0.42	0.06	0.11
Corrected total	95				

\*  $P < 0.05$ .\*\*  $P < 0.01$ .\*\*\*  $P < 0.001$ .TABLE 3. *Mean ( $\log_{10}$ ) airborne aerobic bacteria per 0.028 cuM of air from different locations as determined by multiple and single stage air samplers.<sup>1</sup>*

Sampler	Volume (cu M)	Cooler	Sausage stuffing	Evisceration	Offal	Cutting	Sausage packaging	Sliced meat packaging	Curing cellar	Average
Multiple stage	0.014	1.19e-j	1.58d-f	1.62c-e	1.58d-f	1.26e-h	1.18e-j	1.56d-f	1.68b-e	1.45a
	0.028	1.58d-f	1.24e-i	1.35e-g	1.25e-h	1.27e-h	0.96g-n	1.14e-k	1.41e-g	1.27b
	0.057	0.93g-o	0.91g-o	1.10e-l	2.02a-d	1.13e-k	1.00f-m	0.94g-n	1.07f-l	1.14b
	Average	1.23cd	1.24cd	1.36b-d	1.62b	1.22cd	1.05d	1.21cd	1.38bc	1.29a
Single stage	0.014	0.60k-p	2.21ab	2.42a	2.37a	0.65j-p	0.47m-p	0.32op	0.66i-p	1.21b
	0.028	0.81h-p	2.19ab	2.33a	2.15a-c	0.30p	0.55 1-p	0.32op	0.65j-p	1.16b
	0.057	0.79h-p	2.09a-d	2.19ab	2.34a	0.63j-p	0.35op	0.37n-p	0.57 1-p	1.17b
	Average	0.73e	2.17a	2.31a	2.29a	0.53ef	0.46ef	0.33f	0.63ef	1.18b
Overall average		0.98c	1.71b	1.83ab	1.95a	0.87cd	0.75d	0.78d	1.00c	

<sup>1</sup>Samplers, locations, samplers and volume, and interactions sampler  $\times$  location, and sampler  $\times$  location  $\times$  volume having different letters are different ( $P < 0.05$ ) according to the Duncan test (*l*).

one-sixth the amount of media and petri dishes, and one-fourth as much time for loading as the multiple stage sampler.

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## Occurrence of *Bacillus cereus* and the Bacteriological Quality of Chinese "Take-Out" Foods

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### ABSTRACT

One hundred sixty-five samples of various foods were collected from 24 different Chinese take-out restaurants for bacteriological examination which included enumeration of *Bacillus cereus* by three media, MYP, KG and blood agars. Blood agar was less selective but no quantitative differences in recovery were apparent. Twenty-eight samples (15%) yielded *B. cereus* in excess of 100 per gram, and 20 of these were fried rice (33% positive), which also showed the poorest overall bacteriological quality. Biochemical characterization of 232 isolates of *B. cereus* showed 96% or more positive for catalase, nitrate reduction, beta-haemolysis, subterminal-ellipsoidal spores, aerobic and anaerobic utilization of glucose, Voges-Proskauer, fermentation of glycerol, gelatin hydrolysis, and alkaline peptonization of litmus milk; and a negative reaction in mannitol. Variable results were obtained for motility, fermentation of sucrose and salicin, and starch hydrolysis. Thirty-three isolates were susceptible to 12 of 19 antibiotics tested, and resistant to colistin. Six (18%) were susceptible to penicillin.

Food poisoning outbreaks attributed to *Bacillus cereus* have frequently implicated Chinese foods as the vehicle, especially fried rice (1,4,7,14,15). Gilbert et al. (4) demonstrated that spores of *B. cereus* are able to survive the cooking of rice, and then germinate and multiply readily in both cooked and fried rice. Raevuori and Genigeorgis (19) showed that *B. cereus* grew even better in rice than in brain heart infusion broth.

There have been very few reported surveys on contamination of foods with *B. cereus*, but those available indicate that the organism is ubiquitous (7,12,18). No reports are available on the incidence of *B. cereus* in Chinese "take-out" foods which have not been immediately implicated in a food poisoning.

Three media are used most commonly for enumeration of *B. cereus*: (a) Blood agar (5,9,20), (b) mannitol-egg yolk-phenol red agar (MYP) (16), and (c) egg yolk-polymyxin medium (KG) (13). MYP and KG agars have official acceptance in the United States (6,22). Confirmation procedures for presumptive colonies vary widely in the number and type of biochemical reactions utilized.

Over a 2-year period, our laboratory received on five different occasions samples of Chinese foods implicated in food poisoning. Using blood agar for enumeration, a number of these samples showed high counts of *B. cereus*

(Table 1). This experience motivated a survey to evaluate three different media for enumeration of *B. cereus*; determining the incidence of *B. cereus* in Chinese "take-out" foods; evaluating the usefulness of various biochemical tests for identification of *B. cereus*; and describing the overall bacteriological quality of Chinese foods.

### MATERIALS AND METHODS

#### Food samples

Samples of foods were collected from 24 different Chinese restaurants in the Metro Toronto area, all providing take-out service, and were delivered to the laboratory for analysis on the same day or were refrigerated and tested the following morning. For summary purposes, the food samples were grouped into nine general categories (Table 2). The meat-vegetable group represents mainly chow mein and chop suey. Fried rice includes various meat-flavored rice dishes.

#### Bacteriological analysis

Aerobic plate counts and coliform bacteria were determined by standard methods described elsewhere (22). Fecal coliforms were determined by inoculation of EC broth from positive presumptive tubes for total coliforms and incubated at 44.5 C for 22-24 h. *Staphylococcus aureus* was determined with Baird-Parker agar (22), *Clostridium perfringens* with egg yolk-free TSC agar (11,22), and fecal streptococci with KF agar (22). *Salmonella* examinations were completed by pre-enrichment in lactose broth followed by selective enrichment in selenite-cystine broth at 35 C and tetrathionate-brilliant green broth at 43 C.

#### *Bacillus cereus*

*B. cereus* was recovered by three media using spread plate inoculation and incubation at 30 C: (a) Blood agar (BA), (b) phenol red-egg yolk-polymyxin agar (MYP) (22), and (c) KG agar (22). Negative plates were held for 48 h before discarding, but all positive samples showed good growth on all media after 24 h incubation.

#### Biochemical tests

Colonies resembling *B. cereus* in any way, and showing any degree of lecithinase activity on MYP or KG agars, were streaked onto BA for purification and determination of hemolytic activity. Stock cultures were then prepared for further study. All isolates were first examined by gram stain to verify cell and spore morphology and tested for catalase before further biochemical characterization by inoculation of the following media: (a) Nitrate-motility agar (10); (b) lactose-gelatin medium (11); (c) litmus milk; (d) VP medium (proteose-peptone, 7 g/l; glucose, 5 g/l; NaCl, 5 g/l; pH 6.5-6.8); (e) starch agar (22); (f) phenol red glycerol broth (22); (g) carbohydrate fermentation broth (peptone, 10 g/l; meat extract, 3 g/l; NaCl, 5 g/l;  $(\text{NH}_4)_3\text{PO}_4$ , 2.5 g/l; bromocresol



purple, 0.01 g/l) with 1% of either dextrose, sucrose, salicin or mannitol. All biochemical reactions were determined at 30 C. Nitrate reduction, the Voges-Proskauer test, and starch hydrolysis were recorded after 24 h of incubation. Other tests giving negative reactions were observed for 5 days before recording.

#### Antibiotic susceptibility

Antibiotic susceptibility was determined by the agar dilution method using the replicator device of Steers et al. (21). Agar concentrations for the antibiotics are given in Table 5. Any isolate giving a growth response of four or less colonies was recorded as susceptible to test antibiotic.

## RESULTS

The overall bacteriological quality of the Chinese foods examined in this survey was quite good (Table 2). Thirty-one percent of all samples had aerobic plate counts of < 100/g, and 75% had counts of < 100,000/g. Eighty-five percent of all samples had coliform counts of < 30/g, and only nine samples (5%) showed the presence of fecal coliforms in excess of 30/g. *S. aureus* and *C.*

agar, no difference in quantitative recovery was apparent (Table 3). Blood agar, however, sometimes showed a heavy background flora which tended to mask *B. cereus* colonies and made isolation difficult. Although MYP and KG agars were slightly more selective, background flora on these media was frequently heavy so that purification of presumptive colonies was always necessary before biochemical testing could proceed.

A total of 262 presumptive *B. cereus* colonies were selected from the three test media for identification. Confirmation rates for the three media were as follows (number confirmed/number fished): BA, 63/68 (92.6%); MYP, 86/97 (88.7%); KG, 83/97 (85.6%). Isolates accepted as *B. cereus* were gram-positive bacilli having the biochemical characteristics shown in Table 4.

All of the 232 isolates identified as *B. cereus* were catalase positive, showed beta-hemolysis on blood agar, produced spores which were ellipsoidal and located

TABLE 1. Foodborne outbreaks implicating Chinese foods containing *Bacillus cereus*.

Outbreak No.	No. people ill	Symptoms <sup>b</sup>	Incubation time (hours)	Foods received	APC	Bacterial counts per gram <sup>a</sup>					
						Coliforms Total	Coliforms Fecal	<i>S. aureus</i>	<i>C. perfringens</i>	Fecal Streptococci	<i>B. cereus</i>
1	1	D, V	7½	Curry fried rice <sup>c</sup>	>3,000,000	ND		ND	ND	4,100	ND
				Chicken Chop suey	>3,000,000	ND		ND	ND	>3,000,000	>3,000,000
2	3	V, D, N, C,	5	Chow mein	920,000	ND		ND	ND	ND	40,000
				Chop suey	ND	ND		90,000 <sup>d</sup>	ND	ND	>1,000,000
3	5	V, D	3½-4	Chicken chop suey	4,800	<300	<300	<100	ND	<100	<100
				Egg roll	1,400	<300	<300	100	ND	<100	<100
				Beef fried rice	800,000	<300	<300	<100	ND	<100	>3,000,000
				Fried rice	>30,000,000	<30	<30	<100	ND	200	>3,000,000
				Egg roll	23,000	<300	<300	<100	<100	ND	19,000
5	2	C, D, N	7-10	Chopped pork	>30,000,000	46,000	<300	10,000 <sup>e</sup>	<100	ND	ND
				Sliced pork	350,000	<300	<300	<100	<100	ND	ND
				Shrimp	10,000	<300	<300	<100	<100	ND	ND
				Spare ribs	520,000	<300	<300	<100	<100	ND	ND
				Chicken	15,000	<300	<300	<100	<100	ND	ND

<sup>a</sup>All samples negative for *Salmonella*. <sup>b</sup>C = cramps, D = diarrhea, N = nausea, V = vomiting. <sup>c</sup>Not from the same meal.

<sup>d</sup>Isolates produced enterotoxin type D. <sup>e</sup>Isolates negative for enterotoxin types A, B, C, D, and E. ND = not done.

*perfringens* were not detected in any sample in excess of the sensitivity of the methods, which was 100/g. Fried rice showed the poorest bacteriological quality with a larger proportion of samples having aerobic plate counts in excess of 100,000/g (26%), coliform bacteria in excess of 1,000/g (15%), and the presence of fecal coliform bacteria (11%).

Twenty-eight of 165 samples (15%) yielded *B. cereus* in excess of the sensitivity of the method, that is, > 100/g, but in most instances the count was very low. Twenty of these samples (71%) were fried rice. Thirty-three percent of the fried rice samples contained *B. cereus*, in sharp contrast to boiled or steamed rice where only two of 20 samples (10%) were positive.

Only a limited number of samples yielded colony counts of *B. cereus* large enough to compare the performance of the three enumeration media and with the exception of two samples which showed much higher counts on KG

subterminally, and gave a positive Voges-Proskauer test. Only one isolate failed to ferment glucose aerobically and another gave an acid reaction in mannitol. These aberrant results were not confirmed by retesting. Thirty-eight isolates (16.4%) were not motile by the agar-stab technique using nitrate-motility medium (9). Other biochemical reactions with variable results included anaerobic fermentation of glucose (97.8%+); utilization of sucrose (48.7%+), glycerol (94.0%+), and salicin (25.0%+); hydrolysis of starch (37.5%+); nitrate reduction (98.7%+); gelatin hydrolysis (95.7%+); and alkaline peptonization of litmus milk (97.4%+). There was no apparent difference in biotypes between the three isolation media, with the possible exception of a larger percent of starch-hydrolyzing strains from BA (57.1%) compared to MYP (32.6%) and KG (27.7%) agars.

An association between starch-hydrolysis and salicin-utilization was suggested in that 137 starch-negative

TABLE 2. Bacteriological quality of Chinese foods.

Food category	No. of samples	Number of samples (percent of samples)																	
		APC per gram				Total coliforms/gram				Fecal coliforms/gram			S. aureus per gram	C. perfringens per gram	B. cereus per gram <sup>a</sup>				
		<100	100-99,000	10,000-3,000,000	>3,000,000	<30	30-990	1,000-10,000	>10,000	<30	30-990	1,000-10,000	>10,000	<100	<100	<100	10-990	1,000-100,000	>100,000
Meat-vegetable	50	9 (18)	38 (76)	2 (4)	1 (2)	43 (86)	3 (6)	2 (4)	2 (4)	49 (98)	1 (2)			50 (100)	41 (100)	46 (92)	4 (8)		
Fried rice	61	14 (23)	31 (51)	10 (16)	6 (9)	48 (79)	4 (7)	4 (7)	5 (8)	54 (88)	4 (7)	2 (3)	1 (2)	61 (100)	31 (100)	41 (67)	13 (21)	5 (8)	2 (3)
Vegetables	14	8 (57)	6 (43)			14 (100)				14 (100)				14 (100)		13 (93)	1 (7)		
Rice (boiled or steamed)	20	13 (65)	5 (25)		2 (10)	18 (90)			2 (10)	19 (95)			1 (5)	20 (100)	1 (100)	18 (90)	1 (5)	1 (5)	
Chicken	4	4 (100)				4 (100)				4 (100)			4 (100)	4 (100)	4 (100)				
Egg roll	8	2 (25)	6 (75)			8 (100)				8 (100)				8 (100)	4 (100)	7 (88)	1 (12)		
Pork	4	1 (25)	3 (75)			3 (75)	1 (25)			4 (100)				4 (100)	4 (100)	4 (100)			
Noodles	3		3 (100)			3 (100)				3 (100)				3 (100)	2 (100)	3 (100)			
Won Ton	1		1 (100)					1 (100)		1 (100)				1 (100)	1 (100)	1 (100)			
Totals	165	51 (31)	92 (56)	13 (8)	9 (5)	141 (86)	8 (5)	7 (4)	9 (95)	156 (3)	5 (1)	2 (1)	2 (100)	165 (100)	88 (83)	137 (12)	20 (4)	6 (1)	2

<sup>a</sup>Based on highest count obtained with three media.

TABLE 3. Comparison of three media for enumeration of *Bacillus cereus*.

Type of food	<i>Bacillus cereus</i> per gram		
	Blood agar	MYP agar	KG agar
Chicken fried rice	4,500	4,600	4,600
Potatoes	7,000	2,100	2,100
Fried rice	197,000	199,000	154,000
" "	0/G <sup>a</sup>	2,000	1,800
" "	0/G	5,700	8,600
" "	5,500	4,700	17,000
" "	3,000	3,400	2,800
" "	45,000	41,000	240,000
" "	4,300	5,200	5,100

<sup>a</sup>O/G = Medium overgrown with background flora.

TABLE 4. Biochemical characteristics of *Bacillus cereus* isolates from Chinese foods.

Characteristic	No. positive (percent positive)			
	Blood agar	MYP agar	KG agar	All media
Catalase	63 (100)	86 (100)	83 (100)	232 (100)
Beta-haemolysis	63 (100)	86 (100)	83 (100)	232 (100)
Motility	51 (81)	70 (81)	73 (88)	194 (84)
Spores subterminal and ellipsoidal	63 (100)	86 (100)	83 (100)	232 (100)
Acid from glucose without gas:				
Aerobic	63 (100)	86 (100)	82 (99)	231 (100)
Anaerobic	60 (95)	85 (99)	82 (99)	227 (98)
Sucrose	29 (46)	44 (51)	40 (48)	113 (49)
Glycerol	63 (100)	79 (92)	76 (92)	218 (94)
Salicin	19 (30)	20 (23)	19 (23)	58 (25)
Mannitol	0 (0)	0 (0)	1 (1)	1 (0)
Starch hydrolysis	36 (57)	28 (33)	23 (28)	87 (37)
Nitrate reduction	63 (100)	85 (99)	81 (98)	229 (99)
Gelatin hydrolysis	62 (98)	83 (96)	77 (93)	222 (96)
Voges-Proskauer	63 (100)	86 (100)	83 (100)	232 (100)
Alkaline peptonization of litmus milk	63 (100)	86 (100)	77 (93)	226 (97)

isolates were also salicin-negative, and 49 starch-positive isolates were also salicin-positive, representing correlation in 80.2% of the isolates.

The isolates of *B. cereus* could be grouped into five

types based on colonial morphology on blood agar: (a) large colony, round, strong beta-haemolysis; (b) similar to type a but with weak haemolysis; (c) large colony, irregular shape, rhizoid, smaller zone of beta-haemolysis than type a; (d) small colony, otherwise like type a, large zone of beta-haemolysis; and (e) same as type d with very weak beta-haemolysis.

Thirty-three isolates originating from different food samples or from different media and the same food sample, or having some differences in colonial morphology on BA, were tested for antibiotic susceptibility (Table 5). The isolates were susceptible to 12 of 19 antibiotics, the exceptions being colistin (33 resistant), penicillin (27 resistant), methicillin (22 resistant), carbenicillin (9 resistant), and ampicillin (7 resistant).

TABLE 5. Antibiotic susceptibility of *Bacillus cereus* isolates obtained from Chinese foods.

Antibiotic	Concentration (ug/ml)	Susceptible isolates <sup>a</sup>	
		Number	Percent
Ampicillin	8	26	78.8
TMP/SMX	38/2	33	100.0
Cephalosporin	16	20	60.6
Colistin (Polymyxin E.)	10	0	0.0
Erythromycin	0.8	33	100.0
Furadantin	30	33	100.0
Gentamycin	4	33	100.0
Kanamycin	8	33	100.0
Methicillin	4	11	33.3
Naladixic acid	12	30	90.9
Neomycin	16	33	100.0
Sulphadiazine	100	29	100.0
Tetracycline	4	33	100.0
Penicillin	0.25 units/ml	6	18.2
Chloramphenicol	16	33	100.0
Carbenicillin	100	24	72.7
Tobramycin	2	33	100.0
Clindamycin	1.6	33	100.0
Streptomycin	10	33	100.0

<sup>a</sup>Thirty-three isolates tested against all antibiotics except 29 tested against sulphadiazine.

## DISCUSSION

The poorer bacteriological quality of fried rice compared to other Chinese foods examined in this survey, and the greater incidence of *B. cereus* in this food, is consistent with the epidemiology of *B. cereus* food poisoning (1,4,14,15). The isolation rates for *B. cereus* in cooked (10%) and fried (32.8%) rice agree quite well with those found by Gilbert and Parry (3) for routine samples of boiled (10%) and fried (24%) rice. The poor bacteriological quality and the greater incidence of *B. cereus* in fried rice undoubtedly results from the reported practice of holding cooked rice, which is less frequently implicated in food poisoning, at room temperature before frying and adding other ingredients (1,15). The likelihood of contamination of fried rice with *B. cereus* is increased by addition of spices, which often contain this organism (8,18).

There seems to be little advantage in the use of MYP or KG agars over blood agar for enumeration of *B. cereus*, except for their slightly better selectivity. Neither of these media offer essential colonial identification features over BA. The ability of background flora to proliferate on all media requires subculturing for purity before identification can proceed. In the case of foods implicated in outbreaks, and containing a high number of *B. cereus*, interfering background flora is mostly diluted out and presents less of a problem on BA. BA also has the practical advantage of always being available in public health laboratories, thus eliminating the necessity of stocking a specialized medium or preparing it on short notice to meet infrequent demands.

Seventy-five percent of the *B. cereus* isolates obtained were unable to utilize salicin, a property which Gilbert and Taylor (5) observed was characteristic of food-poisoning strains in Great Britain and Australia, while routine food isolates were generally able to utilize salicin. They noted, however, that strains from European and American outbreaks fermented salicin.

A rather low percentage (37.5%) of our isolates were able to hydrolyze starch in contrast to some other reports (5). Kim and Goepfert (12), however, found that only 52% of their egg yolk-positive isolates from dried foods were able to hydrolyze starch, and Goepfert (6) reported that 10-50% of strains are positive for this reaction. A longer incubation time than the 24 h used in this study, which conforms with instructions elsewhere (6), may have detected other positive strains. Gordon et al. (8), for example, tested after 3 and 5 days of incubation.

The only antibiotic with uniform resistance between 33 isolates was colistin (polymyxin E), which explains why polymyxin has been the only antibiotic used in selective media such as MYP and KG agars. The only other antibiotic with some degree of resistance in the isolates was penicillin, and then six (19%) were sensitive at the relatively low test concentration of 0.25 units/ml. This is a rather high susceptibility rate considering reports of nearly uniform penicillinase production in *B. cereus* (17),

which supposedly allows the organism to grow on agar with 10 I.U. of penicillin (7), and has encouraged development of selective media with penicillin (2).

This survey substantiates that the presence of *B. cereus* in fried rice is not uncommon. As is true with many other foodborne disease agents, practical control lies not in elimination from the food but in proper preparation and handling practices which prevent multiplication. We shall undoubtedly continue to see foodborne *B. cereus* outbreaks involving rice until there are certain changes in preparation procedures as recommended by Gilbert et al. (4).

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## The Foodservice Industry of Our Future

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### ABSTRACT

Foodservice employs the largest work force of any business in America and has sales exceeded by only three other businesses. Furthermore, foodservice is forecast to grow by more than 10% during 1977. Among challenges facing the foodservice industry is the application of nutritional information in preparation, merchandising and sale of foods. Foodservice managers are urged to pursue opportunities to provide consumers with properly identified, nutritious foods rather than have governmental authorities impose regulations.

The second annual study of employment conducted by the National Restaurant Association reports that the foodservice industry provides full and part-time employment for over eight million Americans, giving this industry the largest work force of any business in America. This industry also has the distinction of having the largest number of establishments — approximately 550 thousand locations across America — which provide a variety of opportunities to eat away from home, wherever people are and at whatever price they desire to pay.

Eating and drinking places of America rank fourth in sales among retail establishments — exceeded only by food stores, automotive dealers, and general merchandise stores. The foodservice industry accounts for 4.5% of the gross national product — or \$78 billion. And our share of America's production is growing.

I sincerely believe in our American free enterprise system, whereby an individual can invest his time, talents, and money, and through his own efforts enjoy, to a degree at least, his own measure of success. Our foodservice industry is uniquely representative of our American free enterprise system and typifies the kind of spirit, initiative, and enterprise which has made America great.

### SALES WILL INCREASE

Forecasts of the immediate future realistically evidence our ability to operate within this system. Eating places in general expect a 12.5% sales gain in the year ahead (1977). Various markets within this broad category will show different growth rates.

1. Ice cream stands throughout America, accounting for 1.2% of eating place sales, will record a sales increase of 9.1%.

2. The next largest segment is the social caterers. This group, accounting for 2.3% of eating place sales, will record advances of 11.4%.

3. Cafeterias, with 5.4% of eating place sales, will increase their sales by 10.4%.

4. Fast food establishments — the industry's strongest growth segment, which literally did not exist 20 years ago — provide 32.8% of eating place sales today. And their astounding growth rate will continue in the year ahead, with a projected sales increase of 14.1%.

5. Finally, the largest segment of America's eating places, that broad category called restaurants and lunchrooms, with 58.3% of total sales for eating places, is expected to grow by 11.9%.

The entire foodservice industry, including industrial and institutional operations, is forecast to grow 10.6% in the year ahead, achieving a total of \$86.9 billion.

This projection is a strong indication of America's continued interest in our industry and is brought about by: (a) increased discretionary income, 8% in 1960's — 14% currently — projected 24% in 1980; (b) reduction in size of family — now expected for the first time in our history to average less than three people; (c) increase in number of working wives, 25% in 1965 — currently 55% — projected 75% in 1980; and (d) average income per family for the "me" generation — will exceed \$15,000 per household.

### A NEED TO UNDERSTAND NUTRITION

A challenging issue facing the professionalism of this industry is a fuller understanding of nutrition in commercial foodservice. We have been defensive and frequently cite freedom of choice for customers as a reason for nutrition to be dismissed. We have claimed that we are not hospital dietitians, that we give our customers a wholesome choice, and that we are not guardians of the public palate. Yet we have a growing population of customers who need to be able to

determine how food is being handled for their health and for their welfare.

We also have a growing population of ill-formed or marginally informed but concerned consumers. They depend on the latest "vogue" diet information for dealing with their overweight condition. They read about food additives and fiber content, about nitrates and nutritional labeling. And, as in so many like situations, a little knowledge is a dangerous thing — particularly when that small bit of information is wielded by a loud voice crying "I speak for all consumers."

It is not a simple subject because nutritionists do not agree and research is not conclusive on such basic issues as serum cholesterol and its effect, nitrates and the effect they have upon the body, and numerous other elements of our daily diet. No one has all the answers, but everyone needs to be better informed.

#### NUTRITION IS IMPORTANT IN FOODSERVICE

About one-third of the money Americans spend on food is spent in our industry. By the beginning of the next decade, two out of five food dollars will flow into our industry. Thus, a significant portion of the nutrition of this country is in the hands of foodservice. If this food lacks the required nutrients, great harm can be done to our population.

We know that in many foodservice operations dietary needs are being met. Health facilities and type "A" school lunch programs are planning meals which offer good nutrition. And even restaurateurs, in cooperation with agencies such as the "Creative Cuisine" program of the American Heart Association, are dispensing well-planned nutritious meals to the customer. But, every restaurant offers the potential of good nutrition if the customer makes a balanced selection.

#### CUSTOMERS ILL-INFORMED ABOUT NUTRITION

The question then is: Does the customer make a wise selection? Since two-thirds of the food dollars are today spent for home consumption, let's see how wisely the selection is made in the home. In 1955, a nutritional survey was made of the food selected for home use. Dietary deficiencies were found even though most groups in this nation have sufficient income to afford an adequate diet. We also have vast food resources from which an adequate diet can be obtained. It was noteworthy that some of the poorest food intake patterns were not among low income groups, but among the highest. In spite of very adequate resources, wealthier families made poorer food selections.

In 1965, another nutritional survey of the same kind was made. The situation had not improved. In fact, it had slightly worsened.

The number of people rejected for military service in World War II because of physical disabilities was extremely large. In fact, it was so large as to be of grave concern to those having responsibility for the health of

the nation. Many of the disabilities could be traced to poor nutrition during infancy, early childhood, and adolescence. The amount of dental work that had to be done among many of those admitted to the military, was also extremely great, and much of this could be traced to poor nutrition in years when teeth were forming.

During World War II, a parallel study in Great Britain identified that rationing and the restriction of sugar intake was one of the greatest nutritional benefits to the country's health and welfare of any national program ever undertaken. When the public could not get sweets, they were forced to improve their nutritional intake.

A more recent study by the Head of Pediatrics at Monte Fiore Hospital in New York City demonstrated that a teenager's straight diet of cheeseburgers, milkshakes, and french fries was 98% adequate and constituted a far better diet than what many teenagers think is good nutrition today.

#### NUTRITION IS RESPONSIBILITY OF FOODSERVICE

The foodservice industry does have a responsibility to the public — a responsibility to see that our nation is well fed. Up to this time, educational programs in nutrition have not been successful. We need information which identifies industry responsibility for good nutrition as it relates to preservation of nutrients in food.

The toll of nutrients taken in quantity food preparation is often heavy. A study in Oregon revealed that, after potatoes were pared, soaked, boiled, mashed, and held for service, only 5% of the vitamin C in these potatoes remained. A 95% loss is great. And if the individuals eating those potatoes were expecting a normal amount of vitamin C, they didn't get it.

Nutrient losses are great in quantity food preparation because of the nature of the processing and the time lapse that must occur in such processing. Nutritionists have known of these losses for some time and have adjusted dietary patterns in quantity feeding to take care of it. Vitamin C is so easily lost in quantity food preparations that other sources of vitamin C such as cantaloupe, orange juice, tomato juice, or a similar item should be served to provide human needs for this vitamin. We must avoid having some enterprising journalist pick samples of food in some operation, have these analyzed for their nutrient value, and then publish the findings in sensational articles that would far over-emphasize the nature of the problem.

Thirty years ago, a similar situation arose in regard to sanitation. Several sensational articles were written about sanitary conditions in foodservices. They aroused the public. The foodservice industry immediately set about establishing higher standards of sanitation to counter-act the adverse publicity. Federal and state regulations were also tightened. Today the public has a very high regard for sanitary standards in foodservices because of the concern and action of the industry in promoting higher sanitation standards and also because of the stricter governmental regulation.

### EDUCATION IS A VITAL FACTOR

Educators must improve the level of nutritional understanding of all Americans. It does not help to know how much carbohydrate is in a food if you mistakenly believe that carbohydrates should be avoided because they are especially fattening. It does not help to know how much vitamin A is in a food if you do not know it is frequently missing in some American diets.

The foodservice industry should not wait for sensational disclosures. It should start now through use of formal educational processes to prepare to relate to public pressure for food high in nutritional quality. An informed industry is a prepared industry. An uninformed one is open game to those who would challenge us as we have been challenged in the past.

### MENUS MISREPRESENT NUTRITIONAL CLAIMS

Recently, a dietitian before a large audience stated that, in a study of over 50 menus that advertised a low calorie meal, only two actually provided it. Dr. Jean Meyer, a well-known nutritionist, was interviewed for the *National Restaurant Association News* in May, 1976. He was critical of many practices in restaurants. He implied a lack of nutritional knowledge among foodservice operators. He pointed out that some menus advertise a low calorie meal consisting of chopped steak and cottage cheese while another dish on the same menu, such as sole, may be actually quite a bit lower in calories. "But even then," he added, "that so-called low calorie dish is often fairly high in cholesterol. I think what is needed is not just a low calorie dish, but a dish which is low in saturated fat and cholesterol."

There is much mis-information about nutrition in this country. A great many people have some of the strangest notions about food and its value to them. Organic food faddists demand specific kinds of foods. No foodservice should be expected to cater to all these wild opinions, beliefs, and superstitions. Whatever foodservice is required to do should come from within the realm of proven nutritional science — not fantasy. But, no doubt, the strongest and loudest criticism of nutritional failure in foodservice will eventually come from these people. The clouds on the horizon are gathering. Sooner or later the foodservice industry will find itself facing pressures, both from the public and from governmental agencies, on the nutritional value of the food it serves.

### DESCRIPTIVE MENUS ATTACKED

Bureaucratic interference with copy on our menus could be catastrophic. Menus must not be interpreted as advertisements or copies of labels on food. Interpretations of this type are already being made at the federal level and at some state levels on issues such as "truth in menus." In the industry today, some menus possess romantic "copy" written to embellish the menu in such a way that, at times, it stretches the reality of fact. Truth in menus is being dealt with more severely in the

marketplace. Source of food (origin) style, type, variety are now being questioned by the consumer and the monitoring authorities.

*Newsweek* magazine recently reported a \$4,000 fine brought against a West coast chain of restaurants for the menu claim "The fish you eat today slept last night in Chesapeake Bay", while the fish was actually frozen and came from Nova Scotia. Fifty-five such cases have been taken to court just in the state of California in the past year.

The term "prime" is another menu term under review. It originates from the term primal cut, the rib being a primal cut from a side of beef. The grading system using the term "prime" was implemented some 40 years after the term prime rib became common identity on the menu. Yet, we are now being challenged on the use of the term "prime" as it relates to the grade rather than the primal cut of beef.

The term "fresh" is also now being challenged in that many foods that are held in a frozen state cannot be termed "fresh". The term "homemade" cannot be used if the product is not made on the premises. The terms "Coney Island clam chowder" and "Maryland chicken" have been questioned because products do not come from those areas but are locally prepared. One can perhaps understand why one might not put on the menu "baked Virginia ham" if the ham did not come from Virginia. But for names that mean a specific type or item rather than origin from a specific area, such as French vanilla ice cream, one wonders at the logic of governmental rulings.

### MENUS TO DISCLOSE NUTRITIONAL ACCOUNTING

It is known that there often is wide variation in quantities of nutrition present in foods. The variety of items, the seasonal and climatic conditions which influence growing, and the time of harvest can all make a considerable difference in the amount of nutrients a product will contain. Thus, any listing on a menu will only be an approximate amount, and the range can be quite wide. Some may think this is better than no information at all, but it certainly does not indicate the exact amount an individual is getting of any nutrient.

Menu regulations disclosing nutrient values are not the dream of an optimist. One need only recall some of the regulations imposed on foodservices by governmental agencies such as complex payroll accounting, O.S.H.A., and others, that have added a myriad of problems and substantially increased costs to foodservices. Let's hope we don't have nutritional accounting. An unprepared industry could be much more easily brought under some sort of control than an informed one. An informed one might be able to avoid any control at all or at least see that proposed regulations are fair and reasonable.

We in this industry want to serve the best possible food with the highest nutrient quality. We will not object to instituting nutritional procedures, providing they are practical and economical.

### INDUSTRY'S HIGH STANDARDS CAN BE IMPROVED

The foodservice industry in this country has a far higher standard in food sanitation and quality and a far higher record of public service than any other industry in the world. It has not shirked its responsibility. What, then, can we do? What actions can we take in our operations to satisfy the minds of consumers? We can begin by taking another look at our menus. Let's see if our menu language crosses the border from merchandising to mis-representation.

Let's take another look at those diet and low-calorie meals we added a few years ago and see if they really are dietetic or low in calories. In fact, let's see if they are even selling. All too often, we put something on the menu with the attitude that "well, this ought to take care of those people". If we took a good hard look at our sales item-by-item, we might find that the old chopped beef and cottage cheese is a loser.

Let's take another look at our customers. Older people are far more concerned with cholesterol than young people. If a good percentage of customers fall into this age group, one could be missing a good bet if some of the new low cholesterol food products are not on the menu.

Let's take another look at our customers with an eye toward portion size options. Sure, there are some difficulties. There are items that can't be varied. But think of it as a merchandising plus that could actually work, if customers back it with their dollars. Sheraton is now testing portion options and waiting to see how their customers vote. Maybe foodservice customers would like a choice, and would make it pay to offer that choice.

Let's take a good hard look at what we are really offering the public and ask ourselves: Can we do better? This industry's success has resulted from offering the mass public what it wants. We cannot change simply because a few outspoken people cry "wolf". We cannot change simply to quiet the cries of a few self-anointed consumerists.

We serve the dietary needs of the public at large. We will never satisfy the lame-brained ideas of a few faddists. Therein lies bankruptcy. But we can listen. We can try to separate the faddists from the futurists. We can try to pick out those ideas that work from those that merely wreak havoc.

### CUSTOMERS WILLING TO PAY FOR NUTRITIOUS FOODS

Most of our customers are much smarter than is

believed by the consumerists. The National Restaurant Association has been conducting round-table discussions with consumers in various cities across the country. These interviews, conducted by the research firm of A. C. Nielsen, have been very revealing.

The results have shown us that consumers recognize that they don't live on cheeseburgers and beef Wellington. They are smart enough to know that a restaurant meal is only one part of their total diet. And they are well aware that if they go a bit overboard while enjoying a meal in one of our establishments, they will balance out with other meals. That's a lot saner and smarter approach to good nutrition than most nutritionists had expected. They have also told us that they like good nutritional food and are willing to pay for it.

The challenge that lies before us is to make nutrition pay. Our industry has been able to grow and to prosper by presenting the public with a variety of services and products that the public considered worthy. Patronage of all foodservice establishments is purely voluntary, and providing customer satisfaction is the only way we can hope to survive and prosper. We don't need new legislation to help run our business.

The overwhelming majority of our associates are honest businessmen, who take great pride in the service they offer to their clientele. They know that misrepresentation or dishonesty will be met with the sanction of customer dissatisfaction, which in the final analysis is perhaps the most severe sanction of all. Therefore, we question the necessity for government control and additional regulations.

It is time we proclaim the end of negativism and unproductive, legislated anti-growth philosophies that can only lead us to stagnation and ultimate decline. Let us proclaim an end to mediocrity of all kinds. Let us lift our eyes from the mud and squalor of the lowest to the starry light of our highest hopes and aspirations. To dream — to grow — to build — to make things — to plant crops — to serve nutritional food — to set our feet upon the earth and say, "We are men and women who work to make life better" — these are worthy, inspiring goals. And it is up to us in this industry — men and women like you — to give these goals back to America.

#### ACKNOWLEDGMENT

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## Foodservice Equipment: Technological Trends

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### ABSTRACT

A major incentive for development of improved foodservice equipment is the need for energy conservation. Despite contrary popular belief, preservation of foods in the frozen form provides sufficient comparative advantages and economies to keep frozen foods in the market-place for the foreseeable future. Equipment is being developed for rapid chilling and freezing of bulk foods and for defrosting and heating those foods. Liquid nitrogen is often used. Convection, directed hot air, infrared and microwave heating are being used singly and in combination to temper, thaw and heat frozen foods rapidly and efficiently. The heat pipe concept, a space technology product, has been adapted for use in grills.

According to one foodservice equipment industry spokesman, "Energy sources are dwindling rapidly and foodservice equipment manufacturers are working as quickly as possible to develop innovations for energy conservation." Another spokesman projects new foodservice equipment developments to reduce labor and increase productivity, and expects that productivity will improve from the present 35 to 50 meals per man-hour to greater than 100 meals per man-hour within 10 years, as a result of improved food processing and food service equipment.

There is certainly adequate incentive for developing improved equipment. The rapid growth of the fast food industry, increasing labor pay rates and, more recently, the energy crisis are factors which should have been instrumental in moving manufacturers to develop more efficient, versatile and useful foodservice equipment. However, there is little apparent activity to be seen other than minor cosmetic changes to equipment. One hears lip service being given to engineering improvements, but precious little evidence can be cited of analytical studies being carried out to understand processes so that innovative engineering can be applied.

This presentation will examine, though not exhaustively, some of the activity in foodservice equipment development. The subject of energy conservation leads all others in importance, and therefore this discussion will be concerned with those processes involving heat

removal and heat application. In the latter case, some work of an analytical nature being carried out in the U.S. Army Natick Research and Development Command, which could have an effect on equipment design, will be explored.

### HEAT REMOVAL PROCESSES

Arguments have been presented that energy used to freeze foods is energy wasted. The frozen food industry has been quick to point out that the freezing process is cheaper per pound than canning; that frozen food packaging is cheaper than canning because of the high fuel needs in can manufacturing and is substantially less than for refrigerated or fresh food packaging; the energy required to store fresh food may be greater than one might think. Much energy is used refrigerating portions of a product that would normally be removed or trimmed when preparing that product to be frozen. All that inedible bulk requires space, 30% to 100% more space than the frozen product: more shipping and more storage space. And there are other arguments favoring frozen foods. Londahl (1) gave the theoretical energy demand for various preservation processes (Table 1).

Needles to say, frozen foods will not disappear from the market-place for some time to come. At least in the near future, greater use of frozen foods can be anticipated. Some will be purchased from suppliers in the prepared form, and others will be prepared and frozen on site.

TABLE 1. *Theoretical energy demand in heat treatment*<sup>1</sup>

Preservation methods	Energy (KWh/ton)
Cooling	15
Freezing	100
Pasteurization	130
Sterilization	225
Drying	660

<sup>1</sup>See Londahl (1).

### CHILLED FOODSERVICE SYSTEMS

A number of efforts have been made to establish chilled foodservice systems. The NAAKA<sup>1</sup> and AGS<sup>2</sup> hospital foodservice systems, for example, depended on rapid chilling of prepared foods, then storage at temperatures below 35 F. Claims have been made that at 28 to 30 F a storage life of 60 days is possible without significant quality loss. Neither the NAAKA or AGS systems are in use today, though the reasons for their disappearance from the scene are not entirely clear. A new chilled food process which is in limited use at present is the CAPKOLD process of the Cryovac Division of W. R. Grace and Company. Basically it is a system of rapid chilling of bulk packaged prepared foods and storage and distribution to satellite foodservice outlets. For example, soup prepared in 50-gal steam-jacketed kettles is pumped into 2-gal Cryovac plastic bags, then chilled in a tumbling unit using water as the heat transfer medium. The multiple-ply plastic bags are sufficiently tough to withstand this treatment. Chilling to 38 F takes about 20 min. By comparison, a rapid chilling refrigerator recently marketed is capable of chilling 200 lb. of product in steam table pans (2 inches deep) from 140 to 45 F in 2 to 3½ h. The time in a typical holding refrigerator is about 13 h.

### INNOVATING FREEZING EQUIPMENT

Food freezing equipment for use in small foodservice operations has been limited until recently to freezer chests or cabinets meant primarily for storage, not freezing. A pair of relatively innovative systems are worth mentioning. Victory Metal Manufacturing Division of McGraw Edison has a combination liquid nitrogen-mechanical blast freezer which will cool a batch of food in 2-inch deep pans from 140 to 45 F in 2 h and then freeze the product to 0 F in 1 to 1½ h. A mechanical blast freezer will accomplish the same task in about 8 h. This compares with about 26 h in a conventional freezer. The Teckton, Inc., liquid nitrogen freezer is a vertical unit which occupies approximately one-eighth the floor space of a tunnel unit of comparable capacity (Fig. 1). A typical unit moves product, in trays, into the top of a vertical stack. The trays then descend stepwise down the stack

while liquid nitrogen is introduced through nozzles in vertical manifolds at the corners of the stack. The escaping nitrogen gas acts to precool the trays in the upper part of the stack as they are descending.

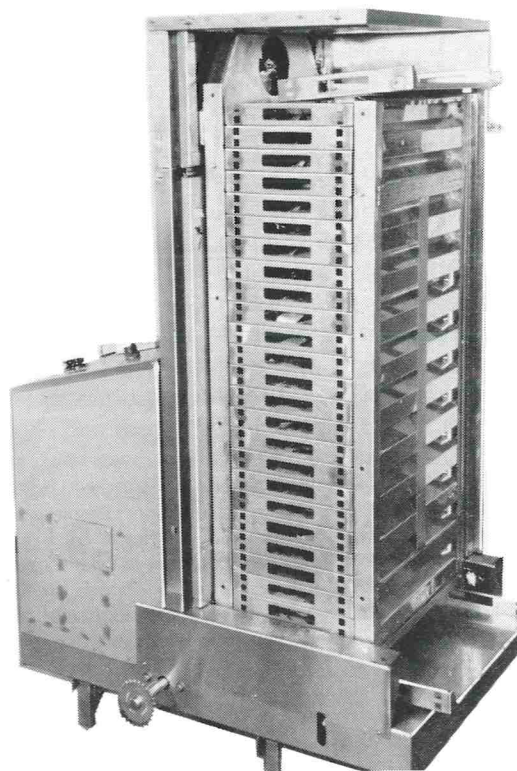


Figure 1. Liquid nitrogen freezing unit (courtesy of Teckton, Inc., Wellesley, MA).

### HEAT INPUT PROCESSES

Convection ovens are widely used for heating frozen prepared foods, and there are many models on the market. A number of them have been evaluated under full and partial load conditions to determine their effectiveness. Results of tests of one model are given in Table 2. A full oven load was heated with the oven temperature set at 325 F, and thermocouples were placed in one pan on each shelf to monitor temperature changes. There were substantial differences in heating rate from shelf to shelf, so that to insure that food in all pans reached 160 F, some were seriously overheated.

<sup>1</sup>NAAKA Hospital, Stockholm, Sweden.

<sup>2</sup>AGS stands for Anderson, Greenville and Spartanburg Hospitals in South Carolina.

TABLE 2. Effect of pan position on heating rate of frozen food in a convection oven<sup>1</sup>.

Location of temperature sensing probe	Front (F) or Back (B) Right (R) or Left (L) Shelf No.	B	B	F	F	B	B	B	F	F	F
		R	R	L	L	R	R	R	L	L	L
		3	5	6	10	1	7	9	2	4	8
Total time (min) from initial to 160 F		120	121	128	131	133	139	142	142	147	160
Temperature this probe when:	Fastest at 160 F	160	158	142	134	138	122	121	110	112	92
	Slowest at 160 F	206	204	203	202	202	188	182	191	178	160

<sup>1</sup>Frozen food: Oatmeal, 6 lb./pan, 8F; oven load: 4 pans/shelf, 40 pans/oven; oven temperature: 325 F

Energy consumption also was measured when frozen food was heated in a preheated oven as well as in the same oven operated from a cold start. Actually less heat was consumed in the latter case (12.97 kWh vs. 14.29 kWh); and when the preheat time was taken into consideration it took much less time to heat from a cold start (116 min vs. 86 min). These results should not be construed to mean that all convection oven designs will give the same results, nor that convection ovens are not useful for heating prepared foods, but merely to point out that there is room for improvement.

Infrared ovens are somewhat faster than convection ovens, but are limited in capacity to a single steam table pan (12 × 10 × 2½ inches). An exception is the Foster "Recon" oven which received some notoriety a few years ago. Models were available with capacities of two, six and 20 steam table pans. Quartz tube infrared heating elements were disposed between the shelves, and the radiant energy was pulsed according to a predetermined program while refrigerated air was directed across the pans to prevent surface scorching. Heating cycles of 60 min for 3-inch frozen food thicknesses were claimed.

Obviously much shorter heating cycles are possible if foods are heated from a chilled or tempered state. The heating time is about 50% less than that for frozen foods. Special thawing cabinets are available which are designed to maintain a constant temperature of 45 F. Thawing cycles as short as 12 h are claimed.

#### TEMPERING AND THAWING SYSTEMS

Tempering differs from thawing in that the final temperature desired is 28 to 30 F or slightly lower. Much less energy is required to temper; however it must be made up in the heating step. Experimental tempering cabinets have been built for the U.S. Army Natick Research and Development Command, which monitor the food surface temperature while balancing heated and cooled air so that product surface temperature does not exceed 28 to 30 F. Under such conditions tempering from a hard frozen condition has been accomplished in 3½ to 4 h for 5-lb. quantities in disposable aluminum pans.

Microwave equipment is also available to temper frozen foods, and cycles as short as 15 min are common with such systems. Quite a few conveyorized microwave systems capable of tempering several thousand pounds per hour are in use today. Smaller batch units which could find use in many foodservice operations are now available (Fig. 2).

Convection oven heating has the disadvantage that an entire oven load is ready at one time but can only be used a pan at a time. An alternative is continuous conveyorized heating using the "Jet Sweep" principle described in U.S. Patent No. 3,844,213 (Fig. 3). The technique is also being employed in conjunction with

microwave energy in a food vending unit (Fig. 4) built for the U.S. Army Natick Research and Development Command. The device has a capacity of 600 food portions, 50 each of 12 different selections. The user, or customer, may select up to three items, typically the components of a complete meal. Each selection is mechanically moved from freezer storage into a heating chamber which has both microwave and directed hot air, "Jet Sweep," heating capability. Three heating chambers side by side permit each component selected to be heated at a rate appropriate to its composition and to the correct serving temperature. To accomplish this, the heating program for each item is controlled by a processor<sup>3</sup>. The product is also moved back and forth on an oscillating belt during heating to insure more uniform microwave as well as hot air heating. The hot air system is used mainly for those food items which require surface crisping, such as fried chicken and French fried potatoes. The product must be exposed for crisping to occur, thus a special package design is required to protect the product during freezer storage. One approach which gives good results is to use a shrink film overwrap on a die-cut open top cover. When exposed to the directed hot air, the film splits and immediately shrinks back exposing the product. After all items have been properly heated, they are mechanically moved to the delivery shelf. The total process from selection to delivery may vary from 1 to 2.5 min.

#### SPACE AGE TECHNOLOGY

An element, which derives from space age technology and is being evaluated for food service equipment potential, is the heat pipe concept. A heat pipe can be used for heating or cooling purposes. In the heating mode, heat is applied to one end. This causes a heat transfer fluid inside the hermetically sealed pipe to evaporate. The vapor then condenses at the cold end to give up heat. The condensed liquid then returns to the heating end by capillary action in a wicking material bonded to the inside of the pipe (Fig. 5). A number of prototype grills have been built using the principle (Fig. 6). The advantages are very rapid heatup — about 5 min — and rapid recovery when a load is placed on the grill. The heat pipe grill also exhibits a uniform temperature over its entire surface. A conventional field grill with comparable capacity of the prototype would use considerably more fuel.

Research in heat transfer is being carried out at the U.S. Army Natick Research and Development Command. This work is related to development of a better understanding of the meat roasting process, to eventually design an oven which will give more consistent results, better quality, higher yields, and use energy more efficiently. A mathematical model was developed first to describe the meat roasting process. The model takes into consideration the initial and final product temperature, oven temperature, thermal conductivity of the meat,

<sup>3</sup>STI Programmable Control System, product of Texas Instruments, Inc., Attleboro, MA 02703.

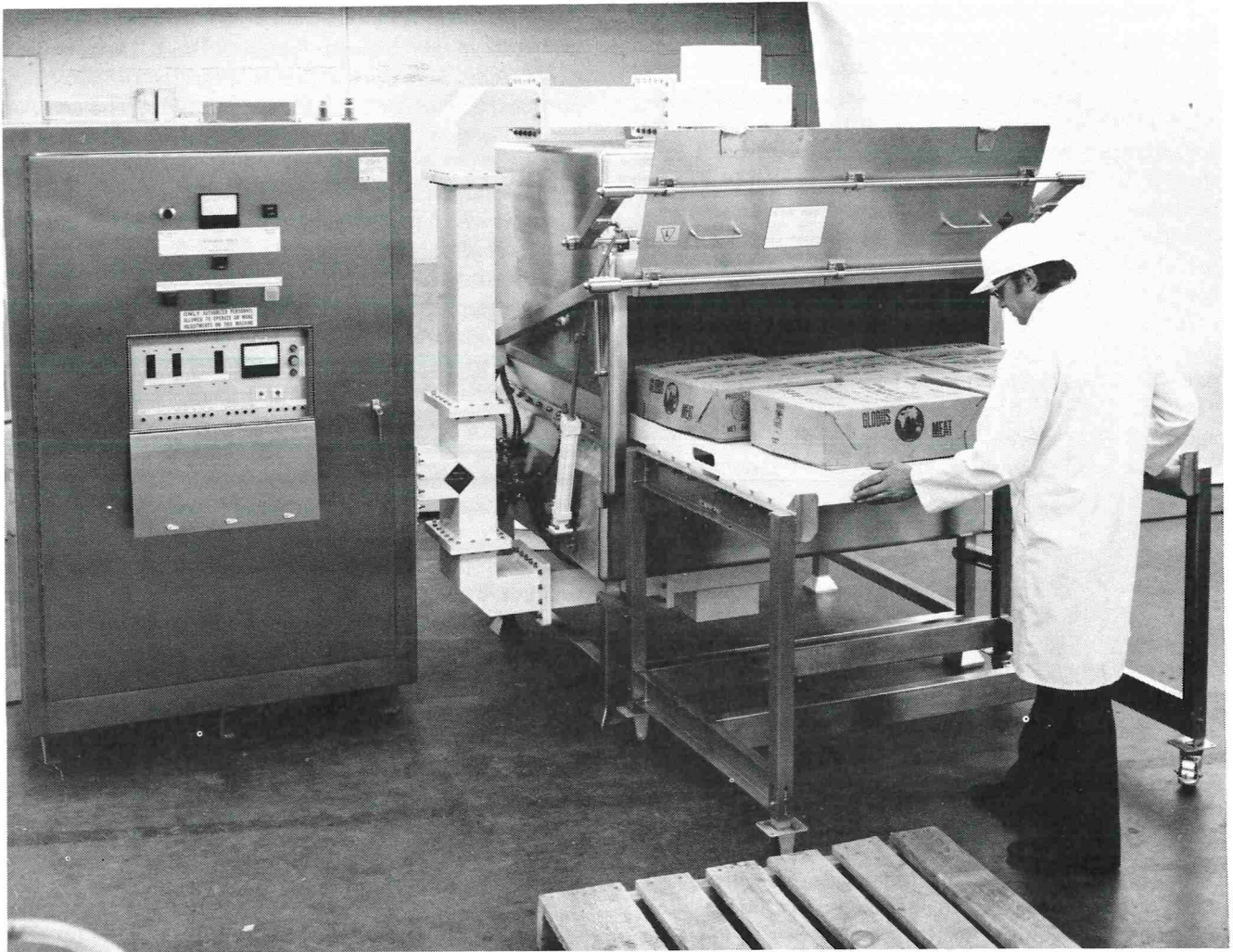


Figure 2. Microwave batch tempering system; operating frequency 915 MHz (courtesy of Raytheon Company, Waltham, MA).

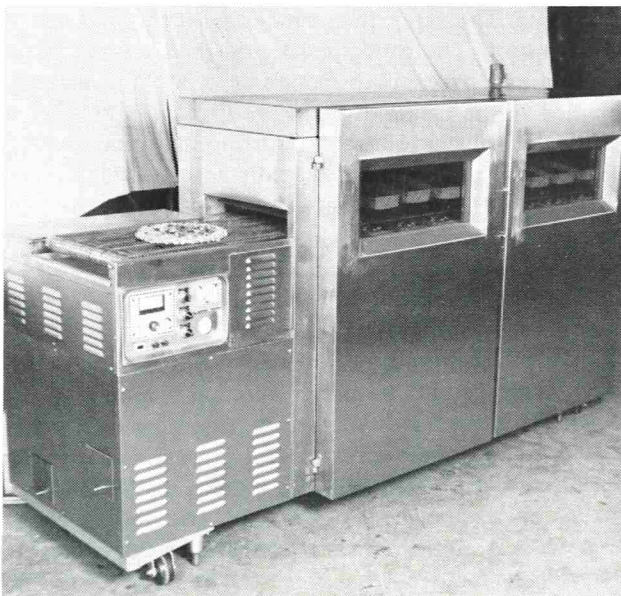


Figure 3. "Jet Sweep" heating concept, applied to heating pizza pies.

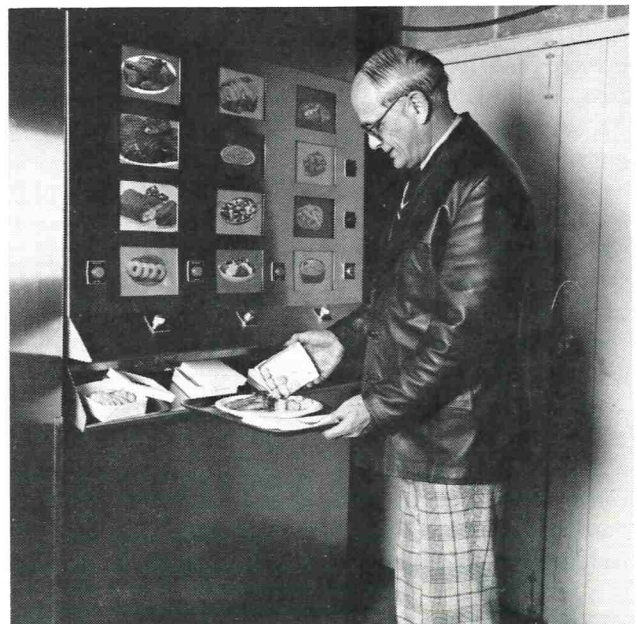


Figure 4. Untended meal heating unit.

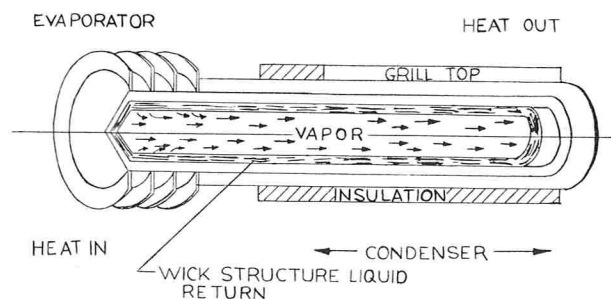


Figure 5. Heat pipe concept.

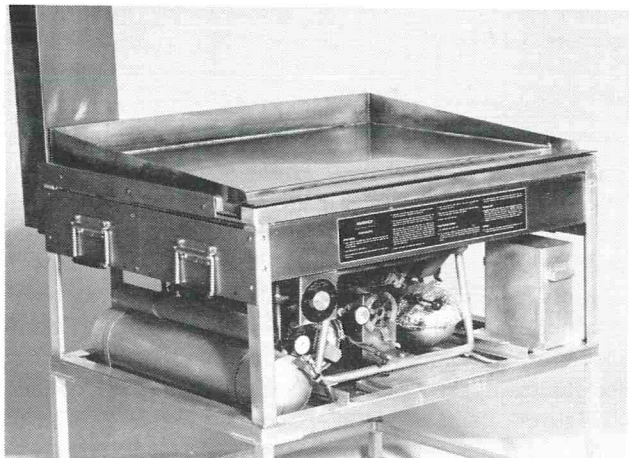


Figure 6. Heat pipe grill.

surface evaporation, the dimension of the roast and changes in the dimensions during roasting. When microwave energy was used, dielectric property data were obtained as a function of temperature and microwave frequency.

Cooking studies were carried out in a research oven that is a pressure cooker to which has been added microwave capability at both 915 and 2450 MHz, a radiant heat source in the oven top and bottom, pressure control at 3 levels (5, 10 and 15 psig), and control of all functions through an IBM card reader.

The best beef roasting results were obtained at 300 watts of microwave power at 915 MHz. Roasts weighing about 8 lb. were cooked from a refrigerated condition to 140 F in about 1 h. The yield of cooked meat was 85% or better under these conditions.

#### SUMMARY

This is only a beginning. The knowledge and the tools are at hand to identify the ideal conditions for processing almost any food item and for designing equipment to place calories precisely where they are required to achieve optimum results in terms of quality, yield, and energy efficiency. We have not always had the incentive in the past. We do now and it is imperative that we make the effort to apply our knowledge in this direction.

#### ACKNOWLEDGMENTS

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## Trends in Food Packaging for Foodservice

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### ABSTRACT

Forces shaping the food package of the future include convenience, economy and energy conservation. Three new packages are particularly interesting, viz., retort pouch, hermetically-sealed trays and semi-rigid retortable trays. The retort pouch has been widely researched and is making inroads on the market. Applications should increase when materials used in the adhesive system are approved as meeting U.S. extractives standards. Foods can be thermally-processed and stored ambiently in shallow, hermetically-sealed trays. Processing is accomplished rapidly with improved quality and energy savings. Semi-rigid retortable containers range in size from single-serving to half-size steam-table trays.

Food packaging has changed markedly in recent years, and it appears that more dramatic changes will take place during the next decade. Although some of the factors which have influenced changes in military food packaging are peculiar to the military, the primary forces which have brought about changes are identical to those which influence the commercial market. Convenience, which reduces labor requirements both for the housewife and foodservice personnel in institutional feeding situations, has probably been the major driving force for packaging innovation during the last decade. In the immediate future, another factor, energy, may become the dominant force which stimulates packaging changes.

In this discussion, I will consider some areas of packaging that we are working on at the U.S. Army Natick Research and Development Command (NARADCOM). These are of particular interest for military feeding applications and may also find a place in the commercial sector.

### RETORT POUCH

The retort pouch is possibly one of the most thoroughly "researched" food packaging innovations ever conceived. From the military standpoint, the potential of the retort pouch as a replacement for the metal can for operational rations was recognized more

than fifteen years ago. Immediately recognizable advantages of the flexible pouch for operational rations include: lighter weight, easier to carry, reduced cube, and ease of disposal. Other, perhaps less obvious, advantages include the potential for a wider variety of products (meatballs, sausage links, cakes), improvements in quality of some items, reduced energy requirements for processing, and ease of opening without a can opener.

Figure 1 shows retort pouches of the type used throughout our development program at NARADCOM. The pouch is a 3-ply structure consisting of an inner layer of 0.003-inch thick polyolefin, a barrier ply of 0.00035-inch thick aluminum foil, and an outer ply of 0.0005-inch thick polyester. An outer carton or folder is considered necessary to provide additional protection against puncture, abrasion and excessive flexing during transportation and storage, especially for military applications, and probably will be used for early entries into the commercial marketplace.

To determine durability of retort pouches, we conducted a series of rough handling tests in which

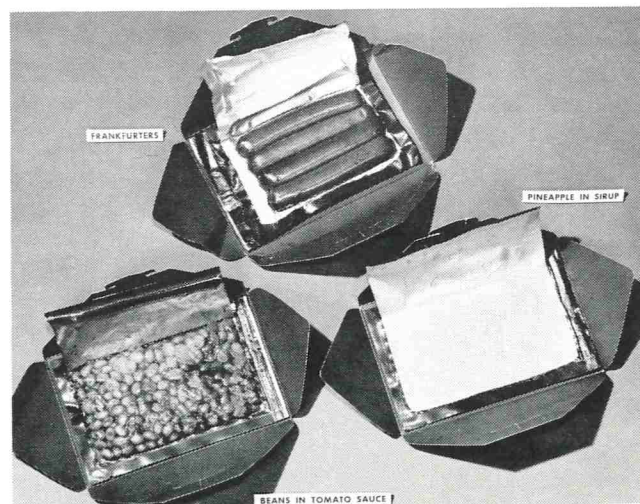


Figure 1. Retort pouches used by Natick Research and Development Command.

pouches and cans of comparable size were subjected to identical simulated handling (1). Our tests showed that the retort pouch is at least as durable as the time-proven metal can. Low-temperature (-20 F) as well as ambient condition tests showed no significant difference in performance between the two package types.

In addition to laboratory tests, field tests of experimental rations — using retort pouches for entrees, desserts, and some fruit items — were conducted to verify their durability under extreme conditions (5). Handling and transportation involved in moving the rations from an assembly contractor's plant in the mid-west to test sites in Georgia and Alaska, followed by transportation in military vehicles and in many instances several man-handlings, did not reveal any signs of lack of durability.

To determine whether retort pouches could be produced reliably under a production environment, NARADCOM sponsored a contract effort to define a system, engineer and construct a line, and produce 50,000 each of six diverse items (2). The results showed that, using basically standard equipment, in terms of process-related critical defects, retort pouches can be manufactured at a defect rate no higher than 0.1%, which is a figure frequently quoted for cans (4).

Products that have been successfully packaged in retort pouches in our development program include fruits, vegetables, stew-type items, frankfurters, beefsteak and a variety of cakes. In all, more than 22 diverse items have been produced and tested for quality and acceptability after various storage times. Acceptability in comparison to similar canned items is illustrated in Figure 2. In this test, soldiers were given free choice of the rations which contained foods in retort pouches or the conventional canned foods. The choice was clearly in favor of the retort pouch. Novelty of the package was ruled out as a significant contributing factor since all test subjects had previously eaten both ration types.

An obvious question at this point is: "What is the commercial potential of the retort pouch?" or "Why is it not available in the marketplace?" There has been, and continues to be, high interest in commercialization of the retort pouch in this country. The sole barrier to the initial introduction of retort pouches into the commercial U.S. market and to the initial procurement by the military is clearance of the pouch material by the Food and Drug Administration (7). FDA has ruled that the data are not adequate on the polyester and epoxy components of the adhesive system, used between the inner layer and the aluminum foil, to permit their use in the levels detected in food-simulating solvents. Basically, two approaches can be taken to obtain FDA approval: (a) conduct 90-day animal feeding studies using simulants for the extractives in question and, assuming favorable results, re-submit petitions to FDA, or (b) develop new material structures which result in extractives levels of virtually zero (less than 50 ppb has been suggested as the levels at which approval would be likely without feeding studies). New

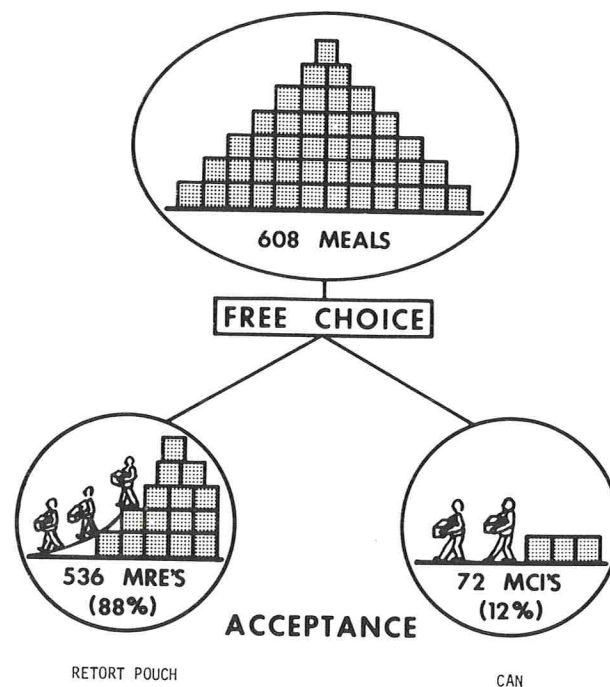


Figure 2. Acceptability of foods in retort pouches vs conventional cans.

materials are being developed which have extractives levels in the "floating zero" range. We have conducted preliminary tests on three such materials in our laboratories and are confident that, in the very near future, materials that satisfy both the physical and extractives requirements will be available.

Based to a large extent on our pioneering work, retort pouches have become a commercial reality in many countries. Figure 3 shows an Italian retort pouch made by Star of Milan, Italy. Reportedly the first producer to market this type of food package, Star has been marketing them in Europe since the mid-1960's. Retort pouches have also been produced for test or full-scale marketing in Scotland, Denmark, Germany, Canada, and Japan.

Several advantages of the retort pouch have been mentioned previously. The factors which I feel will have a significant influence on eventual commercialization of the retort pouch and on food packaging in general are availability and cost of energy. A retort pouch required only about half as much energy (Table 1) to fabricate as a conventional three-piece metal can and less than a glass jar or aluminum frozen food tray (3). When energy savings as a result of greatly reduced retorting times and reduced package weight throughout the transportation chain are considered, the economics of the pouch could be favorable.

Relatively slow production speeds (in comparison with cans) have been cited as a disadvantage of the pouch approach. Initially, production rates will be low, but at least one producer plans to test the pouch approach with gourmet-type items which can tolerate the higher cost associated with low-production speeds. Other firms are



Figure 3. Package and retort pouch produced in Italy.

TABLE 1. Energy required to produce four types of 8 oz food containers (Source: Reynolds Metals Co.).

Container	BTU/Container
Retort pouch Polyester, Aluminum foil, Adhesive, Polypropylene, Inks, Carton	1,934
Frozen food dish Aluminum container, coatings, Plug lid, carton	2,819
Glass jar Lid (Steel), Seal compound, Label, Glue	3,174
Can (211 x 300) Steel, Tin, Coatings, Label, Glue	3,560

already planning systems which are faster and less labor-intensive. Metal Box, Ltd., recently described a system which is capable of running 100 to 120 packages per minute, and equipment manufacturers feel that speeds of several hundred per minute can be attained with present technology.

### TRAY PACK

Another packaging concept which has created considerable interest both by the military and by the civilian sector is the use of a comparatively flat, hermetically-sealed tray for institutional feeding situations (8). Figure 4 shows three tray concepts that have been evaluated at NARADCOM for thermally-processed shelf-stable foods. Our initial work was done with shallow drawn aluminum trays, with a heat-sealed lid, shown in the lower right of Figure 4. Some feasibility work has been done with polymeric trays, and extensive studies are in progress with steel trays, filled and processed at NARADCOM, as well as with the commercial version, the KRAFT Pan.

Storage studies have shown that some food items thermally-processed in shallow trays of this type, after storage under ambient temperatures over a period of 26 months, compare favorably with frozen counterparts

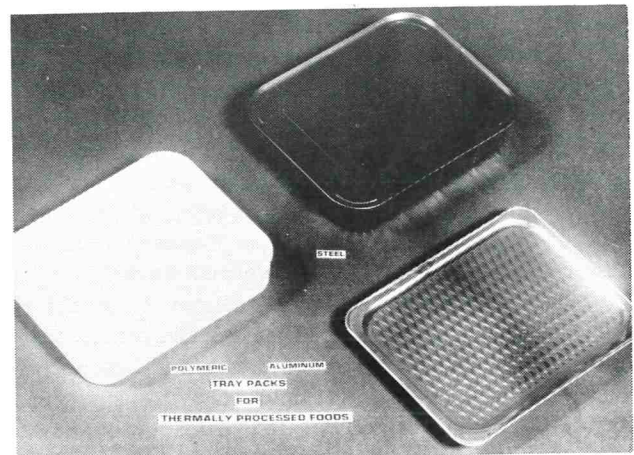


Figure 4. Three types of tray packs for thermally processed foods.

which were stored for the same period of time at 0 F (-17 C).

As with the retort pouch, the geometry of the tray permits processing to commercial sterility in considerably less time than a #10 can of nearly the same capacity. Mencacci (6) reported that by using agitation during retorting, processing times as low as 35 minutes are possible. The primary advantages of the reduced cooking time are improved quality and energy savings.

There are two variations of the steel tray-packs currently available:

(a) The unit produced by the Central States Can Company is made from tin-free steel and coated on the inside with a conventional can-coating enamel system. A flanged upper portion permits the pan to be placed into the well of a steam-table for reheating and serving.

(b) Kraft, Inc. is test marketing a similar unit. Although similar in outside appearance to the Central States unit, the Kraft tray is made from 25-lb. tin-plate (80-lb. base weight steel), has smooth walls, and the radii of the corners are somewhat sharper.

A polymeric tray, as shown in Fig. 4, has been used for preliminary tests at NARADCOM. These trays were thermoformed from coextruded polypropylene/PVDC/polypropylene and were closed with heat-sealed lids made of a foil laminate. Acceptability of beef stew was tested after 1-year storage in polymeric trays with and without a laminated overwrap. The data from these preliminary studies indicate that for some food items adequate oxygen and water vapor transmission barriers may be provided by polymeric trays.

Based on encouraging results from our preliminary tests and potential advantages envisioned, we are planning further tests with polymeric half-size steam-table trays. Primary among the potential advantages of polymeric material over metal is the potential for using microwave ovens for reheating, resulting in savings of both energy and time. Heat-sealing the lid to the container body also offers the possibility of increased production speed over double-seaming, as is used for the steel containers.



### SEMI-RIGID RETORTABLE CONTAINERS

Semi-rigid, polymer-coated, drawn-aluminum containers for thermally-sterilized foods have been developed in Europe and appear to be finding markets in various parts of the world. To my knowledge, this type of container is not in use in this country; however, at least one version of the semi-rigid tray has been approved chemically by FDA.

An array of sizes, ranging from single-serving to half-size steam-table trays, is available. Shown in Figure 5 is a typical single-serving size semi-rigid container purchased at a market in France.

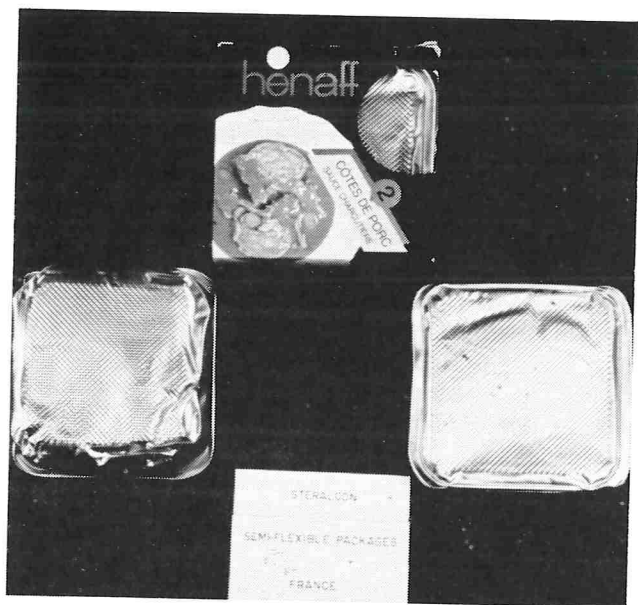


Figure 5. *Semi-rigid single-serving retort package.*

The limited testing of single-serving size semi-rigid retort packages that we have conducted has shown that, despite severe denting, the incidence of package failure is surprisingly low. From the commercial standpoint, there is a possibility that denting may be interpreted as package failure, as is frequently the case with metal cans. Heavier gauge aluminum, presumably to overcome the denting problem, is being explored.

A recently completed series of rough-handling tests on half-size steam-table units made from the semi-rigid material (5-1/2 mil aluminum foil 1.2 mil Nylon) showed a very high failure rate. Additional strength, both to

reduce failures and to improve handling characteristics, would probably be required for this type of container to withstand military handling and transportation.

### CONCLUSIONS

During this discussion, I have considered several approaches to packaging which differ somewhat from those most familiar to the housewife, the soldier, and the foodservice worker. None of the approaches is so superior that it will have smooth sailing or achieve instant success, nor are conventional cans or frozen, boil-in-bag items about to be instantly replaced by a revolutionary packaging method. Each new packaging system will have to establish its own place in the market. Rather than viewing new packaging systems as replacements for existing systems, it would be better to view them as additional options available to the food packer.

### ACKNOWLEDGMENTS

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## Food Ingredient Update

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### ABSTRACT

Some 2500 substances are used as food additives, but the number of food ingredients is much larger. Major functions of food ingredients are related to nutrition, preservation, physical and sensory qualities and processing. Special attention is given to functions of ingredients in microwave heating, freezing and thickening. New products are discussed, including cheese analogues, sterile pack potatoes, shell-less boiled eggs, simulated nut meats and portion control omelets.

The term food ingredients includes all intentional substances that become components of finished food products. Under this definition food additives are food ingredients. Substances which enter our food chain unintentionally, such as pesticides, insects, rodent contamination, and certain microorganisms, are not considered food ingredients. In the additive class of food ingredients, the *CRC Handbook of Food Additives* lists 1797 compounds. This listing includes: 30 preservatives, 28 antioxidants, 44 sequestrants, 85 surfactants, 31 stabilizers, 24 bleaching and maturing agents, 60 buffers-acids-alkalies, 35 colors, nine special sweeteners, 116 nutrient supplements, 720 flavoring compounds, 357 natural flavoring materials, and 158 miscellaneous materials. Others have indicated that there are at least 2500 substances that are used as food additives. The numbers of items in the total class of food ingredients is unknown.

### FOOD INGREDIENTS SERVE SEVERAL FUNCTIONS

Many food ingredients serve several functions (Table 1). As an example, carotene may be used both as a color and a nutritive agent.

Considering the theme of this 25th Annual Food Technology Conference, "Food Science Focusing on Foodservice," and the title "Bridging the Gap," it is appropriate to discuss the effect that many ingredients have on processes that are used in foodservice operations.

TABLE 1. *Functions of food ingredients.*

Functions	Ingredients
Nutrition	Proteins, Amino acids, Minerals, Vitamins
Sensory properties	Colors, Flavors, Flavor enhancers, Texturizers, Clouding agents, Acidulants, Sweeteners
Keeping properties	Antioxidants, Antistaling agents, Anti-microbial agents, Sequestrants
Physical properties	Anticaking-, Antispattering-, and Wetting agents, Humectants Propellants, Foaming and antifoaming agents, Emulsifiers, Bulking agents
Processing aids	Enzymes, Curing agents, Shortening, Leavenings, Firming agents

### THE MICROWAVE PROCESS

Let us consider the effect of various ingredients in microwave heating. First we must understand that microwaves are a source of electrical energy which must be converted to heat energy in the food product. Certain components, primarily water, of the food products are polar in nature, i.e., one end of the molecule is negative and the other end is positive. When microwaves pass through foods, the molecules which are polar or have induced polarization, act like tiny magnets and attempt to align themselves with the electric field. Under the influence of the high frequency alternating electrical field, the particles oscillate about their axes creating intermolecular friction which manifests itself as heat. Most food items contain sufficient water, which is a polar molecule, so that they heat well in a microwave oven. The chemical make-up of glass, paper, and ceramics, which are used as food containers in microwave heating are relatively non-polar and thus do not readily absorb microwave energy.

Now that we have some understanding of how microwaves generate heat, let us look at the effect of various food ingredients on absorption of microwave energy. Let us look first at a model system consisting of a 4-inch cube of water solidified with 2% agar. This block in a microwave field (2450 MHz) will melt first in the

center. A similar block containing 0.9% sodium chloride will heat uniformly throughout the mass. As the salt content is increased we get more peripheral heating until at above 5% the block essentially reflects the microwave energy and no heating occurs. This last is a surface phenomenon in that the salt only needs to be in a thin surface layer. In other words, wrapping in aluminum foil would give the same results. All soluble salts behave similarly to sodium chloride on an equimolar basis. Thus, products that are intended for microwave heating should be formulated so that they do not contain the level of soluble salts that will inhibit absorption of microwave energy.

Similar experiments with ingredients such as starches, sugars, acids, proteins and fats do not show inhibition of microwave absorption.

#### INGREDIENTS DETERMINE FREEZE/THAW QUALITIES

Various ingredients are affected by freezing. Let us look at the staple potato. It is used as an ingredient in many dishes. However, if the product is to be frozen, one must choose a variety of potato that can be frozen, thawed, and reheated and still maintain its identity in structure and texture. For freezing purposes one must use a potato with a high solids content. Preferable varieties are Irish Cobbler, Russet Burbank, Russet Rural, Sebago and a few others. White Rose should not be used.

Now for thickeners. Many years ago many frozen gravies and sauces were unsatisfactory because of syneresis, separation of fluids, on thawing. At that time the only satisfactory answer was the use of a waxy rice starch for at least a portion of the thickener. Now we have available 10 modified starches of 23 manufactured by seven companies that are satisfactory as thickeners for frozen gravies and sauces.

Frequently in foodservice operations, there is a requirement for holding a reasonable quantity of food hot for prolonged periods. Here again, with gravies and sauces, the type of thickener used is important. Many of the thickeners are partially hydrolyzed during prolonged heating and progressively lose their thickening properties. There are many more examples of the effects of ingredients on processes but we will move on to another area of interest concerning ingredients.

#### INGREDIENTS CONSIDERED IN LABELING

One of the prime differences between food production in a foodservice establishment and food processing for distribution through grocery outlets is that of label and ingredient clause requirements. For example, a foodservice operation can process squid, a delectable seafood, and place it on the menu as "calamari," the French name for squid. The seafood processor must label his product squid. Ten years ago I was involved in development of a squid product and attempted to obtain a label using the name Monterey Calamari Fillet with

squid shown in the ingredient clause. The FDA required that squid be in the product name. As a result, my only sales were to restaurants where they could call it calamari, because the general consumer will only eat squid when offered under its French nomenclature. Another example is shark meat labeled as grey fish steaks or filets.

However, as time goes on, the trend of greater and greater consumer protection will include the greater regulation in foodservice as is happening in food processing. There has already been a push to make foodservice notify patrons if they are being served frozen foods. Butter and margarine is an old example of future trends. We also have the more recent example where only special vitamin-fortified proteins with a minimal PER (protein efficiency ratio) are to be used with ground beef. In many ways, the standard of identity for many foods will be required in the foodservice industry.

#### NEW PRODUCTS COST LESS

Of particular interest to the foodservice industry is new food products that are of good quality and reduce labor requirements. Available now, to mention a few, are: cheese analogs, sterile pack potatoes, shell-less boiled eggs, simulated nut meats, and portion control omelet.

Many of the new cheese analogues have attributes of interest in several areas of foodservice. The Parmesan analogue has full flavor of the natural cheese and sells for about half its price. The Mozzarella analogue cannot normally be distinguished from its natural counterpart and also sells for about half its price. The Cheddar analogue has all the virtues of the natural Cheddar, is available in low cholesterol form, high in polyunsaturated fats and also is cheaper than the natural Cheddar cheese. All of these cheese analogues are presently manufactured with special casein and vegetable fats. However, it is expected that new vegetable proteins will soon be able to provide the functional properties that casein contributes to cheese.

Another ingredient of interest is sterile-pack potatoes, in diced, shredded, and sliced forms. Presently this product is packed in a heavy polyethylene vacuum-sealed bag (2½ lb.) with no liquid. In this package the product has an ambient shelf life of at least 100 days. Where increased storage life is needed, improved films are available. Other products packed using the same patented process should soon be available.

There are now shell-less "hard boiled egg" products designed to save time and product loss involved in handling, cooking, and peeling eggs. The average loss in commercial kitchens is 11% due to breakage and whites sticking to the shells. One product is a refrigerated peeled whole hard boiled egg that has a 3-week refrigerated shelf-life. Another product is a frozen foot-long shell-less egg with yolk running down its center. The process for both keeps yolks and whites from falling apart on slicing and prevents the dark ring often found around boiled yolks.

Simulated nut meats are available that have the flavor, appearance, and texture of English walnuts, black walnuts, or pecans. They are of lower cost and have extended shelf-life compared to their natural counterparts.

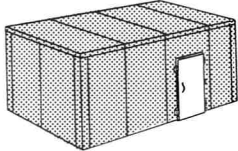

A potentially useful patent describes a method for making several food products in portions of controlled size and shape. In the process, gelatin is incorporated into a liquid uncooked food of the class consisting of pancake batters, egg batters and egg omelets. This liquid food is then placed in a mold which is chilled to a

temperature sufficiently low to cause the gelatin to set. The gelled food is then cut into portions of predetermined size. Pancakes and eggs made by the method when cooked will exhibit the natural flavor and texture of pancakes and eggs, and no change in these characteristics is noted as a result of having had the gelatin incorporated into the batter.


#### ACKNOWLEDGMENT

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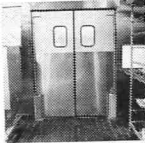



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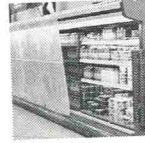
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## Hospital Foodservice — 1978 and Beyond

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### ABSTRACT

This paper (a) discusses how changes within the health care and food processing industries have influenced development of alternate foodservice systems and (b) projects some future trends related to resource usage. Schematic diagrams for four alternate foodservice systems are presented and discussed. The need for strengthening cooperation among food processing and foodservice industries is emphasized. Research activities related to the quality and safety of foods within each of these systems have been limited. In addition, these foodservice systems evolved without adequate consideration of effective use of energy resources. In the future, food processors and foodservice managers will have to coordinate their functions to serve good quality, energy-efficient menu items.

Hospital foodservices are uniquely operating within the health care environment as well as within the regional and local community. Therefore, political, social and economic changes within the health care field directly affect foodservice management and established policies and procedures. In addition, hospital foodservice managers are pressured to adopt technological changes in equipment and market forms of foods with the goal of increasing productivity.

What are the current issues within health care facilities? Recent issues of the *Journal of the American Hospital Association, J.A.H.A.*, feature headlines about cost with phrases such as cost containment, controlling costs, financial crunch accountability, scarce resources, shared systems, and changes in operational systems.

Since about 1960 the flow of food materials within the foodservice facility has been increasingly altered. This in turn has altered food purchasing. Such changes were initially made in response to increasing labor costs. In 1960, convenience type hospital foodservice systems began to develop. Another innovation, which appeared about 10 years ago, was temporary storage of cooked food between production and service. Thus the food production and foodservice stages became separated, both in time and in physical location. Many of these changes are radical departures from the conventional

foodservice system. They have all happened within the last 15 to 17 years. Such rapid change makes it difficult for foodservice administrators to control systems so that quality and effectiveness are maintained.

### FOOD PROCESSING/FOODSERVICE INTERFACE

The following are schematic diagrams which delineate four alternative foodservice systems within hospitals. These conceptual frameworks were published in a research foodservice bulletin (1) developed by a North Central Regional Research Committee on food quality and safety of foods within mass feeding operations.

With the evolution of current foodservice systems the interdependence of the food processing and the foodservice industries has become more apparent. Many highly processed foods are available for use in foodservices. The types of foods procured from food distributors for foodservices tend to describe the interface between the two industries. Figure 1 gives a schematic diagram of this interface.

The food processing continuum represents the amount of processing which food items receive. Food items at the far left in this continuum have received little or no processing; at the far right processing has been completed.

To illustrate this concept a ready-to-cook, whole chicken carcass which is chilled in ice slush receives little processing before distribution. If the bird is cut up, packaged and frozen, it has received moderate processing. However, if the chicken has been diced, frozen, incorporated into chicken cacciatore, portioned into 10-12 lb. aluminum containers, frozen, and distributed to a foodservice system, it has been completely processed for the menu item. Figure 1 represents a foodservice operation which tends to procure food items with either no processing or a limited amount of processing.

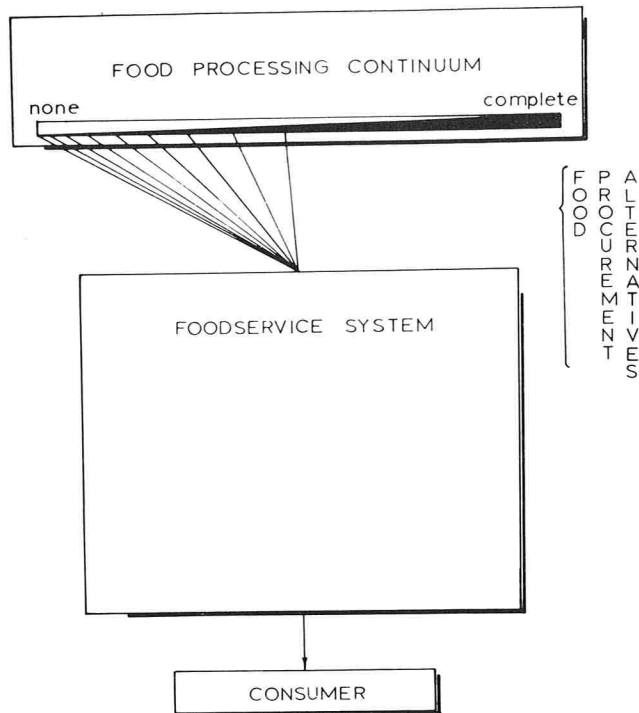


Figure 1. Food processing/foodservice interface.

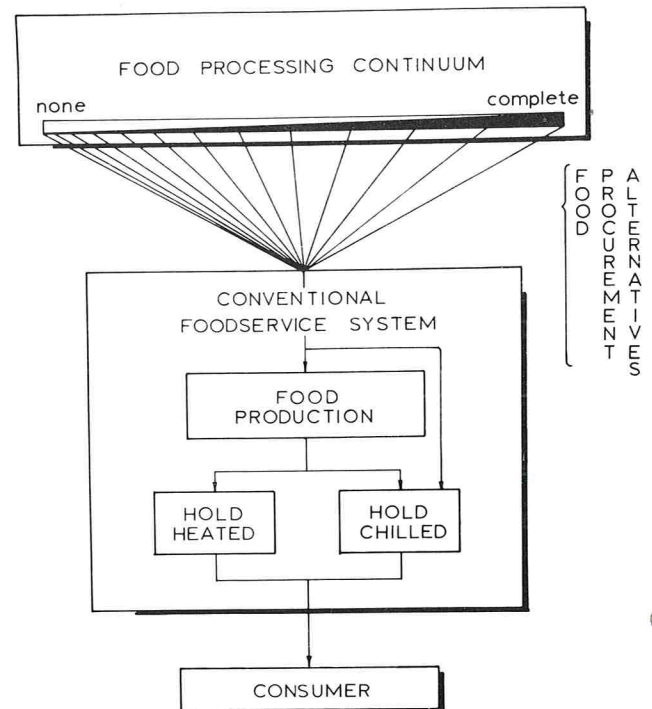


Figure 2. Food processing/foodservice interface for conventional foodservice system.

### PRODUCT FLOW IN FOODSERVICE SYSTEMS

Four major categories of systems provide a basic conceptual framework of the current foodservice industry. In some establishments, a combination of two or more of these categories may be used to prepare different menu items.

In considering alternative systems the following should be kept in mind:

1. Selection of any type of foodservice system will depend on the objectives and constraints of the individual situation. No one system is best for everybody.
2. There is no concrete evidence in the literature that cost effectiveness has been adequately substantiated for any of the four categories of foodservice systems that will be described.
3. Only limited research data are available on the quality of food produced and served from these systems, although there are plenty of claims that certain systems improve or maintain quality.

A *conventional foodservice system* (Fig. 2) is one that uses some prepared food items, such as bread, ice cream and frozen or canned vegetables, but relies primarily on preparation "from scratch", particularly for entree items. Since conventional systems require so much preparation "from scratch", they are heavily labor intensive. Because of increasing labor costs, administrators with conventional systems have gradually made changes to reduce the labor component for meals served. Foodservice administrators are procuring foods from all points along the processing continuum. One exception is

in correctional facilities where labor is abundant and the conventional system is normally used. These foodservice systems tend to have their own meat processing, baking, and vegetable preparation areas.

#### Hot-holding

When food is subjected to hot-holding conditions, quality can be affected. The effect upon the product during the holding stage must be considered when managerial decisions are made concerning food production scheduling. Temperature and humidity are critical factors affecting food quality. Prolonged holding at 160-170 F usually has adverse effects on nutritional and sensory quality. Batch cooking of food in quantities to supply the service line for approximately a 15-min interval is an effective production technique for vegetables.

Hot delivery systems for trays to patients have the problem of not being able to maintain sensory quality and proper temperature for an extended period. "Late trays", or "hold trays" are also special problems.

#### Ready-prepared foodservice systems

These (Fig. 3) were developed in response to a critical shortage of skilled food production personnel and increased labor costs. Food items for ready-prepared systems may be procured from all points along the food processing continuum. However, if adequate skilled labor is available, there generally is a tendency to procure less completely prepared menu items. Following receipt, procured food products are placed in appropriate storage conditions until needed for ingredient unit assembly and production.

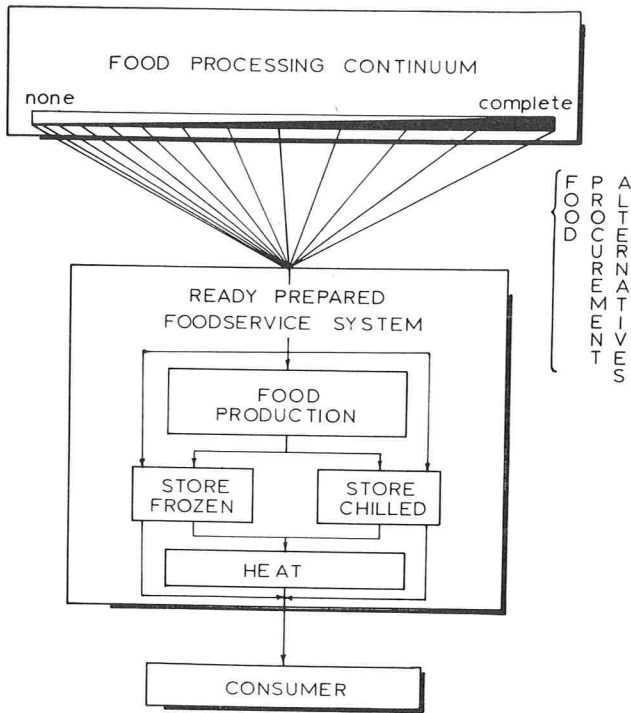


Figure 3. Food processing/foodservice interface for ready-prepared foodservice system.

Generally, foodservice administrators who adopted these systems found that available completely prepared foods did not meet their organizational requirements. Thus they went into on-premise production and storage systems which we know as...cook-freeze and cook-chill systems.

*Cook-freeze system*

This system is one in which batches of food are prepared on a Monday through Friday production schedule, individually portioned and plated immediately after production, blast frozen, stored, thawed, and reheated at point-of-service to consumers. The main problems in frozen cooked foods are damage to texture and structure and development of off-flavors. According to Palmer (2) much of this damage can be reduced or eliminated by substituting more stable ingredients, adding stabilizers and exercising control of storage time, temperature, and packaging.

*Cook-chill system*

In this system batches of food are prepared daily, usually chilled in bulk for 24 h, individually plated, and stored in refrigerated carts. Food is reheated, usually in a microwave oven, as needed in each patient area. In some cook-chill systems, food is prepared on a Monday through Friday food production schedule and food is then refrigerated for 24 to 72 h.

Recipe reformulation is a major consideration in cook-freeze and cook-chill systems. Entrees and hot vegetables in these systems receive two heat treatments. The first heating occurs in quantity production and the second is at point of service to the consumer. Terminal

temperatures of food given these two heat treatments should be carefully controlled as they can greatly affect quality. Because food products are subjected to a variety of temperature zones and methods of handling, close supervision in production is essential to maintenance of quality. Advantages to the cook-chill systems are that cold foods are less perishable and retain nutrients longer than hot foods. Their major limitation is the large capital investment required initially for freezers, refrigerators, large volume cooking equipment, and, perhaps, packing equipment. This processing/storage equipment requires significant space in the production area. Also, space is required in patient housing areas for foodservice employees to reheat food, and there is an added investment in reheating equipment, usually microwave or convection ovens.

*Commissary foodservice systems*

Evolution of these systems (Fig. 4) has been made possible by development of sophisticated foodservice equipment, initially in Europe. Dynamic Systems in Philadelphia is currently selling this equipment in the U.S. and adapting it to our market forms of food products (3).

Foodservice administrators who adopt these foodservice systems emphasize economics-of-scale in food production. These systems have centralized food procurement and production functions with distribution of prepared menu items to several remote areas for final preparation and service.

Commissary managers tend to acquire foods which have received little or no processing. The economics of

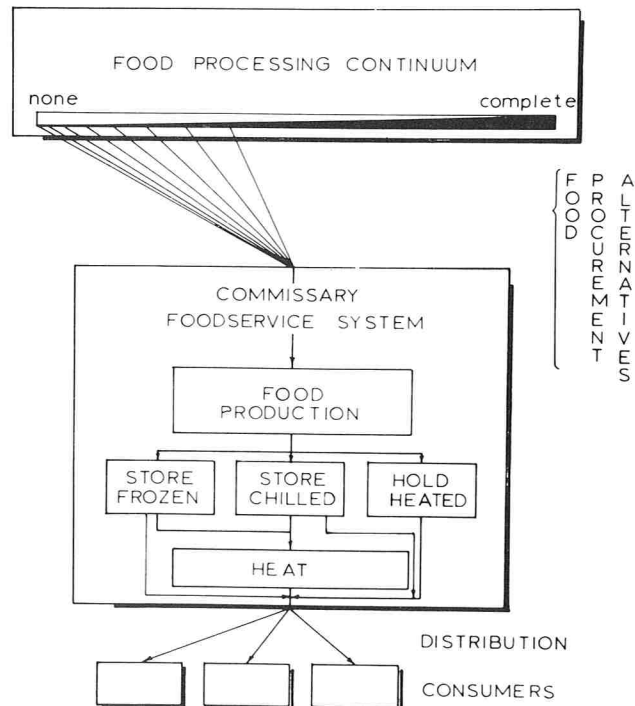


Figure 4. Food processing/foodservice interface for commissary foodservice system.

large scale purchasing and production realized from utilizing one central facility often justify procurement of expensive multi-function foodservice equipment which may be automated and computer-directed for preparation of foods from the unprocessed state.

Following procurement, food supplies are received and stored frozen, chilled or dry. Most food items are completely processed in the central production stage, which is the same as the ready-prepared service or conventional systems.

#### *Assembly-serve foodservice systems*

These systems (Fig. 5) evolved in response to (a) the chronic shortage in skilled personnel available for food production, (b) technological changes within the food processing industry which made feasible production of high quality, frozen food products, and (c) the extensive nationwide marketing and distribution system for frozen food products.

Three market forms of completely processed frozen entree products predominate in the assembly-serve systems: (a) bulk, (b) pre-portioned, and (c) pre-plated. Following receipt and frozen storage, the bulk form requires portioning before or after reheating within the foodservice system. In addition to reheating, the pre-portioned form requires an assembly step. The pre-plated product requires only reheating before distribution and service.

#### IMPLICATIONS FOR EFFECTIVE ENERGY USE

Throughout the discussion of these systems, I purposely ignored one scarce resource, energy. These

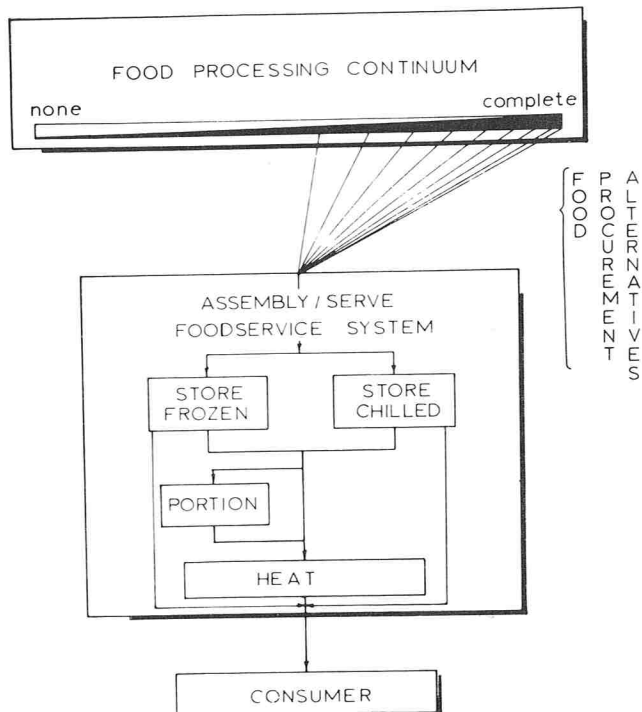


Figure 5. Food processing/foodservice interface for assembly-serve foodservice system.

systems evolved without much consideration of energy — it was abundant. Some of the feasibility studies for alternative foodservice systems have been negligent concerning energy. In 1975, a feasibility study was commissioned by and completed for the Commonwealth of Pennsylvania (4). This study concluded that five to six commissaries could serve all of the 80 government foodservice facilities throughout the state, including hospitals. This conclusion was reached without adequate consideration of energy requirements for initial food production, blast freezing, frozen storage, distribution, satellite storage, and product reheating.

The Department of Food Science and Nutrition at the University of Missouri, in cooperation with the College of Engineering, has completed a preliminary study of energy use throughout the food processing/foodservice industry (5). This involved development of a computerized energy accounting model to identify accumulated energy expenditures from the initial stages of food processing to the point of service. The data for each of the foodservice systems were expressed in BTU's per gram of protein and per calorie. We compared regular vs. modified diets, initial vs. leftover production, and limited vs. extensive food processing. In addition, energy expenditures for various types and distances of food distribution were identified.

Within each type of foodservice system we found serious energy inefficiencies. In hospital foodservices this is not surprising, seeing that 90% of the nation's existing health care facilities were built before 1973-74 and are largely energy inefficient foodservice systems (6). It would be disastrous to compare and make recommendations for use of inefficient systems. Before such comparisons can be made, each hospital foodservice system must make an effective use of energy as technically feasible. Increasing the efficiency level includes three important, distinct, yet interdependent dimensions:

1. *Identify and implement energy conserving technologies* (such as microprocessors to control ovens). When technologies are identified, their effect on the entire food product flow must be ascertained. Without such accountability, a reduction of energy in one process may increase energy expenditures for subsequent processes.
2. *Identifying, implementing and monitoring of policies and procedures* to effectively manage scarce energy resources.
3. *Accounting for use of energy on a producer-user level.* Within the food processing industry scientists should consider the energy expenditures needed for flow of products within the hospital foodservice department. Conversely, foodservice administrators cannot decide to use all convenience foods which lower their energy expenditures without considering and having knowledge of the energy which must be expended to process, store and distribute that highly processed and usually energy-intensive product. There has to be cooperation between



food processors and foodservice administrators to produce menu items with minimal energy expenditures on an industry-wide scale.

With energy supplies becoming increasingly limited, there will be no excuse for serving an item which has accumulated energy expenditures per nutrient content of 500, 800 or 1200% more than is feasible by another system. Our technological developments and managerial policies must preclude these types of error.

To summarize, there is not a gap between the functions of food processors and foodservice managers. We are all working toward the service of energy-efficient menu items, produced with good quality, in a productive foodservice environment.

#### ACKNOWLEDGMENT

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## Management of Sludge Use on Land

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### ABSTRACT

Passage of the Federal Water Pollution Control Act in 1972 has caused a huge increase in the amount of sewage sludge for disposal. The Food and Drug Administration has worked with the Environmental Protection Agency and other agencies to recommend proper management of the application of sludges to food and feed crops to ensure the safety and wholesomeness of the food supply. FDA's concerns about contamination of food by pathogenic microorganisms, heavy metals, persistent pesticides and industrial chemicals such as polychlorinated biphenyls (PCBs) are described. The reasons for special concern about direct application of sludge onto growing food and feed crops are discussed. The estimated daily intake of lead and cadmium, as compared to the proposed tolerable daily intakes, is presented, together with FDA's program to develop sufficient data on the natural background levels of these metals in raw agricultural products. Limitations recommended to prevent hazardous cadmium, lead, PCB and pathogen contaminations of food and feeds by sludge are presented.

Passage of the Federal Water Pollution Control Act in 1972, which mandated at least secondary treatment of municipal sewage, clearly foreshadowed a huge increase in the amount of sewage sludge for disposal. Management of this sludge disposal has become a problem of growing magnitude and complexity as our population increases, as more and more sewage plants are installed and as a greater number of municipalities accept industrial wastes into their sewage plants.

It must be recognized that there are no simple ways to dispose of or use this material. Disposal in landfills, incineration, ocean dumping and application to productive land, are all methods which pose certain problems.

The Food and Drug Administration recognizes the fact that this sludge must be disposed of, and that one attractive alternative is to use it as a source of water, fertilizer and soil conditioner on productive land. However, one of the overriding public health responsibilities of the Agency is to ensure the safety and wholesomeness of the nation's food supply for humans and animals. The data we have seen show that sludges can contain pathogenic microorganisms, toxic heavy metals, pesticides and industrial chemicals such as the polychlorinated biphenyls (PCBs). For this reason we have welcomed the opportunity to work with EPA and other

agencies to make sure that proper controls are instituted for application of sludge on crops in the human food chain.

We are aware that a certain amount of sludge has been applied to lands for growing crops for years without known harm to consumers. However the acreage involved has been relatively small. Now that many municipalities, including the large industrial metropolitan centers, are interested in application of this sludge to cropland, the possibility of introducing unsafe amounts of residues into foods will increase tremendously. Obviously it is necessary to make certain that contaminants from sludge are kept at a low enough level so that (a) consumers of these foods are not subjected to unnecessary risks and (b) it will not become necessary to withdraw large acreages from food production because of the presence of hazardous levels of contaminants in the soil as a result of unwise application of sludge.

### POTENTIAL FOOD CONTAMINANTS AND ROUTES OF CONTAMINATION

In regard to organic chemical compounds, a number of them, including some pesticides, are refractory, and will either not be destroyed at all in the sewage treatment process, or will be altered. Compounds found most often in sludge are the polychlorinated biphenyls (PCBs) and the chlorinated pesticides.

Less information is available on the levels in municipal sludges of PCBs and chlorinated pesticides than of metals or microorganisms. The currently available data on these products (8,10,11,12,13,23) are summarized in Table 1. PCBs have been found in dried sludges at levels up to 352 parts per million. The chlorinated pesticides were found at lower levels. There is great need for more up-to-date and extensive data on PCBs and chlorinated pesticides in sludges.

Plant studies have shown that edible parts of plants contain residues of these organics, but only at 5 to 20% of the levels in the soils. Generally, root crops take up more chlorinated organics from the soils than other crops.

TABLE 1. Pesticide and PCB content (ppm), dry sludges.

Contaminant	Range		Sludges
	Min.	Max.	
Aldrin <sup>1</sup>	ND	16.2	5
Dieldrin <sup>2</sup>	ND	2.2	40
Chlordane <sup>3</sup>	ND	32.2	34
DDT + DDD <sup>4</sup>	ND	1.1	26
PCBs <sup>5</sup>	ND	352.0	116

<sup>1</sup>Examined in 1971.<sup>2</sup>Examined in 1971, 1972, 1973, 1976.<sup>3</sup>Examined in 1971, 1977.<sup>4</sup>Examined in 1971, 1976.<sup>5</sup>Examined in 1971, 1972, 1973, 1975, 1976, 1977.

However, some studies have shown that heptachlor, dieldrin and chlordane are translocated from the soil into soybean plants and stored in the oil of the seed (19). Although the levels found were low, these results do show that the use of sludge can be a means of recycling chemical contaminants back into the plant food supply.

In addition, chemicals and microorganisms can contaminate plants when liquid sludges are sprayed on, or dried sludges are applied directly to the growing crops. Recent information and events have caused FDA to be more concerned about these methods of application. Table 2 summarizes data obtained by Chaney (4) and associates of the USDA, under an Inter-Agency Agreement sponsored by FDA. It can be seen that the dried grass still contained about 5% by weight of sludge when it was mowed 80 days after it had been sprayed with the sewage sludge. In this instance, about 30% of the applied sludge remained on the grass. This is even more surprising when we realize that about 16 inches of rain fell during this period. The implications for contamination of food and feed crops by microorganisms, persistent chemicals such as DDT and PCBs, and toxic metals are serious.

Direct application of sludges to growing plants obviously concerns FDA with respect to hays, fodder, forage and straw because of the potential for contaminated milk and meat that might result from animals eating such feed. We would expect little of the sprayed sludge to remain on corn or soybean grains; more might remain on wheat. The opportunity for chemical and microbiological contamination would be much greater on leafy crops than on grains.

Another source of sludge contaminants for grazing animals is the direct ingestion of sludge from the soil. It has been estimated that grazing animals ingest soil in amounts ranging from 2 to 14% of their diet (1). Under FDA and EPA sponsorship, Colorado State University/

TABLE 2. Sludge retained by forage after direct application.

Days after application	Sludge content of forage, % Dry weight	
	Sludge application 0.5 cm.	Sludge application 1.0 cm.
0	24.4	31.5
14 <sup>1</sup>	16.7	22.1
80 <sup>2</sup>	5.5	4.0

<sup>1</sup>Rainfall, 27 cm. (10.6 in.).<sup>2</sup>Rainfall, 41 cm. (16.2 in.).

Metro Denver have fed Denver sewage sludge to cattle as part of their regular diet, to simulate physical ingestion of sludge. There were no detectable levels of chlorinated chemicals in the drinking water. The levels of chlorinated residues in the fat, as reported by Kienholz, et al. (16), are shown in Table 3. It can be seen that the levels of the chloro-organic residues in the sludge used were low. The highest contaminant level found was 2.60 ppm of PCBs. There was a significant increase in concentration of p,p'-DDE, dieldrin and PCBs in the fat of the cattle which were fed sludge.

TABLE 3. Levels of organic contaminants (ppm) in fat of cattle fed sludge.

Product	Levels in sludge	Level in fat	
	Dry weight	0% Sludge in diet	11.6% Sludge in diet
HCB	0.01	T	T
$\alpha$ -BHC	ND	T	T
Lindane	0.05	T	T
$\beta$ -BHC	ND	ND	T
Oxychlordane	0.09	T	T
TNC	ND	T	1
p,p'-DDE	0.05	T	0.06
Dieldrin	0.10	T	0.04
PCBs	2.60	T	1.00

In 1975, milk from a cow grazing on pasture to which the farmer had applied dry sludge obtained from Bloomington, Indiana was found to contain 5 ppm PCBs in the milkfat. This was double FDA's temporary tolerance of 2.5 ppm PCBs in the fat of milk and the farmer immediately quit using the milk until the situation could be rectified. He was understandably worried, since his family, including a child, had been drinking this milk.

From the standpoint of the general consumer, it was fortunate that his was a one-cow family operation, and not a 50-cow dairy herd. However, this was of small comfort to the farmer and his family. The Bloomington incident, plus the available data on the amount of sprayed sludge remaining on grass, indicate why FDA's concern with the practices of applying either dry or sprayed sludge directly on growing crops is more than academic.

Incidentally, the Food and Drug Administration has recently proposed lowering the tolerance for PCBs in milk fat to 1.5 ppm, because data developed since 1973 show that they are more toxic than had been previously assumed.

The tolerances for residues of pesticides, which are established by EPA and enforced by FDA, are published in the Code of Federal Regulations — pesticides in or on raw agricultural products in Title 40, part 180, and pesticides in processed animal feeds in Title 21, part 561 (6, 7). The tolerances for PCBs in foods and animal feeds are published in Title 21, part 109 (5). A compendium of tolerances, action levels, administrative guidelines and pending tolerances for pesticides has been published by Pesticide Chemical News (21).

These sources of regulatory information will show what levels of these contaminants in various foods and feeds give EPA and FDA cause for concern. It should be pointed out that pesticide tolerances are established by EPA for food or feeds where residues result from approved applications. However, if a pesticide residue occurs on or in a crop because of application of sludge, these pesticide tolerances would not apply, and it would be necessary for EPA to establish tolerances, or for FDA to set action levels for the resulting pesticide residues. Likewise, it would be necessary for FDA to establish action levels or tolerances for residues of other environmental contaminants such as PCBs, lead and cadmium which occur in raw agricultural products as a result of sludge application.

With the exception of red meat and poultry, which are monitored by USDA, FDA monitors agricultural products in interstate commerce for pesticides and other contaminants. Additionally, the individual States monitor agricultural products in intra-state commerce.

With regard to microorganisms, FDA microbiologists are concerned that use of pathogen-containing sewage on land and crops will cause public health problems. In a study carried out by the Agricultural Research Service of USDA (3) and sponsored by FDA, sewage sludges from 21 Pennsylvania cities were examined for the presence of ascaris ova (worm eggs) and *Salmonella* bacteria. These pathogens were present in all samples. Further investigations showed that the ova in many of these sludges were viable. These eggs are extremely hardy in the environment. Data in the literature indicate that they can survive for at least 3 years in the soil.

*Mycobacterium tuberculosis* and other bacteria are also cause for concern in sludge-treated crops. In addition, the complex question of transmission of human viruses remains to be resolved.

At this time, cadmium and lead are the metals in sludge that present the greatest hazard to the safety of the food supply. They are both found in all municipal sludges. The lead levels have reached around 5000 ppm in the dried sludge, with 50% of the sludges containing lead at a level below about 600 ppm. Cadmium concentrations of up to about 1000 ppm in the dried sludge have been reported, with 50% of the sludges containing cadmium at a level below about 20 ppm. Studies have shown that many plants, particularly grains, legumes and leafy vegetables, take up cadmium quite readily from the soil. On the other hand, lead is much less readily translocated from the soil to edible portions of plants.

Kidney and liver are important organs in the accumulation of cadmium and lead in animals. Data reported by various investigators show significant uptake and accumulation of cadmium and lead from sludge by kidney and liver of animals and fowl (14,16,17,20,24).

This uptake may occur when animals are allowed to graze on sludge-treated pasture and thereby ingest (a) sludge with soil directly; (b) sludge adhering to

vegetation, from overhead sprays or direct application of dried sludge; and (c) vegetation which had taken up increased levels of contaminants from the sludged soil. Tissues other than liver and kidney also show large percentage increases in cadmium and lead contents, but the absolute concentrations are much lower, except for bones, which store lead readily.

The establishment of regulatory levels for toxic metals in foods is complicated by the fact that they are all present in the earth's crust, and therefore occur naturally in foods. Thus, FDA must develop an accurate estimate of the levels of the particular metal in the whole food supply, including the major agricultural products, to establish regulatory levels for that metal in specific foods, where appropriate.

FDA has attempted to estimate more accurately the average daily intake of cadmium and lead by a teen-age male, the heartiest eater in the U.S. For this purpose, we have combined the analytical results obtained for levels of these metals in 12 composites of kitchen-prepared foods in the FDA Total Diet Studies with results of analyses of over 40 foods (9,15). Table 4 summarizes the estimated daily intake of cadmium and lead as compared to the proposed tolerable daily intake which was calculated from the tolerable weekly intake proposed by the Food and Agriculture Organization and World Health Organization (FAO/WHO).

TABLE 4. Estimated average daily dietary intake, adults, U.S.

Metal	Abg. concentration in total diet <sup>(1)</sup> (ppm)	Avg. intake (Micrograms/day)	Proposed <sup>(2)</sup> tolerable daily intake (Micrograms/day)
Lead	0.089	254	429
Cadmium	0.025	72	57-71

(1) Including drinking water.

(2) FAO/WHO.

We have estimated the daily dietary intake of cadmium at 72  $\mu\text{g}$  per day. This approximates the total tolerable daily intake proposed by FAO/WHO (22). The estimated margin between a tolerable level and a level that can cause minimal adult kidney damage is not great; however, cadmium levels in the diet would have to be significantly elevated for years for these effects to occur. While there is no evidence that the present cadmium level in U.S. diet poses a health hazard now, prudence dictates that new developments should not be established on a substantial scale that could cause a significant and possibly irreversible increase of cadmium in the food supply. The uncontrolled widespread application of sewage sludge on land should be considered in this category.

With lead, there is some margin between the estimated average dietary intake of 254  $\mu\text{g}$  per day for adults and the tolerable daily intake of about 430  $\mu\text{g}$  per day from all sources proposed by FAO/WHO (22). However, this margin is not sufficient for us to be complacent. An HEW-appointed Ad Hoc Committee has proposed a tolerable daily intake of 300  $\mu\text{g}$  per day from all sources for 1-to-3-year-olds. The daily intake should be lower for

children less than 1 year of age, because of their smaller body size and substantially greater gastrointestinal absorption of lead. Mahaffey (18) has recently proposed that the tolerable daily intake of lead from all sources should be 100  $\mu\text{g}$  per day for infants from birth to 6 months, and the intake should be no more than 150  $\mu\text{g}$  of lead per day for children between 6 months and 2 years.

From data developed at FDA, it is estimated that the average daily dietary intake of lead might vary from around 60 to 115  $\mu\text{g}$  per day for those in the 2-month to 2-year age group (9).

For lead, FDA has given the highest priority to establishing regulatory levels in foods eaten by infants. We already have proposed lowering our guideline of 0.5 ppm of lead in evaporated milk to 0.3 ppm. Other guidelines are being considered for infant formulas (both regular and milk-free), infant foods in both cans and jars, and ultimately adult canned foods that are eaten by infants and toddlers. Obviously, this Agency is particularly concerned about any use of sludge which might cause an increase in lead content in the foods eaten by infants and toddlers.

Data from various sources indicate that uptake of metals by crops is dependent upon many factors, including type of soil, climate, soil pH, organics in the soil, level of contaminant in the sludge and soil, level of application, the crop concerned, and other factors. As a result, it is not possible to say that addition of *W* tons/acre of a sludge containing *X* ppm of contaminant *Y* will result in an increase of *Z* ppm of the contaminant in a given crop. Nevertheless, the data we have seen show that use of sludges on land does cause increases in levels of metals in foods. In some instances the repeated application of a cadmium-containing sludge to soils has caused a significant increase in cadmium content of various products, including soybeans, corn, wheat and certain vegetables. Grains are the types of crops requiring large acreages and are therefore attractive to large metropolitan sewage districts that would like to dispose of their sludge on cropland.

It should be kept in mind that grains and cereal products already supply about 23% of the total cadmium intake to the average diet (2). Therefore, a substantial increase in cadmium content of the grains could result in a significant increase in the cadmium intake from our food supply. The cadmium intake for persons such as vegetarians, family farmers, or home gardeners, whose diet may include a high proportion of vegetables and grains, could be substantially higher. This level would be higher yet if sludge containing a high level of cadmium were used to grow foods they eat.

As stated previously, sufficient data must be developed on the levels of naturally occurring chemicals such as cadmium in a given agricultural product before a regulatory level can be proposed for it in this food item. This in itself can be a complex job if the crop is grown in many different sections of the country. FDA initiated a survey of lead and cadmium in important raw

agricultural products, and including the major grains, in Fiscal Year 1976, and plans to continue it in 1977 and 1978, to aid in establishing appropriate regulatory levels.

#### RECOMMENDED LIMITATIONS ON APPLICATIONS OF SLUDGE TO LAND

In the meantime, we strongly recommend against waiting until FDA establishes action levels for a contaminant such as cadmium in certain foods before corrective actions are taken. FDA regulatory levels for contaminants in certain foods may provide some guidance, but the best way to control a pollution problem is by decreasing the pollution at its source. For example, the fact that FDA first established a level for PCBs in fish in 1970 did not decrease the contamination of fish in many areas, since little was done to control the PCB pollution of the streams and lakes until recently. As a result, the Hudson River, Lake Michigan, Lake Ontario and other rivers and lakes are essentially closed to commercial fishing. It would simply add to the tragedy to see large acreages of land retired from farming as a result of unwise application of high-cadmium sludges to land when FDA does establish action levels.

We realize that deciding on proper limits for contaminants in sludges is complicated because so much can be accomplished by good control and management of the application of sludge to land. However, except for a few projects, the use of sludge on cropland is inadequately controlled, nor is there assurance that a municipality will continue a proper system of control into the future, even if one has been established. Consequently, to protect the public health, FDA has recommended the following limitations on application of sludge to land used to grow human and animal food:

- (a) sludges should not contain more than 20 ppm cadmium, 100 ppm lead or 10 ppm PCBs on the dry basis;
- (b) in support of the limits proposed by the W 124/NC 118 Committees of Land Grant Colleges, the maximum total which should ever be added to an average soil (cation exchange capacity of 5-15) is 9 lb. of cadmium/acre and 900 pounds of lead/acre;
- (c) crops which are customarily eaten raw should not be planted within 3 years after the last sludge application;
- (d) crops such as green beans, beets, etc. which may contaminate other foods in the kitchen before cooking should not be grown on sludge-treated land unless the sludge gives a negative test for pathogens;
- (e) because sewage can be regarded as filth, food physically contaminated with sludge can be considered adulterated even though there is no direct health hazard; hence, sludge should not be applied directly to growing or mature crops where sludge particles may remain in or on the food;
- (f) commercial compost and bagged fertilizer products derived from sludges should be labeled properly to minimize any contamination of crops in human food

chain which may result from their use.

Possible exceptions to the maximum levels of cadmium and lead allowable in sludges might involve carefully controlled and monitored use of sludge in which total and annual application rates of the sludges and toxic metals are carefully limited.

### CONCLUSION

We believe the best way to minimize the hazard from application of sludge to crops in the human food chain is to control the levels of chemical contaminants in the effluents the sewage plants receive from industrial sources and to control pathogens by proper operation of the sewage plant.

FDA recognizes that many sludges exceed the contaminant levels recommended in this paper, and that the industrial contributors to municipal sewage plants of some of the heavy metals, especially cadmium, may say that it is economically impossible for them to decrease concentrations in their effluents to the necessary levels. There were similar cries of alarm when agencies proposed drastically lower levels of mercury in effluents, of vinyl chloride monomer in PVC, and of PCBs in effluents. Yet, once the goals were defined, industry was able to achieve these lower levels without causing the predicted widespread plant closings. The capabilities of our chemists, chemical engineers and sanitary engineers should not be underestimated. History has shown that once they are given the responsibility of solving a challenging problem, they often achieve results that were thought to be impossible technically and economically.

In conclusion, FDA appreciates the difficult and complex issues of sludge management that confront us. However, we believe that the issues raised by FDA are not insurmountable, and that through the continued cooperative efforts of all of us, we can accomplish our respective goals.

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# Microbiological Criteria for Food<sup>1,2</sup>

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## ABSTRACT

Microbiological criteria can be separated into standards, guidelines and specifications. These criteria are applied to reduce potential health hazards associated with foods and to evaluate food quality. Microbiological criteria must be realistic, enforceable and consistently applied. In fulfillment of their responsibilities to consumers, both regulators and food purveyors will continue to improve and to establish new microbiological criteria for food.

Since the discovery by Pasteur and others of the role of microorganisms in disease, man has taken strides to preclude, destroy and/or prevent multiplication of microorganisms in food supplies. The dramatic reduction, since the turn of the century, in foodborne diseases resulting from pasteurization of dairy products and establishment of microbiological criteria for dairy products has stimulated interest in microbial criteria for other food items. This interest has been stimulated in part by increased consumer awareness, the desire by regulatory agencies to insure wholesomeness and quality of food and industry efforts to market consistently high quality wholesome food with a long shelf-life. Controversy among consumer groups, regulatory agencies and industry exists regarding several issues. To what foods should criteria be applied? What organisms or groups of organisms should be used as indicators? What maximum number of microorganisms can be accepted? Are enumeration methods suitably precise and do the prescribed criteria fulfill the intended purpose? This report is intended to present an update on the current status and philosophy of microbiological criteria for foods.

## TYPES OF CRITERIA

Microbiological criteria include standards, specifica-

tions and guidelines which are defined as follows: (a) A microbiological standard is a law or administrative regulation designating the maximum number of microorganisms acceptable and/or the types of microorganisms present in a food as determined by prescribed methods. A microbiological standard is enforceable through civil or criminal courts. (b) A microbiological specification is a contractual agreement, usually between a buyer and a seller, which defines acceptable products from a bacteriological standpoint. Specifications should address the maximum number of microorganisms or type of microorganisms as determined by prescribed methods. (c) A microbiological guideline designates the same requirements as a standard but has no legal status; hence it is not enforceable. Federal regulatory agencies generally prefer the use of standards as criteria because of the provisions for enforcement. They view guidelines as useful only as a transitional step toward establishment of standards (4). State and local regulatory agencies generally prefer the guideline approach and look to Federal agencies for establishment of information upon which to base criteria (5). In addition, state and local agencies usually lack the resources and jurisdiction to properly develop and enforce national standards. Industry lacks the authority to impose legal standards, thus to protect economic interests and reputation, industry frequently relies on microbiological criteria in the form of specifications for food items purchased.

## FOODS THAT NEED CRITERIA

Food classes requiring microbiological criteria can be separated into two categories: (a) items that present a potential health hazard, and (b) items that may suffer a reduced shelf-life and lower quality but present no health hazard. The International Commission on Microbiological Specifications for Foods (ICMSF) (1) has devised a scheme in which the type of health hazard and the conditions of use associated with a product are evaluated

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<sup>2</sup>The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense.

into 15 levels of health hazard severity. Conditions of use are considered from the standpoint of whether the degree of hazard is reduced, unchanged, or increased. For instance, dried whole-egg used in food to be cooked before consumption would result in reduced hazard. If consumed immediately after reconstitution, dried whole-egg would not alter the risk; however, the hazard would increase for foods that were reconstituted and not cooked within a significant period before consumption.

The types of health hazards considered by the ICMSF (1) are: (a) *None* - Reduced shelf-life, i.e., aerobic plate count (APC) (levels 1-3); (b) *Low* - Non-pathogenic indicator organisms - i.e., coliforms (levels 4-6); (c) *Moderate* - Limited potential for secondary transmission - i.e., *Clostridium perfringens*, *Staphylococcus aureus* (levels 7-9); (d) *Moderate* - High potential for secondary transmission - i.e., *Salmonella* (levels 10-12); and (e) *Severe* - Possible death - i.e., *Clostridium botulinum* (levels 13-15).

By using this method for classifying the degree of health hazard, an agency or industry can establish criteria consistent with its needs. Obviously, more stringent microbiological criteria are applied to foods with a high potential to present moderate or severe health hazards than applied for the purposes of ensuring an ideal product shelf-life.

#### ESTABLISHING CRITERIA

Whether or not microbiological criteria are intended to ensure consumers of either shelf-stability or wholesomeness of a product, factors involved in the establishment of criteria are similar. Sampling, storage, shipment of samples and laboratory methodology must be standardized and give reproducible results. There must be a positive correlation between shelf-life and wholesomeness for microbiological criteria to be relevant. For example, a high aerobic plate count (APC) of a cured salami does not adversely affect shelf-life, whereas a high APC of freshly ground beef probably indicates limited shelf-life. Similarly, in certain food items, high fecal coliform counts correlate with poor sanitary conditions, thus increasing the possibility of the food being unwholesome.

Criteria in general, and standards in particular, must be administratively feasible. In other words, can an agency enforce the standard effectively? The penalty for noncompliance with microbiological standards also must be realistic and relevant to the offense. Producers suffer economic and adverse publicity for violations and penalties considered too severe may contribute to standards being rescinded (2).

Considerable criticism has been voiced, particularly from industry, of the use of pass/fail microbiological criteria. The question is often posed, "Why is a product with an APC of 9,999,999 acceptable but one with

10,000,001 unacceptable?" Criteria recently have been devised to eliminate this criticism (1). Rather than a product being judged either acceptable or unacceptable, a third category, marginally acceptable, has been added. A sampling plan is established that specifies the following: (a) number of samples to be examined -  $n$ ; (b) maximum number of microorganisms that are tolerable -  $m$ ; (c) maximum number of samples that can exceed  $m$  without declaring the lot unacceptable -  $C$ ; and (d) maximum number of microorganisms any one sample can contain without causing the lot to be unacceptable -  $M$ . Any lot having one or more, but fewer than  $C$ , samples exceeding  $m$  is considered marginally acceptable. The marginally acceptable category alerts regulatory and quality control personnel to investigate and rectify the cause of the high microbial counts. This scheme provides for rejection of a product if the microbial count from one sample is excessively high, the sample contains potentially hazardous microorganisms, or if the number of samples with counts exceeding  $m$  is greater than  $C$ . The ICMSF and Canadian authorities are developing microbiological criteria utilizing this three class acceptance system (1,3). It is likely that many regulatory agencies also will adopt this type of microbiological acceptance system (5).

In addition to consumer, economic and health considerations, microbiological criteria also must consider the capability of industry to consistently produce products in compliance. A basic knowledge of food production, food microbiology and statistics, supplemented with extensive data relative to the normal microbial content and load of the food are required to establish realistic criteria.

Microbiological criteria must be routinely and consistently enforced. Periodic enforcement is ineffective in improving either shelf-life or wholesomeness and tends to be viewed as harassment by producers. Collection of samples should be coordinated with sanitary inspections of the processing and handling facilities. A deliberate effort to provide sanitary handling at every step of production is necessary to produce food of minimal microbiological populations.

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## Delayed Chilling of Beef — A Review

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### ABSTRACT

Tenderness of beef can be influenced by various factors. Biochemical changes undergone by the components of muscle during the various stages of rigor mortis influence tenderness of the muscle. One of these changes, the "cold shortening" involved in contraction of muscle, has a particularly strong effect on tenderness. Factors such as relative rates of chill and delay-chill, post-mortem drop in pH and cold storage treatments have a tenderizing effect on beef.

Variation in tenderness of meat exists not only between anatomically different muscles but also between corresponding muscles from animals of the same or different species, and is influenced by both pre-slaughter and post-slaughter conditions. A great deal of research has gone into establishing the effects of pre-slaughter factors such as species, breed, age, sex, nutrition, and exercise and of post-slaughter treatments such as aging (i.e., prolonged storage at temperatures above freezing) and freezing.

Structurally, striated muscle can be regarded as being made up of a fibrillar component responsible for contraction and relaxation of the muscle and a connective tissue component which holds the fibers together and attaches the muscle to the skeletal section. It was believed that the quantity and strength of the connective tissue solely determined the toughness of the meat (12). However, changes in the myofibrillar component during the period between slaughter and the full development of rigor mortis can markedly influence the tenderness of the resulting meat.

One of the earliest observations showed that tenderness was influenced by pre-rigor changes. Muscle cut or excised soon after slaughter was tougher when rigor mortis had developed than uncut muscle which had gone into rigor mortis on the bone (17). Another was that meat cooked soon after slaughter was more tender than meat cooked soon after development of rigor mortis (18).

Therefore the objective of this paper is to review the chilling effect on the beef in relation to other factors involved in meat quality.

### POST MORTEM SHORTENING

Studies on meat have demonstrated that muscle shortens upon exposure to cold in the pre-rigor state. Such a shortening results in a reduction in tenderness. To avoid the effect of too rapid chilling or "cold-shortening," some studies suggest that the temperature of the carcass must not be lower than 50 F (10 C) during the first 10 h following slaughter. The amount of shortening with ox neck muscle decreases from about 30% at 37 C to 10-15% at 15 C, but increases with further reduction in storage temperature — a phenomenon known as cold-shortening (8).

Marsh and Leet (9) reported that factors affecting tenderness of meat include breed, feeding and management, anatomy, cellular activity, enzymes, chemical changes both analytical and physical, and cooking techniques. Also research has shown that during the first few hours post mortem, components of muscle undergo a series of biochemical changes culminating in rigor mortis, but few reports even mention the temperature at which the experimental material was held during rigor onset, according to Marsh and Leet (9).

There are a few indications, however, that a muscle which has been cut or excised in a pre-rigor condition may be tougher than expected following rigor onset and cooking.

Locker (7) reported that the toughening might be due to a shortening of the muscle during the onset of rigor mortis. This rigor shortening has been studied recently and showed an interesting "cold shortening" phenomenon in which exposure of bovine muscles to near freezing point causes shortening (8).

Wilson et al. (20) obtained evidence favoring a relationship between temperature and shortening and an effect of both on tenderness. He showed that the effect is much greater in the lower (0-15 C) than in the upper (20-43 C) temperature range. In addition, the accelerated aging to be expected at higher temperatures might well

eliminate any toughening produced during rigor onset at an elevated temperature.

Dutson (2) as well as Parrish et al. (13) and other workers have shown an increase in aging temperature to be associated with more rapid tenderization of the bovine carcass.

In the bovine as well as in the ovine carcass, the "cold shortening" problem has been shown to be more severe in the smaller and leaner carcass which chills at a slower rate (10). In view of the influence postmortem shortening exerts on meat tenderness, delayed chilling of the bovine carcass combined with boning out of muscles before chilling are possible alternatives to reduce "processing toughness" (19).

### CHILLING RATES AND TENDERNESS

Will and Hendrickson (19) examined the effect of muscle removal at three delayed chilling periods (3 vs. 48 h, 5 vs. 48 h, and 7 vs. 48 h) and related this to meat tenderness. In their experiments the Warner Bratzler Shear data for three bovine muscles, for the 48-h chill versus 3-, 5-, and 7-h delayed chill boning treatments, are shown in Table 1. On the other hand, preference tests (Table 2) conducted with panelists yielded no significant difference between the chilled BF, LD and SM samples and those of the delayed chill process.

TABLE 1. Warner Bratzler shear (kg) measurements of 3.5 and 7 vs. 48-h treatments from biceps femoris (BF), longissimus dorsi (LD) and semimembranosus (SM) muscles.<sup>1</sup>

Process treatment	n	BF	LD	SM
A Chill (48 h)	72	7.87 <sup>a</sup>	6.41	8.89
Delay chill (3 h)	72	6.22 <sup>a</sup>	6.89	8.74
B Chill (48 h)	72	6.01	6.28	8.62
Delay chill (5 h)	72	6.44	6.68	9.06
C Chill (48 h)	72	7.15	6.17	8.99 <sup>b</sup>
Delay chill (7 h)	72	6.53	5.42	9.81 <sup>b</sup>

<sup>1</sup>By Will and Hendrickson, 1976. J. Food Science 41:1102.

<sup>a,b</sup>Denotes significant difference at P < 0.01; no superscript denotes no significant difference.

TABLE 2. Preference rank analysis for the BF, LD, and SM muscles. Higher numerical values denote stronger preferences.<sup>1</sup>

Process treatment	n	BF	LD	SM
Chilled (48 h)	48	1.58	1.56	1.56
Delay chilled (3 h)	48	1.42	1.44	1.44
Chilled (48 h)	48	1.60	1.54	1.62
Delay chilled (5 h)	48	1.40	1.46	1.38
Chilled (48 h)	48	1.58	1.38	1.56
Delay chilled (7 h)	48	1.42	1.62	1.44

<sup>1</sup>By Will and Hendrickson, 1976. J. Food Science 41:1102.

Objective and subjective data led to the conclusion that no major differences in meat tenderness existed between muscle which was boned at 3-, 5-, and 7-h post-mortem and that allowed to remain on the suspended carcass for 48 h.

Bailey and Cox of the Meat Research Institute in

England have studied rates of chilling of beef carcasses of different weights and degrees of fatness in air at different temperatures and velocities (16). They used 200 beef carcass sides weighing 220-250 lb. and differing in the degree of fatness. Their studies show: (a) chilling times were as much as 40% faster for the leanest carcasses as compared to the fattest carcasses considering 308 lb. wt. at 32 F and 0.5 m/sec; (b) fatter carcasses at all weights suffered less from shrinkage during the chilling process than leaner carcasses; (c) there is little advantage in using air velocities above 1 m/sec; and (d) cold-shortening will occur if the temperature reaches 50 F or less within 10 h of slaughter.

Thus, fatness was shown to slow down the chilling process. Reduction in cooling time can best be obtained by small reduction in air temperature. Conditions must be selected that will avoid chilling faster than that rate necessary to avoid cold-induced toughness.

### CONTRACTION AND TENDERNESS

It is known that some relation exists between tenderness in beef and state of contraction of the muscle fibrils (5). The study by Koonz et al. (5) arose from an experiment in which they observed that an excised piece of beef psoas muscle shortened less at 37 C than at 2 C in passing into rigor mortis.

Locker and Hagyard (8) reported that the maximum shortening of 47.7% occurs at 0 C; at 2 C there is little change, but above this there is a very rapid decline with rising temperatures; also the greatest shortening was obtained with muscle of highest initial pH 7.1 (Table 3).

According to Locker and Hagyard (8), the reversibility of the contraction suggests a cold stimulus effect, perhaps related to the response to an electric stimulus, which persists for a similar period. It should be noted that the shortening temperature curve in the Locker-Hagyard experiments differs from the curves of the other experiment. Thus the relation between toughness and contraction suggests that the cold-shortening effect may be of significance in meat processing wherever freshly slaughtered meat is exposed to rapid chilling or freezing.

### STORAGE AND TENDERNESS

Studies on tenderness of beef have shown that beef becomes first less and then more tender with cold storage between slaughter and consumption. On the other hand, freezing has been reported to have a tenderizing action on beef by some workers (3), but not by others (15).

TABLE 3. Effect of delay at 25 C on shortening at 2 C.<sup>1</sup>

Process treatment	Delay time at 25 C			
	1 1/2 h	7 h	9 h	11 h
Shortening at 25 C (%)	3	4	6	15
Shortening at 2 C (%)	45	32	28	16
pH at time of chilling	7.1	6.55	6.5	6.3

<sup>1</sup>By Locker and Hagyard, 1963. J. Sci. Fd. Agric. 14:787.

Paul and Bratzler (14) used eight pairs of longissimus dorsi muscles from prime, good and commercial grade beef, to study the effect of various cold storage treatments on losses and on shear tenderness. They showed: (a) the high correlation between heating time and losses; (b) prime grade steaks were more tender than those from the good and commercial grades; (c) the increase in cold storage tended to minimize the grade difference; (d) removal of muscle from the carcass before or during storage, or cutting of the muscle on the carcass, resulted in less tender steaks than those aged on the carcass; and (e) additional cold storage after 3 days aging on the carcass increased the tenderness.

**pH AND TENDERNESS**

It has also been reported that beef is least tender when the ultimate pH is about 6.0 and increases in tenderness as the ultimate pH increases above or decreases below this value (12). In contrast, the tenderness of rabbit (11), sheep (1) and fish (4) has been shown to be greater with higher ultimate pH. The rate of pH decrease can vary among different muscles from individuals of the same or different species (6). In the living animal the pH of resting muscle is about 7.3. It is known that the post-mortem decrease in pH is the result of production of lactic acid from glycogen. Thus it is clear that the extent of the pH decrease may depend on the amount of glycogen present in the muscle at the time of slaughter. The glycogen content can be reduced by starvation, exhausting exercise, imposition of pre-slaughter stresses of various sorts, or by struggling at time of slaughter (6).

**CONCLUSION**

Even though rapid chilling rates reduce the eating quality of the meat, they may be advantageous to the meat industry by improving yield, hygiene, and weight loss. Processing methods should be aimed at minimizing post-mortem shortening which affects tenderness and attention should be given to conditions applied during the period between slaughter and the full development of rigor mortis.

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## *A Field Topic*

### Fieldmen: Planning Their Work

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#### ABSTRACT

Most milk producers, co-op leaders and plant managers feel their fieldmen are doing a good job. The fieldman's basic job is as the milk plant's personal contact with its member producers. The fieldman's basic reasons for contacting member producers include: milk quality, Grade A and Manufacturing Grade milk requirements, flavor control, dairy farm building plans, milking equipment installation, herd health, sales and financial arrangements for purchase of equipment, member relations and dealing with members's problems and complaints. The fieldman also works for his milk plant in procurement of new members, hauler relations, membership meetings, administration and record keeping, and cooperating with sanitarians. Along with the foregoing, fieldmen must maintain proper personal habits in dress, vocabulary, smoking and driving. There have been too few rewards given these industry ambassadors, who must fill the varied roles of troubleshooter, psychologist, sanitation specialist and salesman. In the interest of energy conservation and driving time, a daily plan of farm calls in a given area should be worked out by the fieldman. Most fieldmen can best work out their own plan of work, taking into consideration location of the farm and urgency of calls to be made.

Speaking from personal experiences as a fieldman, I can tell you a fieldman could manage his time much more efficiently if he were not frequently called upon to do unscheduled jobs, such as an errand above and beyond the normal call of duty to help a member — or possibly even speak at an annual meeting!

I tried to enlist the aid of a ghostwriter for this discussion, but was told, if a fieldman has a difficult or undesirable task to do, he should get it done — not procrastinate in

the hope it will go way.

But, back to the unscheduled jobs requested of a fieldman, which throw the routine out of whack. It is more worthwhile to help out a producer in a pinch and keep his goodwill than to keep a rigid daily routine.

Each request for help must be considered, however, to see if you are being moved into the position of an errand boy for the possible benefit of one producer and neglect of others.

Surveys indicate most milk producers, co-op leaders, and plant managers think their fieldmen are doing an excellent job. In my opinion, there have been too few rewards given these dairy industry ambassadors, who must fill varied roles as psychologists, sanitation specialists and salesmen.

But, despite the fact the professional receives far too little public acclaim, is often underpaid, works long hours and is continually on call, he has set an enviable pattern for dedication, integrity, and concern for his clientele. In a study of attitudes toward their jobs, most fieldmen indicated they enjoyed their work and liked working with people.

#### KNOW THE JOB

Since fieldmen work with dairy farmers, whose livelihood is production of milk, it is only right to mention that milk is probably the most regulated agricultural product in America today. It involves price supports; standards; health, safety

and environmental regulations; and the list goes on. In many instances, Government regulates the flow of products, sets minimum prices, and makes the rules under which we operate, involving many departments and agencies.

Basically, the fieldman functions as the milk plant's personal contact with its member-patrons. He is the dairy plant's goodwill ambassador to its members, most of the time welcome, but at times not as welcome as he might like to be. There are many reasons for the fieldman to contact the member, but they can be basically categorized as quality, Grade A requirements, flavor control, farm building plans, milking equipment installations, arrangements for purchase of equipment, member relations, dealing with member's problems and complaints. Member relations can include milk price and this can lead to some quite lengthy discussions. More and more interest is developing regarding component pricing of milk. The fieldman must be aware of how this system would affect the paychecks of the producer-members in his working area.

The fieldman must also be active in several other areas, which would include: procurement of new members, hauler relations, membership meetings, administration and record keeping, cooperation with sanitarians — and he must show respect for competitive organizations. He must also maintain proper personal habits and cooperate with fellow employees, fieldmen and others.

Milk quality is by far the main reason there is such a position as dairy plant fieldman. Since this is his main reason for being around, it is very important he be knowledgeable in this field.

There are many tools for the fieldman to use in assisting the producer to produce high quality milk. Among these are the numerous tests done by every dairy plant. The fieldman must be familiar with these tests — raw count, pasteurized count, keeping quality (some refer to this as PI plate count), etc. Any of these can be an indication of the care

given milking equipment. Milk quality standards are more rigid today than those of a decade ago, because of longer shelf life of finished products in today's market place.

Care of milking equipment is very important. No other piece of equipment on today's dairy farm will get a careless operator into trouble faster than a faulty or incorrectly operated milking machine. Lack of proper sanitation will increase the bacteria content and poor operation will contribute to poor udder health, resulting in high leucocyte counts and even sporadic, excessively high, bacteria counts.

Many dairymen do not have a complete understanding of the milking machine's operation. You, as a fieldman, need to be familiar with requirements to give effective advice. The fieldman must be in a position to help the dairy producer set up a cleaning program to be followed after each milking, being certain there are no shortcuts in the cleaning procedure.

The rubber parts used in milking — especially inflations — must have special treatment to remain in good condition. Inflation replacement should be based on number of cow milkings.

So the fieldman must be thoroughly familiar with cleaning and sanitizing compounds and their various uses, and be positive there is an adequate supply of hot water for thorough equipment cleaning. An increasing number of dairymen rely entirely on automated C.I.P. milking systems, so beginning and ending water temperatures are becoming more and more important. An adequate amount of hot water for the wash cycle, with tepid water for the prerinse and final rinse, is a necessity.

Fast cooling of milk in a properly operated bulk tank will sometimes hide the sins of poor cleaning and sanitizing of milk equipment. Also, a tank which is too small can cause quality problems, along with a loss of milkfat from churning before the milk is cooled. So he must be aware of these angles.

Other information available to the fieldman — and which he must know how to use — includes screening tests and direct microscopic readings for somatic cells, indicating mastitis problems in the dairy herd. A cryoscope reading indicates the percentage, if any, of added water. Needless to say, this is becoming an increasing problem in many organizations. An inhibitor test will indicate the presence of antibiotic contaminants in the milk.

An "acid degree value" (ADV) test, done routinely on milk pipeline milkers, indicates rancidity levels. Fieldmen must be thoroughly familiar with pipeline milkers, along with milking management, as related and interrelated to rancid flavor development in milk.

The fieldman must be completely familiar with the Grade A milk requirements for the milk shed in which he operates. Generally, these requirements differ very little throughout the country, except for specific interpretations.

The requirements for production of Grade A milk are spelled out in detail in the Grade A Pasteurized Milk Ordinance (PMO), a publication of the FDA and U.S. Public Health Service. The fieldman must be able to translate and interpret these requirements for members so they can and will maintain a Grade A status — a farm score of 90 or better.

The dairy farm which is clean-appearing on the outside will most likely be the same on the "inside," as outside appearances would usually be indicative of the farmer's overall operation. In most instances, we find such a clean-appearing farm will also produce high quality milk.

Another area where the fieldman must be knowledgeable, or prepared to quickly obtain information, is in construction and building plans. What is acceptable? Many questions arise on various types of barns, disposal systems, and milkhouse plans, and occasionally the fieldman must make suggestions for improving proposed construction or remodeling.

The fieldman must know what is required when milking equipment and bulk tanks are being installed. However, he must avoid involving himself with brand names, unless the equipment under consideration is unacceptable. Of course, the exception would be a dairy plant which is involved in selling and installing a certain brand of milking equipment.

Most herd problems are related to some extent to an inadequate and/or malfunctioning milking system. So it is an absolute must that the fieldman understands how a milking machine works and knows the requirements for an adequate system. The requirements of a milking system installed today are much different from those of a system installed some 10 to 20 years ago.

As milking herds become larger, milking systems also become larger and more sophisticated. It then becomes a must — for the dairyman — that the maintenance on this equipment be done on schedule. The idea of preventive maintenance is beginning to take hold, but it is safe to say milking equipment, as a whole, is still the most neglected equipment on many dairy farms. A properly functioning system can be neglected but temporarily appear to perform adequately. However, wear and the effects of neglect are progressive, and eventually the time comes when such neglect takes a heavy toll in the dairyman's milk check.

The fieldman must know about herd health, especially in all areas relating to causes and control of mastitis. He must make use of tools and testing devices, as they can tell him a great deal and be an aid in educating the dairyman. The use of a strip cup and CMT or MQT cowside tests are important in detecting problem cows.

Some dairy organizations have made laboratory facilities available for culture of producers' samples to identify specific types of infection. Knowing and working with veterinarians improves relations and further aids understanding of herd health problems. Another "must"

which cuts into the fieldman's "off" hours, is milking time calls. This is the only way to find the cause of some problems. A milking time call can tell you in short order if the dairyman knows how to milk a cow. This may sound like a bold statement, but many people who are milking cows do a very poor job — especially in properly preparing the cow.

Proper milking must be coordinated with milk let-down process of the cow. It is necessary to be somewhat familiar with the internal structure of the udder and how milk is actually made, to understand the significance.

The problem of antibiotics in the milk supply seems to require more and more of the fieldman's attention and time. This situation always involves unscheduled extra time, miles, sampling, explaining, testing and usually retesting, a great deal of tact, hopefully, along with the possible loss of milk by the dairyman or plant — or sometimes both.

Processors cannot make cheese and cultured products from antibiotic milk because desirable bacteria will not grow, nor, are antibiotic residues acceptable in any milk, whether for fluid or manufacturing use. The milk from just one cow treated with 100,000 units of penicillin can cause detectable residues in the milk from 1000 untreated cows.

Lack of communication is perhaps the most common cause of antibiotic-contaminated milk. A study reported 40% of accidental adulterations occurred in this manner. It is extremely important to follow label instructions for dosage and withdrawal time, along with proper identification of all treated cows so anyone concerned with the milking operation will know which cows should not be milked in the routine manner.

Most dairy organizations have set up very specific, rigid procedures with regard to milk found to contain antibiotic adulterants. Also, many milk plants offer some compensation for milk which must be discarded on the farm due to such accidental

contamination of the supply, but only, and I repeat, but only, if the producer notifies his milk plant or lab so a sample can be tested before the milk is picked up by the hauler and commingled with the load. Many milk plants are not paying producers for milk which is found to contain antibiotic adulterants.

Many milk plants are involved in financing or assist in arranging financing for dairy and related equipment, such as bulk tanks, pipeline milkers, standby power generators, etc., for their members. So the fieldman becomes involved in setting up the necessary paperwork for the purchase of such equipment by the producer.

#### ASSISTING PRODUCERS

Again, member relations is an all-important segment of a fieldman's plan of knowledge for keeping producers and haulers posted on association affairs. It is important to work closely with haulers, since most haulers have the closest and most frequent contact with members. A conscientious hauler is invaluable to the fieldman in performing effective field work with dairymen. Haulers should be consulted often, and fieldmen must be aware of the hauler's needs and problems. The purpose and function of the organization the fieldman represents should always be kept before the membership.

Fieldmen must be prepared to discuss and assist in solving producers' problems and complaints. These can include malfunctioning equipment, possible errors on milk weights and checks, insect and pest control, and information on approved fly sprays and spray materials for various areas of the dairy operation.

Uppermost on the list of producers' complaints would be milkfat test variations. There are many, many reasons for these variations, but it is important to know the relationship is a complicated process.

Breed and inheritance play major roles in the milkfat production of a dairy animal. The types of feed,

preparation of feed, forage quality, and more important, the ratio of forage to grain, may have individual and combined effects which may cause milkfat tests to be below what are considered the normal inherited levels.

Cooperation with sanitarians needs the fieldman's attention. Fieldmen must work with sanitarians to help members meet regulatory requirements and maintain a satisfactory rating, and, in turn, strive to make a uniform interpretation of the PMO.

Show respect for competitive organizations — they will always be around. It is well to keep on speaking terms and learn to live with such people. One should not make the practice of "running down" the "other guy."

Along with all the previously mentioned items of performance which affect how the fieldman plans his work, he must maintain proper personal habits. His vocabulary must be kept clean, and smoking habits must always be respectful of others. A proper image goes a long way in establishing a good working relationship with the producers. Important in creating this proper image are personality, individual mannerisms and character.

A smile is contagious. Sometimes the success of your call at the farm starts when you get out of the car. In the case of being new in an area, possibly a new producer, or a prospect, make certain you have the dairyman's name correct. A man's name is the dearest and sweetest sound to him. In talking to a dairyman, don't say, "I was just driving by." It tends to make the dairyman or prospect feel unimportant. Don't gossip. In speaking, stand close to the individual you are talking to, but not rubbing noses or bellies. Proper individual mannerisms are important. Fingers can be used to point out items of importance, but never at an individual.

Two practical items often overlooked in public relations are "Garb and Gab." Dress according to the occasion; obviously social calls and

service calls require different "duds." Clothing should be conservative enough for the roles of troubleshooter, communications specialist, and company ambassador; yet, should show enough style so you will not appear "behind the times."

The "gift of gab," we are frequently told, is the key to success in our professions. Yet rarely are we good listeners. We seem to live in a world where it is mistakenly believed a true leader is one who babbles continually and is able to dominate every situation. It is important to be humble and sociable — not overbearing. It is equally important to tell the truth, and if you don't know, conscientiously say so.

The discerning fieldman recognizes the problems, attitudes and feelings of the producers by being a good listener. He recognizes there can be two sides to every problem, and looks at both sides.

He is able to "read between the lines" and sense any innate hostilities or suppressed criticisms. With this in mind, he can respond with tactful speech that is "seasoned." His suggestions for solving problems will then be more palatable.

Psychologists tell us there is great therapeutic value in airing problems with one who is sympathetic and understanding. Accordingly, it seems producers would be more inclined to follow the suggestions of those who have a sympathetic ear.

The fieldman's car should be kept in a clean and orderly appearance. I've heard comments about the fieldman who tells the dairyman how to get things shaped up around the farm, and then drives off in a dirty

car in which everything, including his supplies and records, is a mess. Good driving habits for safety and to avoid criticism and accidents are also essential.

The fieldman is expected to and should participate in dairy-related organizations, such as the local fieldmen's association and sanitarians' association, and he can now participate in the IAMFES. Such organizations give dairy fieldmen an opportunity to improve their image, professional stature and technical knowledge of subjects related to their work. He should subscribe to *and read* appropriate periodicals, such as *Hoard's Dairyman*, and other farm magazines to keep up-to-date on present and new technology related to dairy farming and milk production. All of this makes him better qualified for his job. As a general rule, education is a commodity we all seem to try to get the most out of for the least input.

#### PLANNING WORK

In all of the previous comments, nothing has been mentioned about how to actually plan day-to-day work. The active, energetic, hard-working fieldman is in the best position to determine his own monthly, weekly and daily work plan.

Different organizations have different job outlines — and probably give certain goals or procedures. The locale in which he works and type of producers he serves also have a bearing on how the fieldman schedules his work.

Today dairy farmers account for only about 0.1% of America's popu-

lation. The distance between active dairy producers becomes longer. In the interest of energy conservation and making the most of his time, a daily plan of farm calls in a given area should be outlined so a minimum amount of time and miles will be expended in driving. The conscientious fieldman will not waste his time or the time of his dairy farm constituents.

#### IN SUMMARY

In summary I would like to say, "public relations" holds all of this together. Public relations is selling yourself by being interested, optimistic and enthusiastic about the job at hand — being informed on all aspects of milk, the industry, and your organization.

We are all more alike than we are different. The little difference is attitude. The big difference is whether it is positive or negative. Successful people make a habit of doing things unsuccessful people do not do. Your public relations approach is essential in helping the producer understand what his association stands for, and your assistance is needed to help him operate more effectively, and that association policies are made in the interest of the members, and benefits to the association are reflected back to the producer-member. Remember, the fieldman is the organization's contact with its producer-members.

#### ACKNOWLEDGMENT

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Transflow tubing cleans quickly and thoroughly. Its inner bore — smoother than rubber tubing and stainless steel pipe — leaves no place for butterfat or milkstone to accumulate. And because Transflow tubing is clear, you can **see** that it's clean and residue-free.

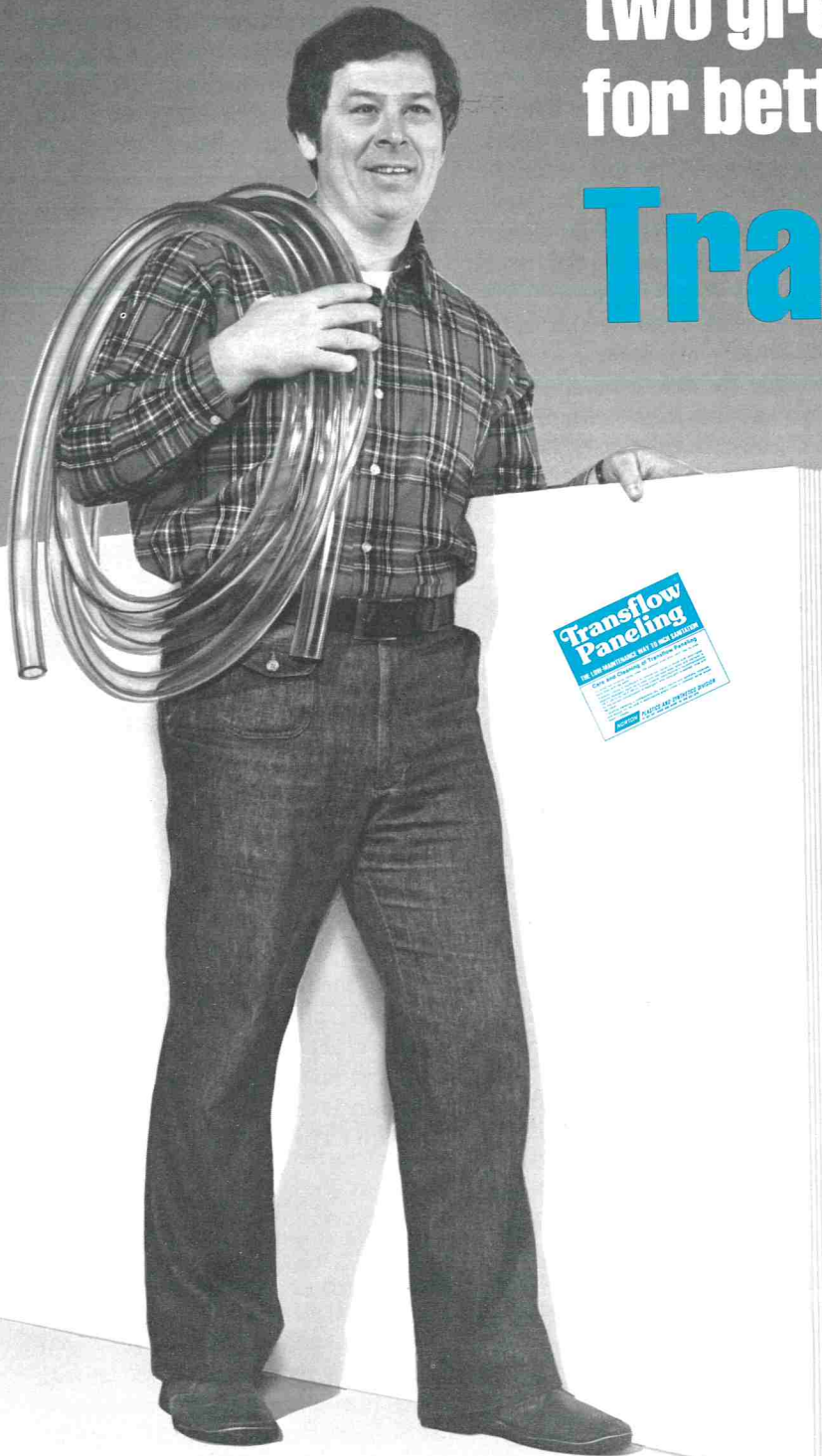
Insist on genuine Transflow M-34R tubing, which complies with FDA and 3-A standards. Just look for its distinctive blue strip.

## Transflow<sup>®</sup> paneling

The Transflow paneling system is fast gaining a reputation as the premier wall and ceiling covering for dairy operations.

The system — panels, moldings and connectors — installs easily with no special tools. Transflow panels are built tough to withstand repeated cleaning, yet stay bright and new-looking for years. They inhibit mold growth, require little maintenance, and never need painting. Like Transflow tubing, Transflow paneling meets FDA and 3-A standards.

Don't accept substitutes — choose Transflow paneling for your operation. When Transflow paneling goes up, maintenance goes down.



33-132

**Transflow Hot-Line:**  
**1-800-321-9634**

Want more information on Transflow tubing or paneling? Call us toll-free and we'll give you the whole story. Ohio call collect 216-633-3224.

**NORTON**

**PLASTICS AND SYNTHETICS DIVISION**  
P.O. BOX 350 AKRON, OHIO 44309 TEL: (216) 633-3224



## 3-A Sanitary Standards For Pressure and Level Sensing Devices

Number 37-00

*Formulated by*  
*International Association of Milk, Food and Environmental Sanitarians*  
*United States Public Health Service*  
*The Dairy Industry Committee*

It is the purpose of the IAMFES, USPHS, and DIC in connection with the development of the 3-A Sanitary Standards program to allow and encourage full freedom for inventive genius or new developments. Pressure and level sensing device specifications heretofore or hereafter developed which so differ in design, material and construction, or otherwise, as not to conform to the following standards but which, in the fabricator's opinion, are equivalent or better, may be submitted for the joint consideration of the IAMFES, USPHS and DIC at any time.

### A.

#### *SCOPE*

#### A.1

These standards cover the sanitary aspects of elements used on milk and milk products equipment for sensing pressure and/or product level.

#### A.2

In order to conform with these 3-A Sanitary Standards, pressure and level sensing devices shall comply with the following design, material and fabrication criteria.

### B.

#### *DEFINITIONS*

#### B.1

*Product:* Shall mean the milk or milk product, inert gas, air, vapor, or steam that is in contact with or flows over the milk or milk product.

#### B.2

#### *SURFACES*

#### B.2.1

*Product Contact Surfaces:* Shall mean all surfaces that are exposed to the product, or from which liquid may drain, drop, or be drawn into the product.

#### B.2.2

*Non-Product Contact Surfaces:* Shall mean all other exposed surfaces.

### B.3

#### *Mechanical Cleaning or Mechanically Cleaning:*

Shall denote cleaning, solely by circulation and/or flowing chemical detergent solutions and water rinses onto and over the surfaces to be cleaned, by mechanical means.

### C.

#### *MATERIALS*

#### C.1

Product contact surfaces shall be of stainless steel of AISI 300 series<sup>1</sup> or corresponding ACI<sup>2</sup> types (See Appendix, Section E.), or metal which under conditions of intended use is at least as corrosion-resistant as stainless steel of the foregoing types, and is non-toxic and non-absorbent, except that:

#### C.1.1

Rubber and rubber-like materials may be used for probe insulators, probe holders, gaskets, diaphragms, coatings and coverings, and parts used in similar applications.

#### C.1.2

Rubber and rubber-like materials when used for the above specified applications shall comply with the applicable provisions of the 3-A standard for rubber and rubber-like materials, Number 18-00.

#### C.1.3

Plastic materials may be used for probes, probe insulators, probe holders, gaskets, diaphragms, bonded coatings and coverings and parts used in similar applications.

#### C.1.4

Plastic materials when used for the above specified applications shall comply with the applicable provisions of the 3-A standard for plastic materials, Number 20-00, as amended.

<sup>1</sup>The data for this series are contained in the following reference: *AISI Steel Products Manual, Stainless & Heat Resisting Steels, December 1974, Table 2-1, pp. 18-19. Available from: American Iron & Steel Institute, 1000 16th Street, N.W. Washington, D.C. 20036.*

<sup>2</sup>*Alloy Casting Institute Division, Steel Founders' Society of America, 20611 Center Ridge Road, Rocky River, Ohio 44116.*

## C.1.5

Rubber and rubber-like materials and plastic materials having product contact surfaces that are a bonded coating or a covering shall be of such composition as to retain their surface and conformation characteristics when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment.

## C.1.6

The final bond and residual adhesive, if used, of bonded rubber and rubber-like materials and bonded plastic materials shall be non-toxic.

## C.2

Materials having a product contact surface (s) used in the construction of pressure and level sensing devices designed to be used in a processing system to be sterilized by heat and operated at a temperature of 250°F (121.11°C) or higher shall be such that they can be (1) sterilized by saturated steam or water under pressure at a temperature of at least 250°F (121.11°C) and (2) operated at the temperature required for processing.

## C.3

Non-product contact surfaces shall be of corrosion-resistant material or material that is rendered corrosion-resistant. If coated, the coating used shall adhere. Non-product contact surfaces shall be relatively non-absorbent, durable and cleanable. Parts removable for cleaning having both product contact and non-product contact surfaces shall not be painted.

## D.

*FABRICATION*

## D.1

Product contact surfaces shall be at least as smooth as a No. 4 ground finish on stainless steel sheets free of imperfections such as pits, folds and crevices in the final fabricated form. (See Appendix, Section F.).

## D.2

Permanent joints in metallic product contact surfaces shall be continuously welded. Welded areas on product contact surfaces shall be at least as smooth as a No. 4 ground finish as described in D.1 above.

## D.3

Product contact surfaces not designed to be mechanically cleaned shall be easily accessible for cleaning and inspection either when in an assembled position or when removed. Removable parts shall be readily demountable.

## D.4

Sensing devices that are to be mechanically cleaned shall be designed so that the product contact surfaces can be mechanically cleaned.

## D.5

Product contact surfaces shall be self-draining except for normal clingage.

## D.6

Connections having product contact surfaces shall conform to the 3-A standard for sanitary fittings, Number 09-07, and/or to the applicable provisions for welded sanitary product pipelines found in the 3-A accepted practice for permanently installed sanitary product-pipelines, Number 605-02.

## D.7

Rubber and rubber-like materials and plastic materials in applications having product contact surfaces that are a bonded coating or covering shall be bonded in such a manner that the bond is continuous and mechanically sound, and so that when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment, the rubber or rubber-like material or the plastic material does not separate from the base material.

## D.8

Gaskets having a product contact surface shall be removable or bonded.

## D.9

Gasket retaining grooves in product contact surfaces shall be no deeper than their width.

## D.10

Internal angles of 135° or less on product contact surfaces shall have radii of not less than 1/16 inch, except where smaller radii are required for essential functional reasons, such as those in sensing devices for high pressure gauges.

## D.10.1

When the radius is 1/32 inch or less, the product contact surfaces of this internal angle must be readily accessible for cleaning and inspection.

## D.10.2

The radii in grooves for standard 1/8 inch O-Rings shall be not less than 1/32 inch.

## D.11

There shall be no threads on product contact surfaces.

## D.12

Pressure and level sensing devices used in a processing system to be sterilized by heat and operated at a temperature of 250°F (121.11°C) or higher shall comply with the following additional criteria:

## D.12.1

The construction shall be such that all product contact surfaces can be (1) sterilized by saturated steam or water under pressure at a temperature of at least 250°F (121.11°C) and (2) operate at the temperature required for processing.

## D.12.2

Devices that have a product surface (s) to be used in such a processing system, not designed so that the system is automatically shut down if the product pressure in the system becomes less than that of the atmosphere and cannot be restarted until the system is reesterilized, shall have a steam or other sterilizing

medium chamber surrounding the joint at the product contact surface between the fitting and the device.

#### D.12.3

The connection (s) on steam or other sterilizing medium chamber (s) for the steam or other sterilizing medium lines shall be such that the lines can be securely fastened to the connection (s). The lines shall be connected in a manner that they may be disconnected to allow the sterilizing medium chamber to be inspected and cleaned if necessary.

#### D.13

Non-product contact surfaces shall be free of pockets and crevices and be readily cleanable and those to be coated shall be effectively prepared for coating.

### APPENDIX

#### E.

#### STAINLESS STEEL MATERIALS

Stainless steel conforming to the applicable composi-

tion ranges established by AISI<sup>1</sup> for wrought products, or by ACI<sup>2</sup> for cast products, should be considered in compliance with the requirements of Section C.1 herein. Where welding is involved the carbon content of the stainless steel should not exceed 0.08%. The first reference cited in C.1 sets forth the chemical ranges and limits of acceptable stainless steel of the 300 series. Cast grades of stainless steel corresponding to types 303, 304, and 316 are designated CF-16F, CF-8, and CF-8M, respectively. These cast grades are covered by ASTM<sup>3</sup> specifications A296-68 and A351-70.

#### F.

#### PRODUCT CONTACT SURFACE FINISH

Surface finish equivalent to 150 grit or better as obtained with silicon carbide, is considered in compliance with the requirements of Section D.1 herein.

<sup>3</sup>Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

These standards shall become effective *Aug 1, 1978*



Dr. John W. Hicks (right) Administrative Assistant to The President of Purdue University presents the 1978 award of merit to James Thompson (left), President of Thompson Dairy, Seymour, Indiana.

### Indiana Outstanding Dairyman of 1978

James Thompson, president of Thompson Dairy of Seymour, Indiana was honored as Outstanding Dairyman of 1978 during a recent Dairy Industry Conference at Purdue University.

The "Outstanding Dairyman Award" is presented to an individual that has distinguished himself/herself in the Indiana dairy Industry. Leadership and significant contribu-

tions are factors considered in polling for the award.

Mr. Thompson was recognized for leadership provided over the past 20 years. He served as president of the old Indiana Dairy Products Association. Currently, he is chairman of the Dairy Advisory Committee for the Indiana State Board of Health and president of the International Association of Ice Cream Manufacturers.

### P. Frigo Elected President of the Whey Products Institute

Mr. Pete Frigo, Frigo Cheese Corporation, Lena, Wisconsin, was elected President of the Whey Products Institute at the Institute's Seventh Annual Meeting held in Chicago on April 26-28, 1978. Mr. Frigo had served as Vice-President of the organization for the past two years, and on its Board of Directors since the Institute was founded in 1971; he also is a member of the Institute's Executive Committee.

Other WPI officers elected were: Gerald J. Treleven, Foremost Foods

Company, San Francisco, California, Vice-President; and Nico van Zwanenberg, Cuba Cheese, Inc., Cuba, New York, Secretary-Treasurer.

### A. H. Kaemmer Elected President of the American Dry Milk Institute

Arthur H. Kaemmer, Galloway-West Company, Fond du Lac, Wisconsin, was elected President of the American Dry Milk Institute at the Institute's Fifty-third Annual Meeting held in Chicago on April 26-28, 1978. Mr. Kaemmer had previously served as Vice-President of the organization, as a member of its Executive Committee, and on a number of standing committees. He has served on the Board of Directors since 1958.

Other ADMI officers elected were: Truman Torgerson, Lake to Lake Dairy Cooperative, Manitowoc, Wisconsin, Vice-President; and R. W. C. Gerland, Rice Lake Creamery Company, Rice Lake, Wisconsin, who was re-elected Secretary-Treasurer.

## Restructing Studies Could Expand Food Supply

If food scientists at the University of Wisconsin-Madison succeed in developing a method of restructuring macerated foods, their work may help increase world food production without sacrificing food quality.

Restructuring foods involved pureeing, treating to produce the desired texture and reforming the foods in a mold.

Despite world food shortages, farmers don't grow some high yield crop varieties because of their undesirable textures. High yield green beans, for example, are often too fibrous to be eaten.

UW-Madison food technologist Daryl Lund believes that the ability to restructure foods would make it possible to transform unpalatable high yield varieties into more desirable forms.

Stored macerated foods can be processed to retain color and flavor much better than foods stored in whole forms. Acid foods such as

tomatoes, which are later used to make catsup, are already stored in macerated form in bulk tanks. Lund thinks a similar storage system could be used to preserve other macerated foods. When the foods are needed, they can be removed from storage and resturctured.

The key to restructuring is finding a way to transform the macerated product into the desired texture. Lund and another foods researcher, Thomas Richardson, are investigating two restructuring methods.

One method does not require a puree. Working with the milk protein kappa casein and gum arabic, a naturally occurring polysaccharide, the researchers have succeeded in forming plant-like cells called pseudocells. Now they are trying to induce the pseudocells to interact and form a solid mass. Certain treatments have caused bonding between the pseudocells, but the bonds have been too weak to retain a solid texture.

## Fermented Colostrum Can Be Emergency Disease Protection

Fermented colostrum can be an emergency source of disease protection for newborn calves in cases when the dam's colostrum isn't available, say University of Minnesota dairy scientists J. A. Foley, A. G. Hunter and D. E. Otterby.

Occasionally, maternal colostrum may not be available for a newborn calf. Possible causes include the dam dying at calving time or having calved without benefit of a dry period, when colostrum accululates in the udder.

In addition, cows milked out before calving to relieve pressure due to udder edema won't give "true" colostrum after calving.

Many farms have fermented colostrum on hand, and researchers found that calves fed fermented

colostrum survived without health problems. However, calves fed fermented colostrum plus sodium bicarbonate (common baking soda) acquired higher levels of disease protecting antibodies in their blood.

So if it becomes necessary to use fermented colostrum to supply antibody protection to newborn calves, the Minnesota scientists recommend neutralizing the acidity of the colostrum with common baking soda.

Add on teaspoon of baking soda to each quart of colostrum fed. Newborn calves will oftentimes refuse fermented colostrum so it may be necessary to force the mixture, preferably with a stomach tube. The mixture should be fed three times during the first day of life, two quarts per feeding, if possible.

Juelene Sorenson, a graduate student assisting in the pseudocell study, will present research findings at the Institute of Food Technologists' annual meeting in June 1978.

If the pseudocells can be linked to produce a plant-like tissue, they may form the basis for restructured foods. Nutrients, flavoring and pigment could be added and the tissues could be molded into the desired shape.

In a research project on the second method, Lund and Richardson are attempting to restore the original texture to macerated peas and strawberries by adding various structuring agents to the puree. They hope to find conditions that will impart the desired texture to the puree, which can then be molded into the original shape.

Besides increasing food supply and improving food preservation, restructuring could bring some dramatic changes to food.

More beans can be grown per acre than peas. People who prefer peas to beans wouldn't consider that a good reason for pea producers to grow only beans. But if a way can be found to restructure foods, macerated beans could possibly be reformed to look and taste like peas.

Consumers today accept limp, mushy frozen strawberries because that is what is available. But they expect a firmer texture in fresh strawberries. Restructuring may someday produced a strawberry with a texture that remains firm even when frozen.

Will consumers accept these changes? Lund points out that we are already buying semi-restructured foods such as uniform potato chips, onion rings and soybean burgers. Binding agents are added to all of these foods to hold the tissues together.

Restructured foods may not in the end be a matter of consumer choice. If a growing world population is to be fed, scientists must consider all methods to increase food supplies. Restructuring may become one of the best ways to provide more food.

## Sewage Contamination Could Be Threat to Groundwater Supplies

The sewage from more than 50 million inhabitants of the United States is disposed of by septic percolation fields. As population pressures increase, there is growing concern about the inadvertent widespread contamination of our groundwater supplies, according to a report from the Texas Agricultural Experiment Station.

Microbial and viral contaminants are of special interest because of the possibility of the spread of disease by contamination of drinking water sources.

In addition, research has shown that chemicals such as chlorides, nitrates and sulfates may move freely through the soil with the permeating water. Phosphates appear to be fixed by most soils so they stay put, but gasoline, phenols and picric acid have been observed to travel many miles in underground water.

The mobility of other contaminants such as synthetic detergents, pesticides, as well as fecal bacteria and viruses from the septic systems will depend on the soil properties, the oxygen status of the soil, the pH and the characteristics of each contaminant.

Present criteria for septic tank absorption fields were established by the U.S. Public Health Service (1967) and by many state health agencies.

In the main, these criteria utilize percolation tests to size the absorption fields. The emphasis has been on subsurface infiltration and the prevention of surface and run-off contamination.

Undoubtedly many of the potential and harmful pollutants are removed or inactivated by the soil surrounding septic sewers before they can leach to the groundwater table. There is increasing concern, however, that contamination of groundwater may occur in certain situations, according to Dr. Kirk Brown, a soils physicist with the

Texas Agriculture Experiment Station at Texas A&M University.

Brown and K. C. Donnelly of the Agricultural Experiment Station and two civil engineers with the Texas Engineering Experiment Station (H. W. Wolf and J. F. Slowey) recently completed an extensive study of the movement of sewage bacteria and other contaminants in the soil and groundwater below septic lines.

The study, partially funded by The Environmental Protection Agency, was a joint effort by the Texas Agricultural Experiment Station and the Texas Engineering Experiment Station.

Their research method permitted checking movements of contaminants without disturbing the soil. They found that virus and fecal coliforms (sewage bacteria) were

removed by passage through 40 inches of any of the soils tested.

Heavy metal (arsenic, lead, copper, nickel, cadmium, chromium, zinc) accumulated immediately adjacent to the point of application in the soil. Phosphates moved only slowly in the soil, and their movement was greatest in sandy soils.

When soils were very wet, ammonia accumulated in the soils and moved about as far and fast as phosphate. When the soil was allowed to dry out in summer, large amounts of nitrogen were converted to nitrate which rapidly leached to the groundwater.

Nitrate leachate passing into ground water is the greatest environmental hazard identified in this study.

This problem can be dealt with, Brown says, by limiting the number of septic fields per unit area, removing the nitrogen from the sewage effluent before it is applied or perhaps by using vegetation to help remove it from application.

## Metric Math for Cooks

Madcap metric math will create havoc for cooks unless the foodservice industry leads the way to metric conversion that adds up. The warning comes from Joyce N. Rubash, R.D., the American Dietetic Association's nominee to the United States Metric Board.

Mrs. Rubash, who is Director of College Food Service at Rice University, Houston Texas, urges dietitians to insist upon the 240 milliliter (ml) measure to keep a balance among ingredients in formula or measure. "Misinformation and misbegotten items are being manufactured and sold in the name of metrics . . . and as a result," she says, "we are about to lose our great volumetric measuring system because of passive acceptance of proposed 250 ml cup."

The present customary cup is 236.6 ml, the tablespoon is 14.79 ml, and the teaspoon is 4.93 ml. In going metric, our measures can be improved by rounding off and estab-

lishing a reasonable tolerance. The cup should be rounded off to 240 ml, the tablespoon to 15 ml, and the teaspoon to 5 ml. This is an insignificant 1.4 percent increase in volume.

On the other hand, the proposed 250 ml cup is a 5.4 percent increase in volume, making this basic cooking measure disproportionate in capacity to the two measuring spoons. Mrs. Rubash cautions that the 250 ml cup will cause unnecessary deterioration in product quality.

How did the proposal come about? Mrs. Rubash thinks it probably happened for the simple reason that 250 ml is one-fourth of a liter.

President Jimmy Carter has made nominations for a U.S. Metric Board, but the Senate has not yet approved them. Meanwhile, Mrs. Rubash says, "there is no consumer protection against the metric/mercenaries."

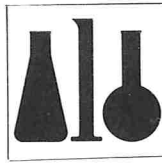
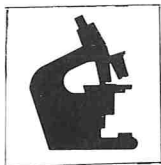
•*Motorola Process Control, Inc.* has announced a new moisture analyzer ("Compu-Trac") which determines the moisture content of organic and inorganic materials with greater convenience and accuracy than available moisture analyzers. It is completely automatic in operation—minimal operator skill is required to insure accurate, repeatable test results. Materials with moisture content from 0% to 100% can be tested. The operator presses a button, loads the sample tray with the material to be tested, closes the lid and walks away to perform any other duties. Within a few minutes, the instrument provides an estimate—via a large, easy to read digital display—of the final moisture reading. This estimated result is refined as the test proceeds, and when the sample has been dried to 0% moisture, the final moisture reading is displayed, and the instrument turns itself off, and informs the operator that the test is completed. Material to be tested with moisture content of 5% to 20% will normally have final results displayed within 7 to 10 minutes. Material with moisture content of 70% or above requires a longer drying cycle to reach 0% moisture—normally about 30 minutes. Further information is available from Motoro-

la Process Control, Inc., 1711 West 17th St., Tempe, Arizona 85281, Telephone, (602) 994-6510.

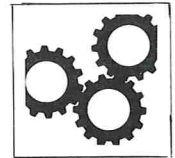
•*Romicon, Inc.* is offering a new brochure on ultrafiltration in sanitary applications where it is necessary to purify, concentrate, or fractionate macromolecules in solutions, colloids, or other suspensions. The company claims that ultrafiltration provides clean-in-place and sanitizing capabilities for stable and economical performance. Applications range from small-scale pilot projects up through large-scale plant applications. At the heart of the Romicon system are modules containing hollow fiber membrane cartridges. A process stream flows under pressure through the core of the fibers. At the liquid/membrane interface, higher molecular weight solutes and particulate matter are separated from lower molecular weight solutes and solvents. To obtain the new brochure, contact David Weber, Romicon, Inc., 100 Cummings Park, Woburn, MA 01810. (617) 935-7840.

•*Amprodex, Inc.*, manufacturer of liquid-level and bin-level gauges, alarms, and controls, now offers the Quanti-Trol, a unique

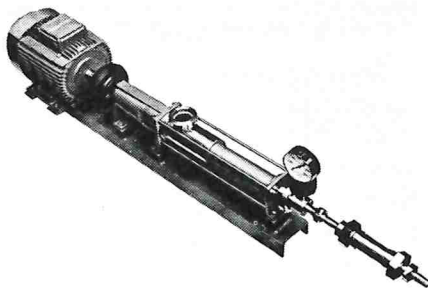
combination gauge with level alarm and control functions. The AMPRODUX Quanti-Trol is made to order from modular off-the-shelf components for from 1 to 24 tanks; it thus provides a reasonable cost multiple tank gauging with readout of all tanks continuously, simultaneously, with alarm and control functions, all at one central location. Readouts at additional locations can be added. The standard indicators read 0-100% in 1% graduations, and scales can be made to order reading in gallons, inches, or other units. In addition to reading the volume in each tank, the AMPRODUX Quanti-Trol provides infinitely adjustable high level, low level, or high and low level alarm and control functions. Special Quanti-Trol models are made for more than two alarm/control levels per tank. The Quanti-Trol can be used to avoid runout, prevent pollution spills, control pumps, automatically fill tanks, and other alarm and control functions, such as preventing unauthorized tank withdrawals, etc. For further information, call or write: R. V. Gustafson, Director of Engineering and Sales, AMPRODUX, Inc., Instrumentation Division, 150 West 28th Street, New York, N.Y. 10001.



## Product Potpourri

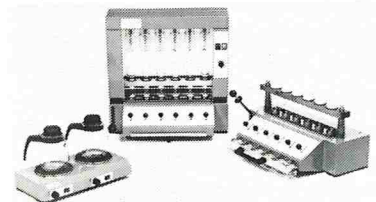


•*Ultrasonics Ltd* introduced a new design in ultrasonic homogenizers for the production of emulsions and non-abrasive powder in liquid dispersions. The DQS range of equipment comprises a homogenizing head and quick strip pump directly mounted onto a motor. The direct mounting is a new feature which eliminates the need for a coupling and subsequently a base plate. Four machines ranging from 5 gallons per minute to 40 gallons per minute can be quickly and easily dismantled and reassembled to facilitate cleaning and sterilization. For more information contact: Ultrasonics Ltd., P.O. Box 619, Kennett Sq., PA 19348.

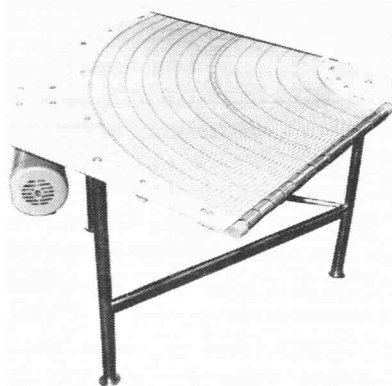


•*A new electronic precision balance*, Type RS 25, is now available from August Sauter of American, Inc. Especially designed for use in the food and paint industries, Sauter's new weighing device features three displays making it easy to mix two or more ingredients, weigh out portions or compare actual with desired values. The values displayed, gross, sum of net and net weight, are clearly indicated by 13 mm high segmented figure indicators, easy to read even under poor lighting conditions. An important feature of the new balance is a trio of control lamps fitted into the display unit. Their function is to prevent the nature of the current operation—taring or sub-taring being forgotten. For example, "Tare" lights up yellow after a taring operation, "Sub-tare" lights up yellow—in addition—after a sub-taring operation and "Status" lights up green for equilibrium control. Blanking of the display occurs automatically if machine is over, or under, loaded. Further information on the RS 25 may be obtained by contacting August Sauter of America, Inc., 80 Fifth Avenue, New York, N.Y. 10011.

•*Tecator, Inc.*, announces the new Fibertec™ M System for the determination of fiber in food and feeds. The system provides a means for performing extractions, filtration, and washing without transfer of the sample to different containers. All of these functions, as well as drying and ashing, are done in a filtering crucible. Filtration is done without the use of asbestos. The Fibertec™ M reduces labor by about 50%, and offers improved precision. It can be used for Dietary Fiber, Crude Fiber, Acid Detergent Fiber, and Neutral Detergent Fiber procedures. The System is available in configurations for performing up to 6, 12, 18, or 24 extractions at once. For more information write Allen Kaplan at Tecator, Inc., 1898 S. Flatiron Court, Boulder, Colorado 80301.



•A space-saving powered conveyor system that gently transports products around small radius turns is available from Wire Belt Company of America of Winchester, Massachusetts. The Wire Belt Model FT-S Flex-Turn<sup>R</sup> Conveyor is a variable speed power turn system with a space-saving 16" inside turning radius that conveys products in perfect alignment around 90° or 180° corners. With a capacity of up to 10 pounds per square foot and an adjustable belt speed of 6' to 36' per minute at inside radius, the system is powered by a fully enclosed 1/3 hp DC motor with SCR control. Positively driven and guided, the belt will not slip or experience



tracking problems. For information contact: Wire Belt Company of America Donald J. Frye, Vice President, 91 River St., Winchester, MA. 01890.

•The Sta-Sieve stationary screening device from SWECO, Inc. is available in stainless steel models for use in special environments. SWECO's new Stainless Steel Sta-Sieve utilizes a slotted screen formed into a cycloid (a curve of quickest descent) and a head box designed for minimum turbulence. The Sta-Sieve is a high-volume, coarse mesh screening device that is ideal for processors that use large quantities of water, such as canneries, fruit and vegetable processors, fish processors, pulp and paper mills, and many other applications. The Sta-Sieve has no moving parts and offers advantages of high flow rate, long screen life, and ease of installation, operation and maintenance. Stainless steel construction ensures long working life of the unit, even in harsh or corrosive plant environments. Models are offered with screens in widths of four feet and six feet, ranging in capacities up to 1200 gpm and 2000 gpm respectively. Screen slot openings may be ordered from 0.01" to 0.12", depending upon the requirements of the installation. The Sta-Sieve can be operated independently for liquids/solids separation or as a system in conjunction with SWECO Separators or Centrifugal Screen Concentrators. For additional information, contact SWECO, Inc., 6033 E. Bandini Blvd., P.O. Box 4151, Los Angeles, California 90051.

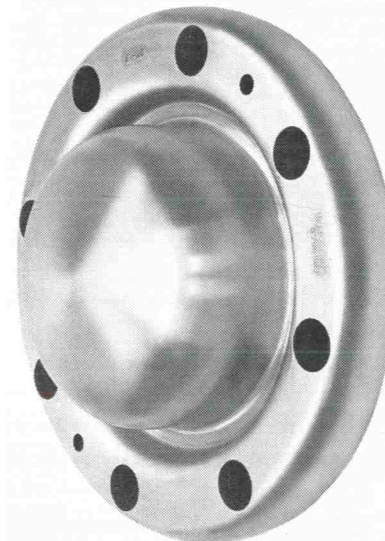
•Flavor, fragrance and color capabilities of Crompton & Knowles Corporation's Flavor and Fragrance Division are described in a new brochure published by the company. The 16-page brochure discusses the manufacturing, research and service capabilities established to make Crompton & Knowles a single source of flavors, fragrances, natural and certified colors, essential oils and related products on a world-wide basis. The company supplies these products not only to the food processing, beverage, cosmetic, toiletry and fine fragrance industries but also to drug, detergent, personal products and a host of other chemical specialty and industrial fields. The division, which is headquartered in Fair Lawn, N.J., also has facilities in Gibraltar, Pa., Belgium and The Netherlands. Copies of the brochure are available on request to Crompton & Knowles Corporation, Flavor and Fragrance Division, 17-01 Nevins Road, Fair Lawn, New Jersey 07410.

•A new free brochure describes an extensive array of custom parts and fabrications available in 304 and 316 stainless steel from tube or pipe in 1" to 6" diameters and in lengths from 1' to 30'. Manifolds, tube bends, spray balls, special valves and other custom components are fabricated to meet specific equipment or installation requirements. Weld assemblies can also eliminate the need for clamps, gaskets and ferrules in CIP or industrial applications. For free literature or further information, contact Superior Stainless, Inc., P.O. Box 622, Delavan, WI 53115.

•Delkor's new Model GS Automatic Case Set-Up and Bottom Sealer can produce up to 15 cases per minute on a sustained basis. Its components are base-mounted for easier maintenance and its automatic sequences permit minimum case handling. The uniformly-squared cases turned out by the GS prevent production-line hang-ups. All transfer motions are on heavy hardened steel shafts. Case size adjustments on the Model GS are easily accessible for rapid changeover, and its adjustment scales are factory calibrated to the user's case sizes. Illustrated on the enclosed sheet, the GS has a power-fed, floor level magazine with a standard capacity of 150 cases. (Up to 450 available, based on "B" flute single-wall cases.) Contact: Evert Sisney, Delkor Industries, Inc., 2920 Talmage Ave. S.E., Minneapolis, MN 55414.

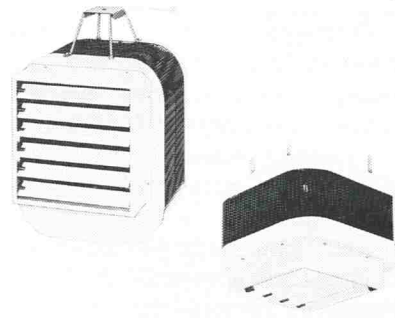
•The new Model MFT-107 milk fat tester designed for speedy practical measurement of milk fat has been introduced by Nippon Digital Co., Ltd. According to Nippon, the MFT-107 is designed to be calibrated to a conventional absolute measuring method for greater accuracy. For information contact: Nippon Digital Co., Ltd., 4-12, Sekimae 2-shome, Musashino-shi, Tokyo, Japan 180.

•A new stainless steel Class 150 flange with a convoluted shape that reduces weight and helps save installation space, labor, and cost is now available from NIBCO, Inc. Since the



new formed flange weighs as much as 60% less than conventional forged flanges, it installs faster and easier. A two-man installation team can comfortably handle a 12" flange without the use of a mechanical lifting device. Less torque is required to effect a tight seal, too, because the force is concentrated in a smaller sealing area. The convoluted shape of the flange increases its strength, allowing stress to be channeled with greater efficiency. So, while the NIBCO flange weighs less, it is still capable of handling the job of much heavier forged flanges. For more information on NIBCO's new stainless steel Class 150 flange, write NIBCO, Inc., 500 Simpson Avenue, Elkhart, Ind. 46515.

•Aitken Products, Inc. has just announced a new line of electric unit heaters. According to the manufacturer, the new Aitken Electric Heater can be top mounted as a conventional unit heater or back mounted as a downflow heater for a wide variety of heating patterns. Spring loaded reversible louvers can be aimed up or down. Aitken Unit Heaters are available with capacities from 3.75 to 50 KW: voltage



selection from 208 to 550V and output from 12,800 BTU/hr. to 170,700 BTU/hr. For information contact Aitken Products, Inc., P.O. Box 151, Geneva, OH 44041.



Joe Oglesby (left) hands his handcrafted cherrywood gavel to Harry Marsh, KAMFES past president.

## KAMFES Holds Spring Educational Conference

"It's surprising the diverse talents you find in individuals within an organization such as ours," said Harry Marsh, past president of the Kentucky Association of Milk, Food and Environmental Sanitarians. Marsh was speaking in reference to Joe Oglesby, a sanitarian and long-time member of KAMFES. Joe's hobby is woodcraft. Recently, he carved a beautiful cherrywood gavel. He presented it to the KAMFES Executive Board at the 1978 KAMFES Educational Conference held February 28 to March 1, 1978.

Joe Oglesby's gift reflected talent. But more than that it represented pride in his organization. However, Joe was not alone in his pride. Numerous KAMFES members worked long and hard to coordinate a very successful program with over 300 members in attendance at the Executive West in Louisville, Kentucky.

Programming, headed by Barry Kinslow, included speakers and several panels covering pertinent issues. Educational material covered involved environmental quality, consumer safety, along with milk and food sanitation.

Addressing the subject of milk and food sanitation were Dr. J. D. Fox, University of Kentucky; James L. Brady, Winn Dixie Foods; Joe A. Rubis, USDA; Niels Ewing; Hank Blau, Diversy Chemical Co; and Shelby Johnson, FDA.

Speaking on environmental issues were Jerad McCowin, FDA; Robert Waldron, Erie County Department of Health; John Tierney, Jefferson County; and G. C. Vanderpool, Jefferson County.

Several members received awards at the Annual Awards Luncheon. Steve Sandlin, Jr., a state food survey officer, received the Outstanding Sanitarian Award. The Outstanding Fieldman's Award went to Lee Pogue, Dean Foods. Further, Roy G. Scott, Cudahy Cheese, received the Outstanding Service Award for his efforts in industry and KAMFES.

Students from universities around the state added yet another angle to the Educational Conference. John Slaughter took highest undergraduate honors with a paper on histoplasmosis. Slaughter attends Moorhead State. In addition, Jean Wesley, University of Kentucky, was the graduate winner with a paper on cookers. Receiving high honorable mention were Barbara Baldwin, Eastern Kentucky University, and Kathy Lubber, Murray State University.

Aside from the conference, several KAMFES members received promotions over the past year. Irving Bell was appointed director of the state Division of Consumer Health Protection. Dudley Conner assumed Bells previous position as Assistant Director of the Division. In addition, Leon Townsend was moved up to Manager of the State Milk Control Branch.

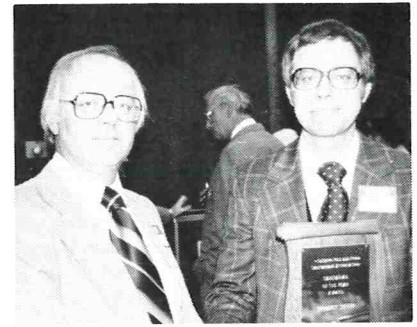
## Annual Meeting Hoe-Down Planned

You may never again have the chance to attend an event like the one being planned for the 65th Annual Meeting of IAMFES in Kansas City August 13-17, 1978.

You'll have the chance to experience an old-fashion chuck-wagon hoe-down on Monday evening August 14th beginning at 6:00 p.m. It's an event guaranteed to give fun for all in a family atmosphere.

Entitled "evening on the farm" on the IAMFES Annual Meeting registration form, it's a bargain you can't afford to miss. A chuck wagon baron roast, live music with square dancing, hay and buggy rides, horseback riding and fishing will all be part of the one night extravaganza.

Bring the family and join the fun. By yourself you won't be alone as old friends can chat in a relaxed atmosphere. So iron up those old coveralls and be ready for the best. An Annual Meeting will never be the same.



(r-l) Doug Varnell awards the Sanitarian of the Year Award to Robert Tiffin.

## Ontario MFSA Meets

The Ontario Milk and Food Sanitarians Association held their 20th Annual Meeting March 28, 1978 at the Cara Inn in Malton, Ontario, Canada.

Over 100 members attended the one day conference which centered around food protection. Several noted regulatory, university and industry personnel lead the discussions.

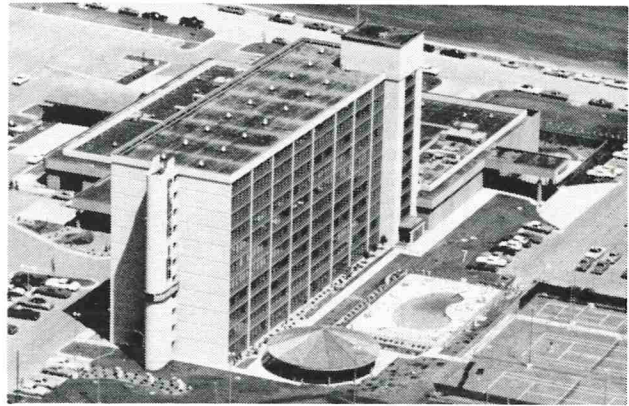
Robert Tiffin was awarded the Sanitarian of the Year Award at the awards luncheon. Robert is with the J. M. Snieder Company. The Award was presented by Doud Varnell of Klenzade Products.

Officers elected for the coming year were; Roger Wray, president; Gail (Evans) Holland, vice-president; Jeanne Bernard, secretary; Bruce Keown, treasurer; and John Sterns, Ralph Abell, John Atkinson, Ron Osborne and Bruce Hamilton as directors. Cyriel Duitschaever assumed the position of past president.



# If you care about professional improvement

Plan to attend the  
**65th Annual Meeting of  
 IAMFES on August 13-17, 1978**  
 at the



## Hilton Airport Plaza, Kansas City, Missouri

For years IAMFES Annual Meetings have offered informative group sessions and discussions in a relaxed and enjoyable atmosphere.

This year promises that much and more. A wide variety of general and technical issues will be presented in a format that lets you plunge right in and tackle current problem issues in your field.

And while your pondering

events of the day the evenings offer nothing but relaxation. As in years past, there's the Annual Awards banquet. But this year the Missouri and Kansas Associations have teamed up to present special evening events you, and even your family, won't want to miss.

Also, you'll have a chance to see Kansas City and all it has to offer, from the Kansas City Royals to the finest restaurants in the Midwest.

So make plans now to meet in Kansas City for a professional program and an enjoyable meeting.

### 1978 ANNUAL MEETING I.A.M.F.E.S.

Advance Registration Form  
 Kansas City, Missouri

65th Annual Meeting  
 August 13-17, 1978

MAIL TO: **Mr. Vernon Cupps, Co-Chairman of Registration** Please Check (If Applicable):  
**IAMFES** City of Saint Louis Affiliate Delegate  Executive Board   
**Milk Control Service** P.O. Box 14702 Past President  Speaker   
**Division of Health** Saint Louis, Missouri 63178 Executive Board  Host

Make Checks Payable to, *IAMFES - 1978 Meeting Fund*

*Advance Register and Save - Refundable if you don't attend*

REGULAR REGISTRATION FEE			ADVANCE REGISTRATION FEE (If Registered prior to August 1)		
		Spouse			Spouse
REGISTRATION	\$23.00	\$10.00	REGISTRATION	\$20.00	\$ 8.00
BANQUET	17.00	17.00	BANQUET	15.00	15.00
EVENING ON THE FARM	2.00	2.00	EVENING ON THE FARM	2.00	2.00
TOTAL	\$42.00	\$29.00	TOTAL	\$37.00	\$25.00

Name \_\_\_\_\_ Name \_\_\_\_\_  
 Childrens First Names \_\_\_\_\_  
 Affiliate or Company \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

### HILTON AIRPORT PLAZA INN

1-29 & 112th Street, N.W.,  
 Kansas City, MO 64195  
 Telephone - (816) 891-8900

Reservations must be received by July 13, 1978.  
 Reservations will be held until 6:00 p.m.,  
 unless a later hour is specified  
 Check out time is 1:00 p.m.

Arrival Date \_\_\_\_\_ Departure Date \_\_\_\_\_  
 Arrival Time \_\_\_\_\_ Means of Transportation \_\_\_\_\_  
 Name \_\_\_\_\_ Name \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Please check type of accommodation required \_\_\_\_\_ Single (one person) \$30 Free Parking.

\_\_\_\_\_ Double (two persons) \$36 Send directly to: Reservation Manager,

Family Plan: There is no charge for children when in same room with parents.

Hilton Airport Plaza Inn.

Limited roll-a-ways available at \$8.00 each.

## Angevine Superior Quality Awards Presented

Winners of the prestigious NEIL C. ANGEVINE SUPERIOR QUALITY AWARD (consisting of an engraved plaque and revolving trophy) were announced at the March 27-29, 1978 ACDPI Kulturets and Kurds Clinic in Indianapolis, Indiana.

This award is given to the dairy plant with the highest cumulative score for all cultured products evaluated by experts at the national judging contest held annually in conjunction with the ACDPI training schools.

First place Angevine Award winner was Smith Dairy Products Co. Second place finisher in the overall products competition was Vandervoorts Dairy. Third place was captured by Bancroft Dairy-Div. of The Southland Corporation.

Other first place award recipients for individual products included: Borden, Inc., Columbus, Ohio-plain and all-categories yogurt; Bancroft



Pictured (L to R) are: Dean Bollinger and Dave Arnold, Bancroft Dairy-Div. of the Southland Corp., Madison, Wisconsin; David H. Hill and Norman Berg, Smith Dairy Products Co., Orrville, Ohio; Dr. C. Bronson Lane, (ACDPI Secretary) Dairy and Food Nutrition Council, Orlando, Florida; Luther Elkins (ACDPI President), The Southland Corp., Dallas, Texas; Everett Ogburn, Vandervoorts Dairy, Fort Worth, Texas; Ken Haynes (national cultured products judging contest assistant coordinator), Cedar Hill Farms, Inc., Cincinnati, Ohio; Dr. Ronald Richter (national cultured products judging contest coordinator), Texas A&M University, College Station, Texas.

Dairy-Div. of The Southland Corp., Madison, Wisconsin-strawberry yogurt; Pine State Creamery Co., Raleigh, North Carolina-lemon yogurt; Purity Dairies, Nashville, Tennessee-cottage cheese; Hillside Dairy,

Cleveland Heights, Ohio- butter-milk; Smith Dairy Products Co., Orrville, Ohio-sour cream.

The Klinik was attended by approximately 290 delegates from 36 states, Canada, France, and Mexico.

## CLASSIFIED ADS

### Faculty Position Announcement

Texas A&M University solicits applications from candidates for an academic position (Assistant or Associate Professor, depending on qualifications) in the Food Science and Technology Program. Applicants should hold the Ph.D. degree in food science, nutrition, bio-chemistry or closely related areas and have a strong background in nutrition, biochemistry, food science and dietetics (Registered Dietitian). Applicants should have the demonstrated ability and desire to teach and counsel undergraduate and graduate students and conduct research in the area of nutritional value of animal products. The successful applicant will be expected to teach undergraduate and graduate courses in the areas of diet therapy, nutrition and nutritional evaluation of processed food products. Applications should include a comprehensive biographical resume, a list of at least five references and transcripts of all University academic work. Position available September 1, 1978; application deadline June 1 or until qualified candidate applies. Texas A&M University is an affirmative action/equal opportunity employer. Applications should be sent to:

Dr. Z. L. Carpenter, Department of Animal Science, Texas A&M University, College Station, Texas 77843 (Phone: 713/845-1541).

### For Sale

Single Service milk sample tubes. For further information and a catalogue please write, Dairy Technology, Inc., P.O. Box 101, Eugene, Oregon 97401.

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THE ONLY Approved  
SANITARY METHOD OF APPLYING  
A U. S. P. LUBRICANT  
TO DAIRY & FOOD  
PROCESSING EQUIPMENT

*Haynes  
Spray*

U. S. P. LIQUID PETROLATUM SPRAY

U.S.P. UNITED STATES PHARMACEUTICAL STANDARDS  
CONTAINS NO ANIMAL OR VEGETABLE FATS. ABSOLUTELY  
NEUTRAL. WILL NOT TURN RANCID - CONTAMINATE OR  
TAINT WHEN IN CONTACT WITH FOOD PRODUCTS.

**SANITARY - PURE**

**ODORLESS - TASTELESS**

**NON-TOXIC**

The Modern HAYNES-SPRAY Method of Lubrication  
Conforms with the Milk Ordinance and Code  
Recommended by the U. S. Public Health Service

The Haynes-Spray eliminates the danger of contamination which is possible by old fashioned lubricating methods. Spreading lubricants by the use of the finger method may entirely destroy previous bactericidal treatment of equipment.

PACKED 6-12 oz. CANS PER CARTON  
SHIPPING WEIGHT - 7 LBS.

THE HAYNES MANUFACTURING CO.  
4180 Lorain Ave. • Cleveland, Ohio 44113

HAYNES-SPRAY INGREDIENTS ARE APPROVED ADDITIVES AND CAN BE SAFELY USED AS A LUBRICANT FOR FOOD PROCESSING EQUIPMENT WHEN USED IN COMPLIANCE WITH EXISTING FOOD ADDITIVES REGULATIONS.



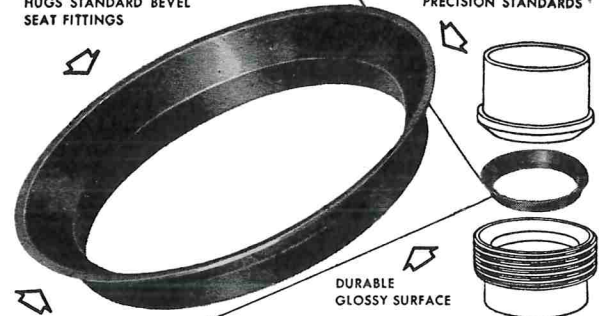
This Fine  
Mist-like  
HAYNES-SPRAY  
should be used to lubricate:

SANITARY VALVES  
HOMOGENIZER PISTONS - RINGS  
SANITARY SEALS & PARTS  
CAPPER SLIDES & PARTS  
POSITIVE PUMP PARTS  
GLASS & PAPER FILLING  
MACHINE PARTS  
and for ALL OTHER SANITARY  
MACHINE PARTS which are  
cleaned daily.

## HAYNES SNAP-TITE GASKETS

"FORM-FIT" WIDE FLANGE  
HUGS STANDARD BEVEL  
SEAT FITTINGS

MOLDED TO  
PRECISION STANDARDS



DESIGNED TO  
SNAP INTO  
FITTINGS

DURABLE  
GLOSSY SURFACE

▶ **LOW COST...RE-USABLE**

▶ **LEAK-PREVENTING**

**NEOPRENE GASKET for Sanitary Fittings**

Check these **SNAP-TITE** Advantages

Tight joints, no leaks, no shrinkage

Sanitary, unaffected by heat or fats

Non-porous, no seams or crevices

Odorless, polished surfaces, easily cleaned

Withstand sterilization

Time-saving, easy to assemble

Self-centering

No sticking to fittings

Eliminate line blocks

Help overcome line vibrations

Long life, use over and over

Available for 1", 1½", 2", 2½" and 3" fittings.

Packed 100 to the box. Order through your dairy supply house.

**THE HAYNES MANUFACTURING CO.**  
4180 Lorain Avenue • Cleveland 13, Ohio

**HAYNES**  
SELF-CENTERING  
**SNAP-TITE**<sup>®</sup>  
*Gaskets*

\* MADE FROM  
**TEFLON**<sup>®</sup>

SIZES 1" - 1½"  
2" - 2½" - 3" - 4"

"The Sophisticated Gasket"  
THE IDEAL UNION SEAL FOR  
BOTH VACUUM AND  
PRESSURE LINES

Gasket Color . . .  
slightly off-white

SNAP-TITE self-centering gaskets of TEFLON are designed for all standard bevel seat sanitary fittings. They SNAP into place providing self-alignment and ease of assembly and disassembly.

HAYNES SNAP-TITES of TEFLON are unaffected by cleaning solutions, steam and solvents. They will not embrittle at temperatures as low as minus 200° F. and are impervious to heat up to 500° F.

FOR A FITTING GASKET THAT WILL OUT-PERFORM ALL OTHERS...

Specify . . . HAYNES SNAP-TITES of TEFLON

• TEFLON ACCEPTED SAFE FOR USE ON FOOD & PROCESSING EQUIPMENT BY U. S. FOOD AND DRUG ADMINISTRATION

\* Gaskets made of DuPont TEFLON<sup>®</sup> TFE-FLUOROCARBON RESINS

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A HEAVY DUTY SANITARY LUBRICANT



Available in both  
**SPRAY AND TUBE**

All Lubri-Film ingredients are approved additives and can be safely utilized as a lubricant for food processing equipment when used in compliance with existing food additive regulations.

ESPECIALLY DEVELOPED FOR LUBRICATION OF FOOD  
PROCESSING AND PACKAGING EQUIPMENT

For use in Dairies - Ice Cream Plants - Breweries -  
Beverage Plants - Bakeries - Canneries - Packing Plants

**SANITARY • NON TOXIC • ODORLESS • TASTELESS**

SPRAY - PACKED 6 - 16 OZ. CANS PER CARTON  
TUBES - PACKED 12 - 4 OZ. TUBES PER CARTON

**THE HAYNES MANUFACTURING CO.**  
CLEVELAND, OHIO 44113

# Teat Dipping Reduces Mastitis and Increases Profits

Dr. Nelson Philpot  
Professor of Dairy Production & Bacteriology  
Louisiana State University



The development of suitable teat dips represents a significant advancement in the battle to control mastitis. Indeed, the most important single step that a dairy farmer can take to prevent this disease in his dairy herd is to dip teats after milking with a product shown by research to be safe and effective.

## Bacteria on Teat Ends Mean Trouble

The rate of infection is related to the number of organisms on the teat end. Management practices that cause an increase in the organisms will result in a higher infection rate while those that reduce the population will lower the infection rate.

The primary sources of the most common mastitis bacteria are infected udders and teats. The bacteria are transmitted during milking by the milkers' hands, udder cloths, and milking machine teat cups. Only a small number of infections will occur during milking if the machines are functioning correctly and used properly. The majority will occur between milkings caused by bacteria left on the teats at the end of milking. Teat dipping with a good product will destroy most of the bacteria and will reduce the new infection rate by an average of 50%, or more. That statement is supported by data from more than 30 carefully controlled research experiments.

Teat dipping should be done as soon as practical after milking because the teat canal starts to close tightly. This process begins at the outside edge of the canal and may result in bacteria being trapped inside the canal out of reach of the dip if application is delayed.

A wide range of teat dip products is available. Most are probably effective, but dairy farmers should require manufacturers to provide satisfactory evidence.

## Teat Dipping: One of Five Steps in Good Herd Health

Teat dipping should be employed as one component of a five step program that includes: (1) correct maintenance and use of milking equipment; (2) teat dipping; (3) prompt treatment of clinical cases; (4) treatment of cows at drying off; and (5) culling of mastitis problem cows.

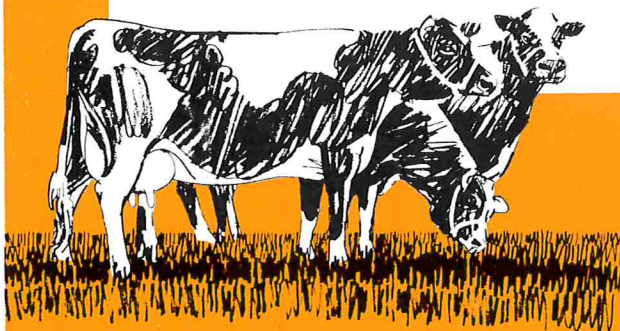
Dairy farmers should not expect to see dramatic results from teat dipping within a short time. This is because the practice does not eliminate existing infections that are best controlled by treatment at drying off. In the long term, however, teat dipping is a highly effective method of keeping mastitis at a low level. *Dairy farmers who don't have time to dip teats after milking just don't have time to control mastitis.*

## Mastitis Control Returns Profit

This disease continues to be a heavy tax on the dairy industry because of reduced milk production, ruined cows, and other costs. The average dairy farmer loses approximately 100 dollars per cow per year in reduced milk production alone—but this need not be the case.

Research conducted in the United States and several foreign countries has revealed that dairy farmers receive three to five dollars in increased profits for every dollar invested in a mastitis control program. Naturally, dairy farmers with a high level of mastitis in their herd stand to realize the greatest return.

My philosophy concerning teat dipping can best be summed up in the statement—"If I had one cow—and she had one teat—I'd dip it, after every milking." Mastitis control makes good sense. Where else can a dairy farmer receive a 300 to 500% return on his investment?



**SURGE**

Babson Bros. Co.,  
2100 South York Road,  
Oak Brook, Illinois 60521.

We make your cows worth more.