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AUGUST 10-14, 1975
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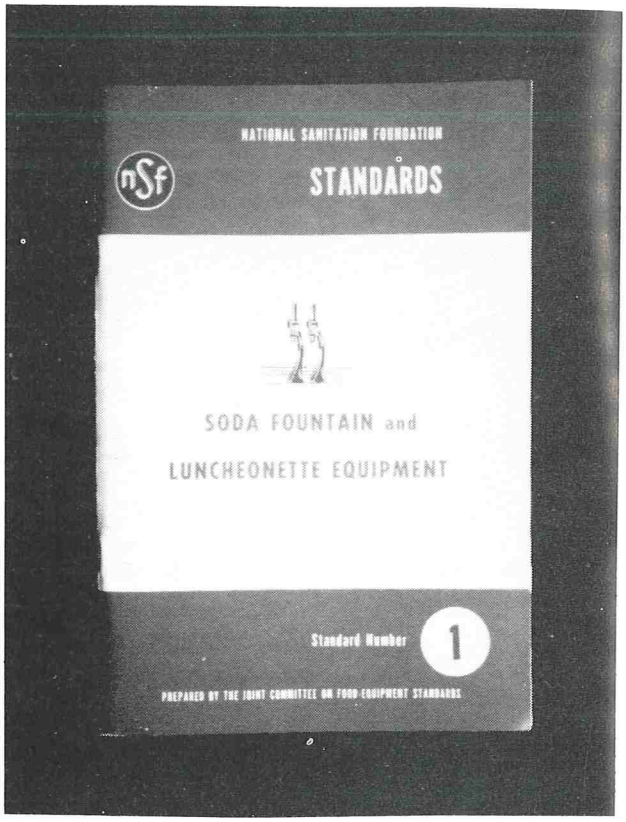

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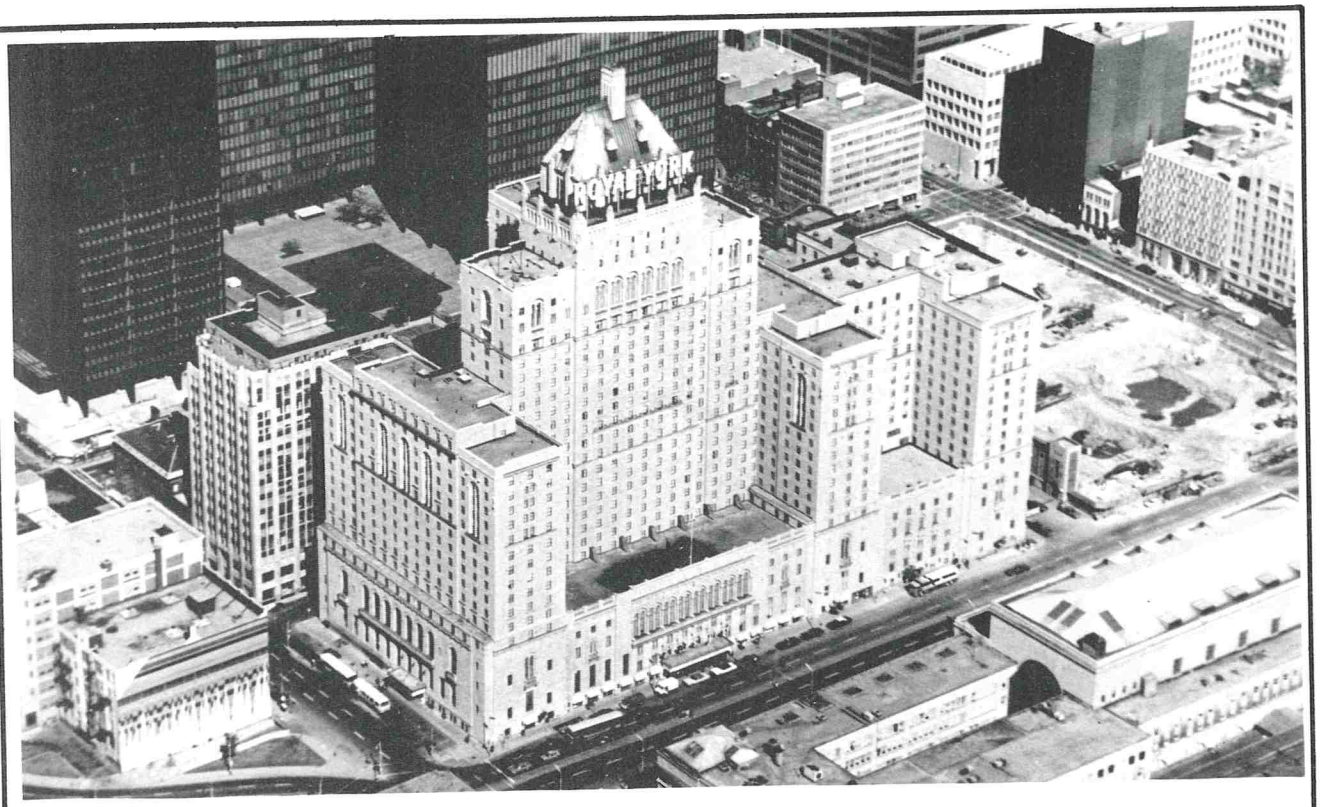

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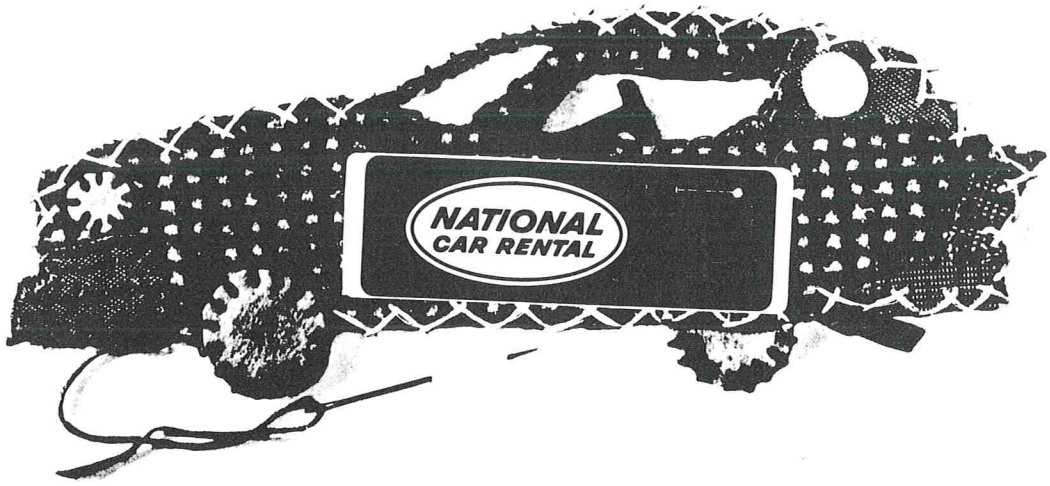

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J. Milk Food Technol. Vol. 38, No. 7, Pages 380-382 (July, 1975)

Protein Content in Raw and Fluid Milk Products[1]

S. E. BARNARD[2] and G. L. HARGROVE[3]

Dairy Science Extension[2] and the Department of Dairy Science[3]
The Pennsylvania State University, University Park, Pennsylvania 16802

(Received for publication October 7, 1974)

ABSTRACT

Protein values of more than 100,000 individual cow samples of milk were determined over a 12-month period. In addition, protein levels of more than 1,100 store-purchased samples of whole, lowfat and skimmilk were determined during 27 months. Protein determinations were made with an automatic Foss Combi protein-fat tester, which is in regulaur use at the Pennsylvania Dairy Herd Improvement Central Milk Testing Laboratory. Lactation averages indicate wide differences among breeds for percentage of protein and total yield. Identification of cows with high fat yield does not assure identification of those cows with high protein yield. Seasonal variations were noted for raw milk and retail samples of fluid milk. Average protein content of retail whole milk samples was 3.26%, but levels ranged from 2.82% to 4.20%. Protein content of low fat milk varied depending on the level of fortification with non-fat milk solids.

Consumers have been concerned about fat, calorie, and nutritional content of many foods. In this light, it is unfortunate that many people think that dairy products are higher in fat than is actually true (*2*). The dairy industry, in response to consumer demands and other economic factors, has standardized milk to lower fat contents before consumer packaging. Introduction of low-fat milk products and the trend toward minimum fat content in whole milk are evidence of this standardization.

The dairy industry has for many years used volume and milkfat content as a basis for payment. Some dairy industry representatives have been interested in paying for milk on the additional basis of solids-not-fat or protein content. This has been done in a few instances, but has not been widely implemented. Reviews of the pricing situations in the province of Ontario and New England have been undertaken. Proposals of multiple component pricing are being presented to milk pricing agencies, processors, and producers.

Nutritional labeling, including protein content, will be mandatory for some foods after July 1, 1975 and it will include low-fat dairy products. Some processors are already providing nutritional information on containers. They have analyzed many samples of their products and provide the complete nutritional label in the form approved by the Food and Drug Administration.

We can expect to see protein content used as a basis for payment in the future. New electronic equipment is available which provides accurate protein values. Processors will want to purchase milk on the basis of protein, since they must label the content of products which they sell. Protein content is especially important for cheese and non-fat dry milk, because protein is a major factor determining yield.

[1]*Authorized for publication on October 9, 1974 as Journal series paper 4669 of the Pennsylvania Agricultural Experiment Station.*

Dairy products should be promoted on the basis of those essential nutrients required in the daily diet. Dairy products are good sources of protein, calcium, riboflavin, and other vitamins and minerals. Thus it seems appropriate to recognize more than volume and fat content in the pricing of milk.

Early textbooks show that milk contains an average of 3.5% protein. The Milk Industry Foundation has published a Nutritional Labeling Manual (*4*) which shows varying protein content depending on solids-not-fat content. There are several sources giving generalized guides to the levels contained and the relationships among constituents of milk.

Objectives of this study are to evaluate raw milk and fluid milk products currently on the market for protein content and to observe the relationship in milk between fat and protein content.

MATERIALS AND METHODS

Individual cow samples, taken at approximately monthly intervals, were collected by Dairy Herd Improvement supervisors from pails or metering devices. Four-ounce plastic bags with potassium chromate preservative were used. Average size of sample was about 2 oz. Air was excluded and bags were tightly closed. Samples were packed in fiberboard boxes and shipped by United Parcel Service or Parcel Post to the Central Testing Laboratory.

Samples were analyzed following warming and mixing. The Foss Combi fat-protein tester was used for analysis. Results were printed on tape and visual read out was indicated. Summary and analysis of protein, fat, and milk were made by computer.

Retail milk samples were purchased at stores throughout Pennsylvania. This was not done on a random basis, but rather as the travel schedule to Extension meetings permitted. Samples were transported to the Central Milk Testing Laboratory in iced, insulated containers. Following mixing, samples were checked for bacterial count and flavor. Two-ounce portions were poured into plastic bags and transferred to the Central Testing Laboratory for protein analyses. Results were tabulated and summarized manually.

RESULTS AND DISCUSSION

Raw milk

About 9000 individual cow samples from about 160 herds were analyzed each month. Protein testing was in addition to that for fat and the routine milk yield measurements.

Breed differences and differences within each breed are important. Averages of lactations completed in 1973 are in Table 1, listed by breed. These figures reflect actual production in lactations of 270 to 305 days in length. Yields of milk and fat are characteristic of the respective breeds (*3*). Substantial differences exist among breeds both for percentage protein and for total protein yield. It is evident that the relationship of protein to fat is not

TABLE 1. *Average lactation production by breed*

Breed	No. records	Yield (lb)			Percentage	
		Milk	Fat	Protein	Fat	Protein
Ayrshire	350	11,980	499	411	4.17	3.43
Guernsey	604	10,605	502	386	4.73	3.64
Holstein	2,887	14,059	531	463	3.78	3.29
Jersey	676	9,030	466	360	5.16	3.99
Brown Swiss	396	12,121	504	448	4.16	3.70

constant, as the Brown Swiss are 4th for fat percentage, but 2nd high for protein percentage.

Examination of the five highest cows in each breed for lactation fat yield and the five highest for protein yield shows the lack of agreement between the fat and protein content of milk. In none of the five breeds did the five high fat producing cows include the five high protein records. In the Holstein breed, none of the five high fat producing cows made the high protein list. To identify cows with high protein yield, test for protein. We cannot select these animals by choosing the high fat producers.

Sample day milk weights and test values for individual cows were combined to determine a "herd test" or an estimate of the bulk tank contents for the day. Table 2

TABLE 2. *Herds tests for protein and fat by month of sampling*[a]

Month	No. herds	Percentage		Protein/ Fat	r_{pf}	b_{pf}
		Protein	Fat			
January	177	3.55	4.21	.84	.82	.45
February	169	3.59	4.19	.86	.79	.41
March	175	3.49	4.13	.85	.83	.40
April	169	3.48	4.11	.85	.82	.37
May	176	3.50	4.08	.86	.75	.32
June	175	3.42	3.96	.86	.78	.40
July	160	3.25	3.97	.82	.80	.39
August	161	3.21	3.92	.82	.86	.48
September	157	3.33	3.98	.83	.83	.48
October	170	3.44	4.04	.85	.86	.44
November	166	3.48	4.17	.83	.85	.44
December	159	3.47	4.24	.82	.87	.45

[a]Herd tests based on estimates of total herd milk yield calculated from individual cows' samples day production. The regression coefficient of protein on fat test is labelled b_{pf} and the correlation coefficient between these two variables is labelled r_{pf}.

shows the number of herds tested during 1973, listed by month of sampling. About 9,000 cows were tested each month, with average daily yield of approximately 40 lb. of milk. Statistical analyses of these herd values for protein and fat test indicate rather poor predictability of protein test by knowing the fat content. The regression values given in the column headed b_{pf} indicate that in May, herd test increased only .32% in protein for each 1% fat increase, while the average change in August and September was .48%. Thus, if a processor were to estimate protein content from fat content, he would be faced with a changing relationship throughout the year. Also the degree of association between these two constituents is far from perfect, as measured by the correlation coefficient r_{pf}.

Seasonal influences are similar for both protein and fat. Both constituents have the lowest values in late summer. However, the protein/fat ratio indicates there are seasonal changes, with this value ranging from .82 to .86. It should be noted that while the data adequately reflect seasonal fluctuations, the means are not representative of all Pennsylvania milk. Herds selected for protein research were intentionally chosen to allow breed characterization. Thus the data represent a greater proportion of high testing breeds than the dairy population as a whole. The number of days a cow has been milking following calving has a predictable influence on protein level (*1*). The lowest testing milk is normally produced about 50 days after calving. Since the number of cows calving in a given period is not uniform throughout the year, there is some confounding of the effect of stage of lactation and environmental seasonal effects.

Processed milk

A total of 1,125 samples of store-purchased milk were analyzed for protein. They included whole milk, 2% milk, 1% milk, and skim milk. Analyses of 890 samples of whole milk showed that protein content ranged from 2.82 to 4.20%. The average protein content was 3.26%. The average and range of protein content for each 3-month period are in Table 3.

TABLE 3. *Protein content of retail whole milk samples*

No. of samples	Period	Percentage	
		Range	Average
113	Apr.-June 1972	2.85-3.52	3.21
127	July-Sept.	2.85-3.71	3.27
66	Oct.-Dec.	3.18-3.63	3.41
158	Jan.-Mar. 1973	2.86-3.76	3.35
111	Apr.-June	2.99-4.20	3.30
49	July-Sept.	2.82-3.56	3.27
44	Oct.-Dec.	2.85-3.62	3.21
106	Jan.-Mar. 1974	2.87-3.57	3.20
116	Apr.-June	2.90-3.48	3.20

The wide variation in protein content can be partially explained by the fact that some samples were from individual herds. These were from farm retail operations which process their own milk and sell directly to consumers. Some of these herds were Guernseys and Jerseys which have milk with a higher protein content, while others were known to have feeding problems which might be expected to lower protein levels. These samples were not randomly selected. However, they included more than 250 brands sold in Pennsylvania and represented nearly 200 processing plants.

Lower protein percentages were noted during the spring and summer with highest values in the fall. Note the apparent decline in protein during the past 2 years. This is thought to be associated with the higher costs of protein feed to dairymen, and the lower feeding level of this nutrient.

Protein content of retail milk varied more than was expected. To comply with nutritional labelling it will require extensive protein testing. The alternative is to use a minimal value such as 3.0% protein on the nutritional label. Nearly all brands of milk would meet this level on a year around basis. Processors may choose to test and fortify with protein at a specific level. One common protein label for all milk will understate nutritional value. This desirable nutrient should be promoted to the fullest extent possible.

The survey included 160 samples of 2% low fat milk which ranged in protein content form 2.99% to 4.15%.

Levels of fortification indicated on containers varied from 0 to 2.0% added solids. Initially there were at least eight levels of fortification as shown in Table 4.

TABLE 4. *Protein content of retail low fat samples*

Product	No. samples	Added solids level	Percentage	
			Range	Mean
2%	51	—	2.99-4.12	3.40
	12	.5%	3.19-3.55	3.41
	17	1.0%	3.16-3.91	3.46
	6	1.5%	3.21-3.83	3.55
	11	1.7-1.8%	3.12-3.77	3.44
	55	2.0%	3.16-4.15	3.62
	4	20% more protein fortified	3.33-3.63	3.52
	4		3.19-3.99	3.43
1%	2	—	3.34-3.58	3.46
	6	1.0%	3.54-3.94	3.75
	9	2.0%	3.54-4.09	3.89
	2	20% more protein fortified	3.67-4.02	3.85
	2		3.40-3.83	3.62
Skim milk	25	—	3.12-4.04	3.49
	5	.5%	3.09-3.65	3.49
	3	1.0%	3.48-4.01	3.76
	7	1.5%	3.28-3.80	3.57
	12	2.0%	3.31-4.12	3.73
	2	fortified	3.43-3.64	3.54

Processors have generally reduced this number to four. There are not enough samples at most levels to be significant. Only two levels, 0 and 2.0% added solids, would seem to have enough samples to indicate a trend. In general, the higher the indicated level of fortification, the higher the protein content.

The levels of added solids and protein ranges and averages are shown for 54 samples of skim and 21 samples of 1% milk. The observations show the trend of some retail products. Labels of some containers now indicate that non-fat milk solids and lactose are added. Usually these commercial combinations contain stabilizers and emulsifiers. According to the latest Pennsylvania Department of Agriculture regulations dairy product containers must show on the label the source and percentage of added solids and other ingredients.

Two percent milk is usually fortified with added non-fat milk solids. These levels vary and have decreased as the price of non-fat solids has increased. Initially most processors used non-fat milk solids to fortify while others apparently used lactose and stabilizers with or without non fat milk solids. Commercial products containing largely lactose and stabilizer do not significantly contribute to protein content. They do improve body and flavor.

Some processors did not seem to have added any milk solids to fortified products. Therefore, protein values were not as high as expected. However, in general, the higher the indicated level of fortification, the higher the protein content of the lowfat milk.

SUMMARY AND CONCLUSIONS

A knowledge of the protein content of raw milk is becoming more important. Protein content must be established precisely to comply with nutritional labelling requirements for low fat milk and other dairy products. Manufacturers are concerned about protein content of milk as it influences yield of cheese and non-fat powder. Wide variations in yield are largely based on protein and total solids content. As prices increase, yield is more critical.

When nutritional labelling becomes effective, more protein testing seems inevitable. Processors need to be aware that raw milk is variable due to the breed of the cow and season of the year, among other factors. Predictability of protein content from fat content is rather poor and appears variable throughout the year. Automated equipment is available to accurately determine protein content of large volumes of samples at reasonable costs. Protein will play a more important role in the pricing of milk and milk products.

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Evaluation of Cultural Methods to Isolate *Salmonella* from Pressed Yeast and Dried Inactive Yeast

CLYDE R. WILSON, WALLACE H. ANDREWS, and PAUL L. POELMA

Division of Microbiology; Food and Drug Administration
Department of Health, Education, and Welfare; Washington, D.C. 20204

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ABSTRACT

An improved method recently developed to isolate *Salmonella* from dried active yeast was evaluated for use with pressed yeast and dried inactive yeast. The method for dried active yeast consists of pre-enriching a 25-g sample in trypticase soy (TS) broth at a sample-broth ratio of 1:10, incubating at 35 ± 0.5 C for 24 ± 2 h, and transferring to lauryl sulfate tryptose (LST) and tetrathionate (TT) broths. After 24 ± 2 h at 35 C, the broths are streaked to selective agars. When evaluated for use with pressed yeast, *Salmonella* attained higher most probable number levels/ml with this method ($7.9 \times 10^4 - 3.3 \times 10^6$) than with 1% tryptone broth and a sample-broth ratio of 1:5 ($1.7 \times 10^3 - 1.7 \times 10^6$), which is the current examination procedure for pressed yeast. *Salmonella* was consistently isolated from selective agars streaked from TT broth, but was seldom isolated from selective agars streaked from LST broth because of massive overgrowth by non-salmonellae. With dried inactive yeast, this modified method was equal to, but not significantly better than, pre-enrichment of the yeast in sterile distilled water at a sample-broth ratio of 1:5, which is the current procedure for dried inactive yeast.

Yeast has been used for centuries in the brewing of beer and in the manufacture of breads, cheeses, and other fermented foods. Today's use of yeast has been expanded so that the yeast itself, once regarded as a useless by-product, is considered a valuable food source. Unfortunately, yeast has been implicated or definitely incriminated in several outbreaks of salmonellosis (*4, 5, 7*). This finding is particularly significant when one considers its use as a dietary supplement in foods for infants and the debilitated confined to hospitals and other institutions.

Methods to detect *Salmonella* in foods are in a state of flux, subject to almost continuous refinements or even major modifications. Because of the occasional, but recurring, isolation of *Salmonella* in samples of yeast examined by the Food and Drug Administration (FDA) it was decided to assess the adequacy of existing methods for detecting *Salmonella* in both pressed yeast and in dried inactive yeast. Present methods for examining these two types of yeast for *Salmonella* were compared with an improved procedure recently developed for use with dried active yeast (*6*).

Pressed yeast consists of viable yeast cells which have been grown in large quantity, washed with water to remove soluble waste material, concentrated by centrifugation, and pressed into blocks with a moisture content of approximately 70% (*3*). Pressed yeast, like dried active yeast, consists of cells of *Saccharomyces cerevisiae*. There are differences between the two yeasts, however, which could affect examination results. The major differences are moisture content, activity on a dry weight basis, use of special strains for preparations of dried active yeast, and significantly different methods of propagation depending upon whether the yeast is intended for drying or pressing.

A second kind of yeast investigated in this study was dried inactive yeast. This kind of yeast consists of the dried cells of any suitable strain of *S. cerevisiae* or *Candida utilis,* the latter more commonly known as Torula yeast. Certain strains, particularly those of *Saccharomyces carlsbergensis,* may also be obtained as a by-product from the brewing of beer.

MATERIAL AND METHODS

Total viable yeast counts for the pressed yeast and inactive yeasts were determined with conventional plate counting procedure (*2*) using Butterfield's phosphate buffer as the diluent and Wort agar for pour plates. Total bacterial counts were obtained by plating from these same dilutions into nutrient agar. Wort agar plates were incubated at 26 C for 96 h and nutrient agar plates at 35 C for 48 h.

To determine which pre-enrichment procedure was more productive for isolation of *Salmonella* from pressed yeast, a 50-g sample was pre-enriched in 200 ml of 1% Tryptone broth (present procedure), and a 25-g sample was pre-enriched in 225 ml of Trypticase Soy (TS) broth (modified procedure).

The pre-enrichment mixtures were adjusted to pH 6.8 ± 0.2, inoculated with *Salmonella,* approximately 2 cells/g of yeast, and incubated at 35 ± 0.5 C for 24 ± 2 h. *Salmonella* populations of these pre-enrichment mixtures were then determined by the 5-tube most probable number (MPN) technique using lauryl sulfate tryptose (LST), selenite-cystine (SC), and tetrathionate (TT) broths. Ten-milliliter volumes of enrichment broths were inoculated with 1-ml portions of dilutions from the pre-enrichment flasks, incubated at 35 C for 24 h, and streaked onto bismuth sulfite (BS) (Difco) agar. The BS agar was examined after 24 and 48 h of incubation at 35 C and suspicious colonies were isolated and serotyped to confirm them as being the same *Salmonella* serotype that had been inoculated. Controls of uninoculated yeast were included with each procedure.

The procedural comparison for the inactive yeast was accomplished by mixing 50 g of yeast with 200 ml of sterile distilled water (present procedure) and 25 g with 225 ml of TS broth (modified procedure). Subsequent pH adjustment, *Salmonella* inoculation, incubation, and MPN determinations were performed as previously described.

The 5 *Salmonella* serotypes used in this study (*S. senftenberg, S. derby, S. oranienburg, S. worthington,* and *S. urbana*) were chosen because they are among the most frequently isolated serotypes from foods. Cultures of *S. senftenberg* and *S. derby* were specifically isolated from dried yeast while the remaining three serotypes were obtained from the Division of Microbiology's stock culture collection.

Additionally, this particular set of serotypes was chosen to include both monophasic and diphasic organisms from five somatic serological groups. Procedural methodology and all media used subsequent to the pre-enrichment stage were in accordance with official methods of the Association of Official Analytical Chemists (*1*).

RESULTS AND DISCUSSION

The count of viable yeast/g in the pressed yeast, made over an 8-week period, ranged from 7.1×10^9 to 1.3×10^{10} with 69% of the 26 determinations falling between 9.2×10^9 and 1.0×10^{10}. No decline in numbers of viable yeast was noted during this 8-week period, but counting was discontinued at that time because of mold growth on the yeast blocks. These findings imply stable yeast cell populations over this extended period and indicate that the limiting factor for the shelf-life of pressed yeast is probably surface growth of mold rather than a reduction in the viability of the yeast. The total bacterial count (mean) of the pressed yeast immediately before the comparative evaluation of cultural methods was 1.6×10^6/g, and no naturally-occurring *Salmonella* was found.

With pressed yeast the modified pre-enrichment procedure gave a higher *Salmonella* MPN with 4 of 5 serotypes tested than did present methodology (Table 1). *Salmonella* counts obtained using the modified procedure ranged from 7.9×10^4 to 3.3×10^6 compared with a range of 1.7×10^3 to 1.7×10^6 using the present methodology. MPN figures for *S. worthington* were identical in both the present and improved procedures.

TABLE 1. *Comparative enumeration of* Salmonella *in pressed yeast pre-enriched in 1% tryptone and trypticase soy broth*

Organism	1% Tryptone Broth Sample/broth ratio 1:5			Trypticase Soy Broth Sample/broth ratio 1:10		
	LST[a]	SC[b]	TT[c]	LST[a]	SC[b]	TT[c]
S senftenberg	–[d]	<2	1.7×10^3[e]	–	<2	1.1×10^5
S. derby	–	<2	1.1×10^5	–	<2	3.3×10^6
S. oranienburg	–	<2	4.9×10^4	–	<2	1.3×10^6
S. worthington	–	<2	1.7×10^6	–	<2	1.7×10^6
S. urbana	–	<2	1.7×10^4	–	<2	7.9×10^4

[a]Lauryl Sulfate Tryptose broth
[b]Selenite Cystine broth
[c]Tetrathionate broth
[d]Overgrowth by non-salmonellae precluded MPN determination
[e]All numbers are MPN/ml

In a previous study (*6*), SC broth inhibited *Salmonella* in dried active yeast, and this inhibition was more pronounced when SC broth was used with pressed yeast. With the dried active yeast, all five *Salmonella* serotypes tested were markedly inhibited in SC broth and growth on selective agar plates was sparse, but recovery of each *Salmonella* serotype was possible. With pressed yeast, *S. worthington* was the only 1 of 5 serotypes tested to be qualitatively recovered in related studies.

Though LST broth functioned well as a selective broth with dried active yeast (*6*), it was not effective with pressed yeast (Table 1). Consistent overgrowth by non-salmonellae rarely allowed the selection of pure cultures of *Salmonella* from the selective agar plates. In using LST broth as the selective enrichment with the pressed yeast, it could have been possible in certain instances to obtain MPNs comparable to those MPNs obtained with TT broth. The results, however, would have been biased and misleading since these LST broth MPNs would have resulted from excessive effort in purification of cultures. A further consideration should be limitations imposed by the MPN technique itself. When used to compare methods, any plate containing at least one *Salmonella* colony would be considered positive regardless of the actual number of *Salmonella* colonies present. Thus, in certain instances, such as in the case reported here, additional qualifications should be given in the interpretation of MPN data. Selective agar plates streaked from TT broth usually contained discrete colonies with little or no additional effort being required for purification of isolates.

In evaluating the modified method for use with inactive yeast, two types (Torula and *Saccharomyces*) were used. Neither type of inactive yeast contained viable yeast cells. The bacterial count was 1.0×10^4/g in the *Saccharomyces* type, and 4.6×10^3/g in the Torula yeast. No naturally-occurring *Salmonella* was isolated from

TABLE 2. *Comparative enumeration of* Salmonella *in two types of dried inactive yeast pre-enriched in water and in trypticase soy broth*

Organism	Water Sample/broth ratio 1:5			Trypticase Soy Broth Sample/broth ratio 1:10		
	LST[a]	SC[b]	TT[c]	LST	SC	TT
Saccharomyces cerevisiae						
S. senftenberg	1.1×10^8[d]	2.3×10^7	1.3×10^7	2.3×10^8	1.7×10^8	3.1×10^7
S. derby	3.3×10^8	2.3×10^8	1.7×10^6	7.9×10^7	4.6×10^8	3.1×10^6
S. oranienburg	3.3×10^8	7.9×10^8	3.3×10^7	3.3×10^8	3.3×10^8	1.7×10^8
S. worthington	4.9×10^8	3.3×10^8	3.3×10^8	1.3×10^8	7.9×10^8	1.3×10^8
S. urbana	2.3×10^8	2.3×10^8	1.1×10^8	2.3×10^8	1.7×10^8	2.3×10^7
Candida utilas (Torula)						
S. senftenberg	2.3×10^8	2.3×10^8	1.3×10^8	7.9×10^8	3.3×10^8	4.9×10^8
S. derby	1.7×10^8	7.9×10^7	4.9×10^7	4.9×10^8	4.6×10^8	1.3×10^8
S. oranienburg	7.9×10^8	4.9×10^8	3.3×10^8	1.3×10^9	4.9×10^8	3.3×10^8
S. worthington	1.3×10^9	1.7×10^9	7.9×10^8	1.3×10^9	7.0×10^8	3.5×10^9
S. urbana	1.7×10^9	3.5×10^9	3.3×10^8	1.3×10^9	1.4×10^9	1.3×10^9

[a]Lauryl Sulfate Tryptose broth
[b]Selenite-Cystine broth
[c]Tetrathionate broth
[d]All figures are MPN/ml after 24 h

either of the inactive yeast types examined in this study. Comparison of the current pre-enrichment method used with dried inactive yeast and the improved procedure developed for dried active yeast failed to show a decided advantage for either procedure. The *Salmonella* MPNs obtained with each method are shown in Table 2. These figures indicate that both pre-enrichment procedures promote a sufficient increase in numbers of *Salmonella* to assure its growth in the secondary enrichment media and its subsequent isolation from selective agar plates. Unlike the situation with the pressed yeast, no inhibition of *Salmonella* by SC broth was noted with either type of inactive yeast. Thus, there is no apparent need for substitution of LST broth for SC broth in the examination of dried inactive yeast for *Salmonella.*

Evaluation of the improved procedure developed for isolation of *Salmonella* from dried active yeast with additional types of yeast was considered a logical sequel to its development. Relating the findings of this study to those of the previous study with dried active yeast (*6*), it is recommended that in the analysis of pressed yeast: (*a*) TS broth at a sample/broth ratio of 1:10 be used since *Salmonella* populations generally attained somewhat higher levels with this pre-enrichment procedure as compared to 1% Tryptone at a 1:5 sample/broth ratio, and (*b*) TT broth be used at the selective enrichment stage since SC broth exhibited marked inhibition for *Salmonella* and LST broth allowed non-*Salmonella* organisms to actively multiply and, in most instances, to overgrow the *Salmonella* organisms. Analysis would be continued by streaking onto selective agars, with subsequent isolation and identification performed as described in official methodology (*1*).

In the analysis of dried inactive yeast for *Salmonella,* it is recommended that: (*a*) TS broth at a sample/broth ratio of 1:10 be used at the pre-enrichment stage for the sake of uniformity with the methods of analyses of the other types of yeast, and (*b*) SC and TT broths be used at the selective enrichment stage since no marked inhibition of *Salmonella* was noted with either broth. Analysis would be continued by streaking onto selective agars, with subsequent isolation and identification done as described in official methodology (*1*). The use of LST broth would be indicated if the figures in Table 2 were the only consideration, but other factors must be weighed. The inactive yeasts used for this study were food grade and contained few contaminating microorganisms. This situation is normal for yeast intended for human consumption but in the event more heavily contaminated material were encountered, *Salmonella* might be overgrown in LST broth. Using SC and TT broths would allow use of the same methodology for examination of feed or fodder type yeasts, which have less rigorous microbiological standards than does yeast produced for human consumption.

The significance of any study involving a comparison of methods can be increased by using naturally contaminated samples. Unfortunately, samples of pressed yeast and dried inactive yeast naturally contaminated with *Salmonella* were not available to the authors at the time of this study, but it is believed that the data accumulated are still valid. It is anticipated that a methods comparison will be done when naturally contaminated samples of these yeast types become available.

Results of this study coupled with those of previously reported data (*6*) indicate the intrinsic variability found in the various types of yeast. This variability makes it necessary to select the analytical procedure in accordance with the type of yeast to be examined to provide optimal conditions for the recovery of *Salmonella.*

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A Research Note

Microwave Pasteurization of Milk

H. O. JAYNES

Department of Food Technology and Science, Institute of Agriculture
University of Tennessee, Knoxville, Tennessee 37901

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ABSTRACT

Pasteurization of milk was accomplished using microwaves (2450 MHz) as the energy source in a continuous heating apparatus with two-stage regeneration. Treatment was 72 C for 15 sec. Adequacy of pasteurization was measured by phosphatase tests and bacterial plate counts and results were compared to those of controls treated 62.8 C for 30 min. A triangle taste panel found no significant difference between microwave pasteurized milk and the control.

Application of microwave heating to food products has, for the most part, involved cavity applicators with the familiar microwave oven being the most popular. Continuous microwave processes are in use for potato chips, and Kenyon et al. (*5*) used continuous processing for unitized packaged materials. Continuous heating of liquid food products for pasteurization has been more limited. Copson (*1*) and Haagensen (*2*) adapted the process for pasteurizing citrus juices. Hamid et al. (*3*) initiated the pasteurization of milk and achieved pasteurization at 83 C, using gravity flow through a microwave heat exchanger consisting of a glass tube in a rectangular waveguide.

This work was undertaken to investigate pasteurization of milk with a microwave energy source in a system which mechanically resembled conventional HTST equipment in the heating-holding-cooling sequence of operations.

MATERIALS AND METHODS

A variable power microwave generator, Holaday Industries[1] Model H1-1200, was used. The power output was continuously variable from 0 to 1.5 kilowatts (KW) at a nominal frequency of 2450 MHz. Microwave energy was applied through a rectangular brass waveguide enclosing a Teflon flow-though liquid applicator with an internal diameter of .635 cm and a length of 12 cm.

A regenerator was assembled to warm incoming cold milk and to cool milk after heating. This consisted of two 60-cm glass Allihn condensers connected in series with plastic tubing so that incoming milk flowed through cores and heated milk flowed through jackets in a counter-flow manner. Condensers were insulated with flexible plastic foam sheets to minimize heat loss. A glass holding tube with an internal diameter of 2.54 cm and suitable length to effect a 15-sec hold time at a given flow rate was inserted after the heat exchanger and before the first Allihn condenser. A thermocouple inserted at the exit of the holding tube measured pasteurization temperatures, and one placed just before the heat exchanger measured incoming milk temperatures. Milk was pumped through the apparatus with a Cole-Parmer Masterflex variable speed pump.

To initiate a trial, boiled distilled water at 80 C was pumped through the system for 15 min. This was followed by distilled water (5-7 C) which had been boiled. Flow rates and microwave power needed to achieve 72 C adjusted while the water was being pumped through, then the system was switched to cold raw milk (5-7 C), and minor adjustments were made in the microwave power unit to give a milk temperature of 72 C at the discharge end of the holding tube. Pooled raw milk from the University dairy herd was used and control samples of the same milk were pasteurized at 62.8 C for 30 min in a constant temperature water bath.

Adequate pasteurization was measured by phosphatase tests and standard plate and coliform counts according to *Standard Methods* (*4*). Flavor comparisons were made via a triangle panel of 27 people as outlined by Larmond (*6*).

The electrical power required to achieve power outputs of .2 to 1.0 KW from the microwave pasteurizer was established. With water flowing through the heat exchanger, the power generator was adjusted to produce a chosen microwave power reading, and the line current at 225 V as measured with an ammeter. Duplicate measurements were taken at increments of .1 KW microwave power, the power inputs in KW were calculated from the amperages, and the results were analyzed by regression.

RESULTS AND DISCUSSION

Electrical power input was a linear function of microwave power generated, and gave the linear regression equation:

Line Input (KW) = .331 + 1.139 (Microwave Output, KW). The standard deviation was .022 KW. The intercept value, .331 KW, represents power required to operate the generator and control unit with no microwave energy being produced.

Milk was pasteurized at three flow rates; 200, 300, and 400 ml/min. Results in Table 1 show power requirements and the temperature differential, ΔC, through which the milk had to be heated. Although the regenerator was not impressively efficient, it did reduce the load on the microwave generator. Come-up times in the MW applicator were calculated for the three flow rates: 1.14 sec at 200 ml/min, .76 sec at 300 ml/min, and .57 sec at 400 ml/min. The rate of cooling in the regenerator was not determined. As milk replaced water in the system,

TABLE 1. *Power required to pasteurize milk (72 C for 15 sec) at three flow rates*

Flow rate (ml/min)	ΔC[1]	Power required, KW	
		Microwave[1]	Line input[2]
200	30.88	0.450	0.844
300	33.25	0.735	1.168
400	33.17	0.957	1.421

[1]Mean of four replicates.
[2]Calculated from the regression equation:
Line input (KW) = 0.331 + 1.139 (Microwave output, KW)

[1]*Mention of Company names does not imply endorsement.*

turbulence was observed in the holding tube at all three flow rates.

Phosphatase tests and standard plate and coliform counts were done on microwave and control pasteurized milk. In all instances, the phosphatase tests were negative. Data on standard plate and coliform counts are shown in Table 2. To increase the microbial load, the first sample at 200 ml/min flow rate was held 16 h at room temperature. Results indicated comparable count reductions by the two treatments at all three flow rates through the microwave heater.

TABLE 2. *Reduction of bacteria counts by microwave (72 C for 15 sec) and control (62.8 C for 30 min) pasteurization of milk*

Flow rate, MW (ml/min)	Bacteria counts	Plate count per ml[1]		
		Raw	Microwave	Control
200	Std. plate	1,000,000	4100	3500
	Coliform	2900	<1	<1
200	Std. plate	45,000	94	460
	Coliform	200	<1	<1
300	Std. plate	12,000	5900	4100
	Coliform	30	<1	<1
300	Std. plate	84,000	90	120
	Coliform	1500	<1	<1
400	Std. plate	20,000	650	420
	Coliform	70	<1	<1

[1]Means of duplicates.

A triangle taste panel test was used to assess possible differences in flavor between the same milk pasteurized by microwaves and by the control procedure, 62.8 C for 30 min. Of 27 panelists, 10 detected a difference, and 8 of these 10 preferred the microwave pasteurized sample. Both results were below the number required for significance at the 95% confidence level. Three trained judges noted only cooked flavor in both samples.

Results demonstrated the applicability of microwave energy as a heat source for continuous pasteurization of milk in a system resembling conventional high temperature short time equipment. For commercial application the cost of microwave heating equipment and electricity would have to be taken into account. In a future situation with low cost electric power and a need to minimize atmospheric pollution from conventional steam generation, the process could have possibilities.

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Fluorescent Light-Activated Flavor in Milk [1]

A. P. HANSEN, L. G. TURNER, and L. W. AURAND

Department of Food Science
North Carolina State University, Raleigh, North Carolina 27607

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ABSTRACT

Homogenized milk packaged in polyethylene containers exposed to fluorescent lights showed flavor and vitamin deterioration. Off-flavor development began within 2 to 4 h after exposure to a lighting system simulating commercial display cases. Detection of light-induced flavor was slight, medium, and strong after 4, 7 and 24 h of exposure. Decreases in riboflavin and ascorbic acid were directly proportional to the amount of light exposure. Various types of colored lamps and lamp filters were tested to prevent this off-flavor and vitamin degradation in milk. Yellow lamps or yellow and green filters protected milk from off-flavor development for 30 to 40 h. It is evident that light-induced off-flavors and vitamin destruction in fluid milk packaged in polyethylene containers can be reduced by colored lamps and lamp filters.

Two types of flavor changes occur in milk following exposure to light. Light-induced off-flavor has been related to degradation of proteins and/or amino acids. It has been described as sunlight, sunshine, activated, burnt, burnt feather, burnt protein, scorched, cabbage, cooked cabbage, and mushroom (*7*). The other flavor defect described as oxidized, papery, cardboardy, cappy, metallic, tallowy, and oily is related to the oxidation of milk lipids (*7*).

Proteins, lipids, and vitamins are adversely affected when milk is exposed to light. Vitamins in milk, especially riboflavin are also photochemically altered by light (*3*).

Anderson (*1*) reported oxidation of ascorbic acid and development of light-induced flavor below a wavelength of 490 nm. Intensity of light, as well as wavelength, can be related to development of light-induced off-flavors (*5, 6, 7, 15, 17, 18*).

Singleton et al. (*16*) reported that monochromatic light (450 nm) was correlated with the development of light-induced activated flavor and maximum destruction of riboflavin and tryptophan occurred at the same wavelength. Ascorbic acid content decreased 66% after 2 days of storage at 48 ft candle fluorescent light exposure (*17*). Other researchers have reported losses of ascorbic acid with minimum destruction of riboflavin after exposure to light (*5, 7*). Use of filters or screening materials incorporated into milk containers to absorb light from wavelengths causing light-induced flavor has been suggested (*11, 13, 18*).

[1]*Paper No.* 3940 *of the Journal Series of the North Carolina State University Agricultural Experiment Station, Raleigh, N.C. The use of trade names in this publication does not imply endorsement by the North Carolina Agricultural Experiment Station of the products named, nor criticism of similar ones not mentioned.*

Light-induced flavor problems have increased due to storage of milk in fluorescent lighted refrigerated display cases and increased used of blow molded polyethylene containers for packaging milk. Surveys in North Carolina (*8*) and Pennsylvania (*4*) showed that milk bottled in these containers frequently had a detectable light-induced flavor. A Connecticut survey (*9*) indicated that only 4.4% of milk in paper cartons developed a light-induced oxidized flavor while percentages for glass and polyethylene were 31 and 33%, respectively.

We studied methods for eliminating light-induced flavor while providing maximum protection for ascorbic acid and riboflavin.

EXPERIMENTAL PROCEDURE

Forty-gram weight polyethylene containers, average thickness of 0.053 cm, were filled with pasteurized, homogenized milk obtained from the North Carolina State University farm over a 1-year period. The processing temperature used was 73.9 C for 17 sec followed by a vacuum treatment at 90 C for 1-2 sec, cooled to 72.8 C, homogenized at 2100 lb/inch^2, and then cooled to 3.3 C. Containers were subjected to 200 ft candles of light from a 40-watt "cool white" fluorescent lamp located 2.5 inches from the samples. The experiment was done in a Bally walk-in refrigerator at 3.3 C. Samples were removed for flavor evaluation at various times up to 72 h of continuous exposure of fluorescent lighting. Samples were evaluated by a taste panel consisting of four individuals trained to identify the presence or absence of a light-induced flavor. Each set of samples and treatments was repeated three times and the average score recorded.

Samples were removed after 6, 12 and 18 h of exposure to light and analyzed for ascorbic acid and riboflavin. Ascorbic acid analysis was made by the micro-fluorometric method (*2*). Oxalic acid (10.5 g) was added to 200 g of milk for preservation. Samples were flushed with nitrogen gas, sealed, frozen, and stored at -28.9 C until analyzed. Riboflavin determinations were made immediately after treatment by the fluorometric method (*2*). Analyses were made in triplicate.

Colored plastic shields (Filter-Lite Company, Greensboro, N.C.) that completely covered the fluorescent lamp and colored fluorescent lamps (Westinghouse Corp., Ralieght, N.C.) were evaluated to determine their effectiveness in preventing development of a light-induced flavor.

A Cary (Varian Corp., Monrovia, California) model 15 spectrophotometer was used to determine the absorption spectra of the plastic shields used in the study. Light intensity measurements of all lamps and shields (micro-watts per cm^2) for various wavelengths were obtained using an Isco (Instrumentation Specialties Company, 4700 Superior St., Lincoln, Nebraska 68505) model SR spectroradiometer.

RESULTS

Examination of the absorbance of plastic shields (Fig. 1) shows that yellow and dark green shields were most

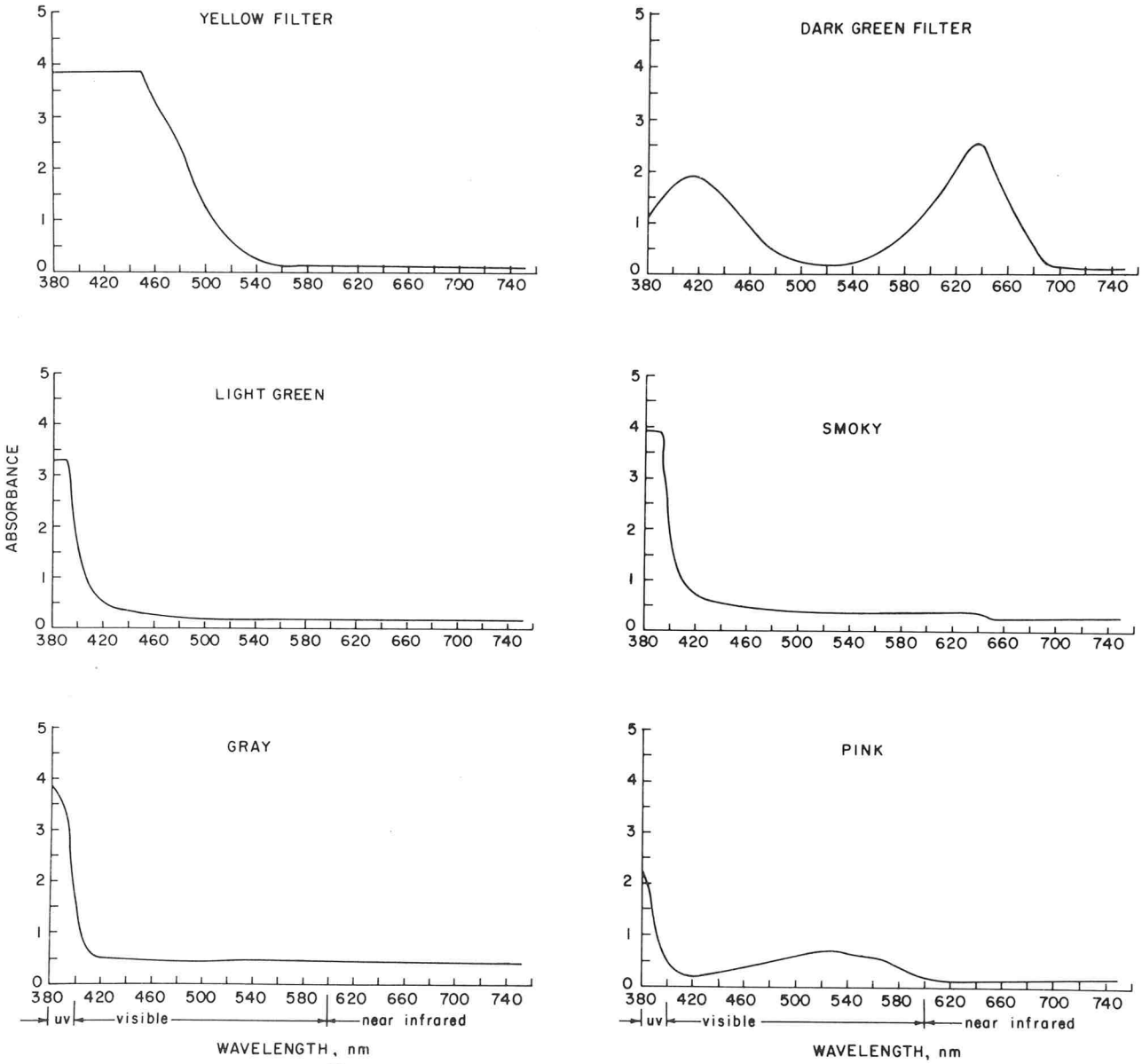

Figure 1. *Absorption spectrum of filters used in this study.*

effective in absorption of light between 400-500 nm. Other light shields tested were not effective in light absorption in this range.

Light intensity transmission patterns are shown in Fig. 2. The pattern of the "yellow lamp" (Westinghouse No. F4050) shows only transmission above 500 nm, which is similar to the "yellow shield." The "smoky shield" pattern is similar to that of the "cool white" lamp but with reduced intensity, 1.5-2.0 microwatts/cm².

Comparison of the flavor scores for milk subjected to continuous fluorescent lighting (Table 1) shows the effect of filtering light on development of light activated flavor. Light activated flavor was first perceived in the unprotected sample (cool white lamp) at 2-4 h by a trained taste panel. A period of 5-7 h (flavor score 2.0) would be required before the average consumer could detect this flavor. It can be seen that the yellow lamp (34 h), yellow shield (32 h) and dark green shield (32 h)

TABLE 1. *Relationship of light-induced flavor in milk to exposure of light from different sources*

Flavor score[a]	Cool white lamp[b] (h)	Yellow lamp (h)	Yellow shield (h)	Dark green shield (h)	Smoky shield (h)	Pink lamp (h)	Light green shield (h)
1	2-4[c]	14-33	17-31	18-31	12-15	16-18	10-17
2	5-7	34-50	32-50	32-47	16-46	19-27	18-21
3	7	50	50	47	46	27	21

[a]Light activated flavor: 1, slight; 2, medium; 3, strong.
[b]Westinghouse, 78 ft candle, 40 watt, fluorescent lamp (Control).
[c]Ranges are used to indicate scores of both winter and early summer milk samples.

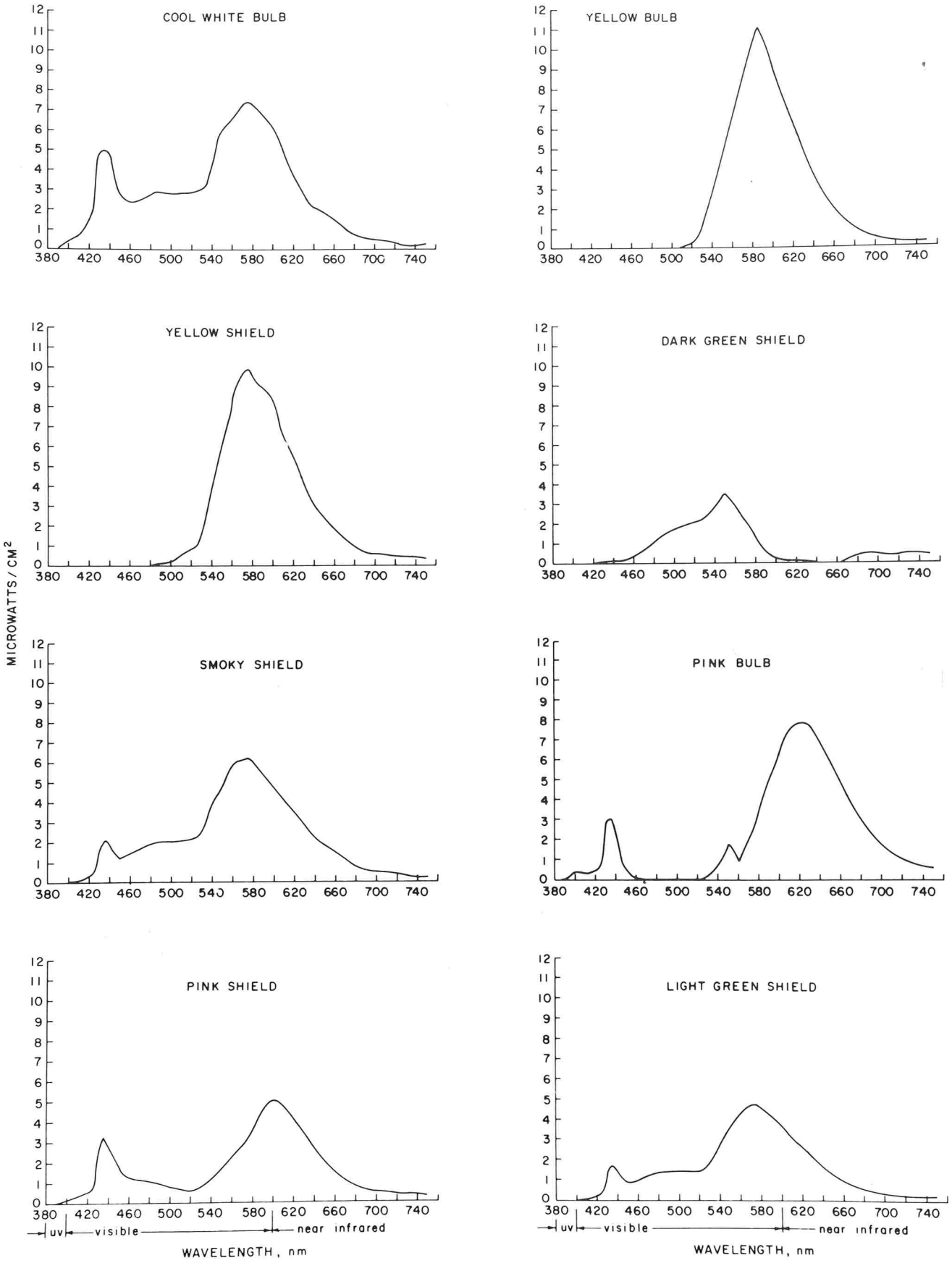

Figure 2. *Light intensity of various lamps and shields after passing through blow molded polyethylene containers (½ gal).*

TABLE 2. *Ascorbic acid values (mg/l) for milk continuously exposed to fluorescent lighting at 3.3 C*

Exposure time (h)	Cool white lamp	Smoky shield	Lt. green shield	Pink lamp	Yellow shield	Dark green shield	Yellow lamp
0	16.64	16.86	16.12	16.67	11.31	15.79	11.90
6	15.38	15.50	15.94	16.33	10.90	15.26	11.90
12	15.21	15.35	14.69	15.51	10.51	15.24	11.65
18	13.25	14.19	13.85	14.96	10.41	15.22	11.50
Average loss (mg/1) per h	0.19	0.15	0.13	0.10	0.05	0.03	0.03
Percentage loss in 18 h	20.37	15.84	14.08	10.26	7.96	3.61	4.62

prevented development of a medium light induced flavor (2.0) to a greater extent than other lamps and shields. Score ranges are the summation of triplicate taste panel studies for each shield and lamp over a one year period.

Variability in ascorbic acid content of milk during this study can be seen in the zero time of the different milk samples, (Table 2), since the study included samples from animals during summer and winter. Average loss per hour and percentage loss are therefore used for comparison of effectiveness of lamps and shields for prevention of light-induced flavor. The control sample (40 g wt polyethylene container), without protection, had approximately 20% loss for the 18-h period compared to approximately 5% loss for the yellow lamp and 4% loss for the dark green shield. Samples of pasteurized whole milk placed in refrigerated storage without light exposure showed no loss of ascorbic acid after 24 h.

TABLE 3. *Percentage loss of riboflavin for milk continuously exposed to fluorescent lighting (cool white lamp) at 3.3 C*

Exposure Time (h)	Riboflavin loss
6	0.00%
12	0.64%
18	1.23%
24	2.01
48	5.87
72	11.65
96	13.12
144	21.12

Decrease in riboflavin content is shown in Table 3. The percentage degradation of riboflavin was greatest for the cool white fluorescent lamp, approximately 2% after 24 h of exposure; increasing to slightly greater than 20% after 144 h of exposure. Less than 1% degradation was observed for all filters and lamps after 24 h of exposure.

DISCUSSION

Light has a dual nature; i.e., wavelength and energy (light intensity). It would appear that reactions for light activated flavor development in milk do not require much energy. This can be readily observed by the low intensity of light that passed through the dark green shield which gave 18 h of protection before any flavor development occurred. This was an increase of 16 h of protection when compared to the unprotected sample.

Wavelength and intensity appear equally important in prevention of light-induced flavor. Various researchers (*1, 13, 16*) tend to agree that wavelengths below 500 nm are related to development of this flavor. Light below 500 nm was effectively "screened out" when using the yellow lamp and yellow shield. The net result was a delay of 16-17 h in development of a detectable light-induced flavor. Intensity for all wavelengths of light transmitted through the yellow lamp and yellow shield was greater than the light intensity transmitted through the dark green shield. However, the yellow and dark green shields afforded approximately the same amount of flavor protection.

Flavor intensity did not change after induction and subsequent storage in a dark refrigerator (Table 4). It

TABLE 4. *Light-induced flavor intensity following exposure of milk to light*[a] *and subsequent storage at 7.2 C*

Exposure (h)	Flavor Score[b]	Flavor score following storage at 7.2 C for 120 h
0.5	0	0
1.0	0	0
2.0	0	0
3.0	1	1
4.0	1	1
5.0	2	2
6.0	2	2
7.0	2	2
8.0	3	3
9.0	3	3
10.0	3	3
11.0	3	3
12.0	3	3

[a]Westinghouse, 200 ft candle, 40 watt, fluorescent lamp.
[b]Light activated flavor; 1, slight, 2, medium; 3, strong.

was concluded that this reaction was photooxidative rather than autooxidative. Flavor intensity (Table 1) and destruction of ascorbic acid (Table 2) were directly related to light intensity. When light was filtered out below 500 nm the flavor development was less severe. It would appear that riboflavin was not destroyed in the formation of light-induced flavor since less than 2% was destroyed after 24 h of exposure to fluorescent lighting. Other researchers (*7, 12*) reported little degradation of the riboflavin of milk due to fluorescent light exposure. Riboflavin could be involved in the reaction that results in light-induced flavor development, without being destroyed.

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Growth of Microorganisms in Chilled Orange Juice

D. I. MURDOCK and W. S. HATCHER, JR.

The Coca-Cola Company Foods Division
Plymouth, Florida 32768

(Received for publication December 6, 1974)

ABSTRACT

Growth of lactic acid bacteria and yeasts in chilled orange juice was investigated. Three suspensions were prepared, each consisting of four strains of *Lactobacillus,* four of *Leucomostoc,* and four of yeast. Each composite suspension was inoculated into a series of bottles containing sterile prechilled orange juice to obtain a final concentration of 1,100, and 1,000 organisms/ml. Samples were stored at 35, 40, 45, and 50 F (1.7, 4.5, 7.2, and 10 C), and were plated periodically throughout the test period. Yeasts grew at all temperatures investigated, their rates of growth increasing with the temperature. *Lactobacillus* organisms grew at 50 F but not at 45 F or below. *Leuconostoc* strains did not grow at 35 F, but grew slowly at 40 F, and rapidly at 45 F and 50 F. Fermentation by yeasts, depending on the level of inoculation, occurred in 1 week or less at 50 F and in 1 to 2 weeks at 45 F. At 35 and 40 F it occurred in 3 weeks but was satisfactory at 35 F for the lowest level of inoculation. Spoilage from growth of *Lactobacillus* was detected between 1 and 2 weeks at 50 F. It did not occur at 45 F or below. *Leuconostoc* required 13 days to 5 weeks at 40, 45, and 50 F. Spoilage did not occur at 35 F. Shelf life of chilled orange juice is dependent upon the initial microbial population at time of packaging and temperature maintained until it reaches the consumer.

There has been in recent years an increasing demand by the general public for convenience-type foods. Chilled orange juice (COJ) is no exception. In the past 10 years consumption of this product has increased from 27.3 million gal. in the 1962-63 season to 112.4 million gal. in 1972-73 (*5*). To continue this phenomenal growth the quality of the product must be maintained from the producer to the consumer.

Chilled juice is a broad class of product sold in single strength form usually refrigerated at the retail level. It may be packed as a sterile or unsterile product and it may contain preservatives. In the non-sterile form it is subject to microbial growth and spoilage—the predominant microflora being yeast and lactic acid bacteria. This orange juice is generally prepared from frozen orange concentrate (FCOJ) by reconstituting with chilled water to the desired Brix level. The resulting product may or may not be pasteurized before packaging. Juice is usually filled into paper cartons, or glass or plastic jugs at a temperature of 35 F or less. The level of contamination at the time of filling has a direct bearing on the ultimate shelf life of the product. The purpose of this study was to determine the growth of yeast and lactic acid bacteria that might be present in marketing non-sterile chilled juice at temperatures normally encountered from the producer to the customer.

[1]*Received from Reseach Dept., Continental Can Co., Inc., Chicago, Il.*
[2]*American Type Culture Collection (ATCC 8082 and 8293).*

EXPERIMENTAL PROCEDURE

Test organisms used in this investigation consisted of: (*a*) four strains of yeast (*Zygosaccharomyces vini* and *Zygosaccharomyces rouxii*[1] *and two isolates from frozen concentrated orange juice*]; [b] four strains of *Leuconostoc* (two of *Leuconostoc* sp. and one each of *Leuconostoc mesenteroides* and *Leuconostoc cremoris*);[2] and (*c*) four strains of *Lactobacillus* sp.[1]

Each isolate was maintained for 3 weeks in sterile single strength orange juice (SSOJ) to insure active growth; then on Potato Dextrose Agar (PDA) slants prepared in 8 oz. screw cap bottles. Incubation was at 86 F (30 C) for 48 to 72 h. Growth on each slant was washed with sterile phosphate buffer (pH 7.1) into a sterile bottle containing glass beads for breaking up clumps of cells. A suspension was made in this manner for each test organism. Concentration of cells were determined by plating in quadruplicate using Orange Serum Agar containing 5% Sucrose (pH 5.4). Plates were counted after incubation for 48 h at 86 F (30 C) and counts were averaged according to standard methods. Three composite suspensions were made from each group of test organisms (yeast, *Lactobacillus,* and *Leuconostoc*) by adding the individual suspensions together in such proportions that gave equal numbers of each strain. The resulting suspension was used immediately or stored in the refrigerator not to exceed 48 h.

Juice used in this study was prepared from reconstituted FCOJ, 12° Brix (pH 3.8). One thousand milliliters were placed into a series of ½ gal. glass screw cap bottles, heated to 180 F for 20 min and then prechilled to desired incubation temperatures before inoculation. Juice was then inoculated with each composite suspension as follows: four bottles with 1,000 organisms/ml, four with 100 organisms/ml, and Four with 1 organism/ml. Juice was incubated at 35, 40, 45, and 50 F (1.7, 4.5, 7.2, and 10 C). Samples were plated in duplicate, using Orange Serum Agar, immediately and at periodic intervals until spoilage was detected. Plates were counted after 48 h incubation at 86 F (30 C). Before each plating the bottles were placed on a mechanical shaker for 30 sec. Controls were prepared for each temperature and were plated and checked organoleptically for off-flavors at the same time that test samples were analyzed for microbial growth. Generation times were calculated as described by Berry et al. (*2*) from the expression:

$$G = \frac{o.3(t_1 - t)}{\text{Log } N_1 - \text{Log } N}$$

Where G ≡ Generation time in hours, N_1 = Number of organisms at t_1, and N = Number of organisms at t.

RESULTS AND DISCUSSION

Growth and survival curves prepared from viable count data for initial inoculum levels of 1 and 1,000 organisms/ml are shown in Fig. 1-3. Generation times are presented in Table 2.

Arrows in the figures indicate when spoilage was first detected at time of plating. The times noted are not precise as spoilage could have occurred just after the previous plating when the product was found to be satisfactory. The samples were generally plated at intervals ranging from 2 to 5 days.

Yeast and lactic acid bacteria

Yeast grew at all temperatures investigated (Fig. 1).

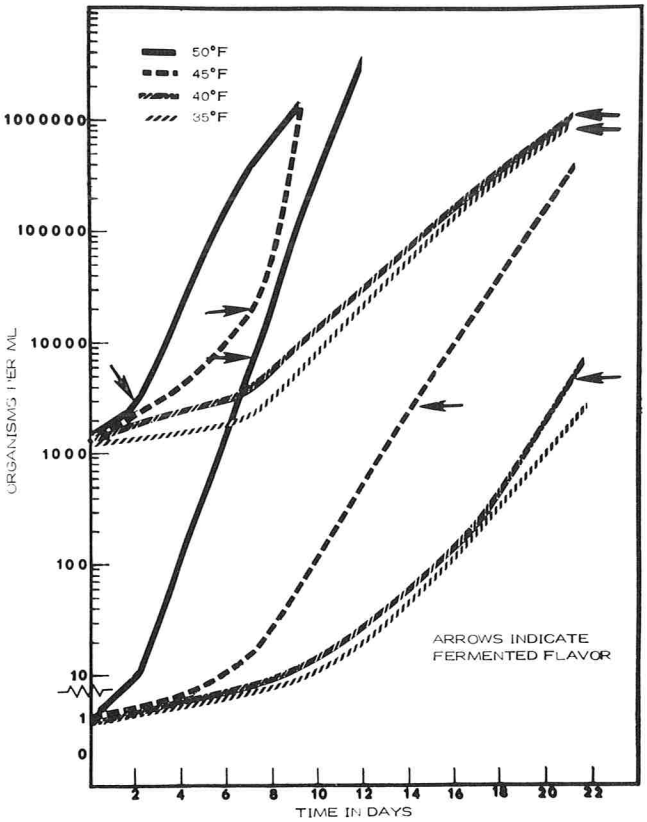

Figure 1. *Effect of temperature on growth of yeast in orange juice inoculated to contain 1 and 1000 organisms/ml.*

They grew progressively faster as the temperature was increased from 35 to 50 F, and the time to produce spoilage decreased accordingly as the level of inoculum increased (Table 1). The yeast appeared to grow slowly at

TABLE 1. *Effect of temperature and level of inoculum of test organisms on development of spoilage in orange juice*

Temp. (F)	Organism and level of inoculum					
	Yeasts		*Lactobacillus*		*Leuconostoc*	
	1/ml	1000/ml	1/ml	1000/ml	1/ml	1000/ml
	—(Days when spoilage was first detected)—					
35	NS[a]	21	NG[b]	NG	NG	NG
40	21	21	NG	NG	35	27
45	14	7	NG	NG	35	13
50	7	2	14	12	20	13

[a]NS = No spoilage detected after 28 days.
[b]NG = No growth.

35 and 40 F but decidedly faster at 45 and 50 F.

Fermentation by yeasts, depending on the level of inoculums occurred in 1 week or less at 50 F and in 1 to 2 weeks at 45 F. At 35 and 40 F it occurred in 3 weeks but was satisfactory at 35 F for the lowest level of inoculation.

Both *Lactobacillus* and *Leuconostoc* strains died at 35 F regardless of the level of inoculum (Fig. 2 and 3).

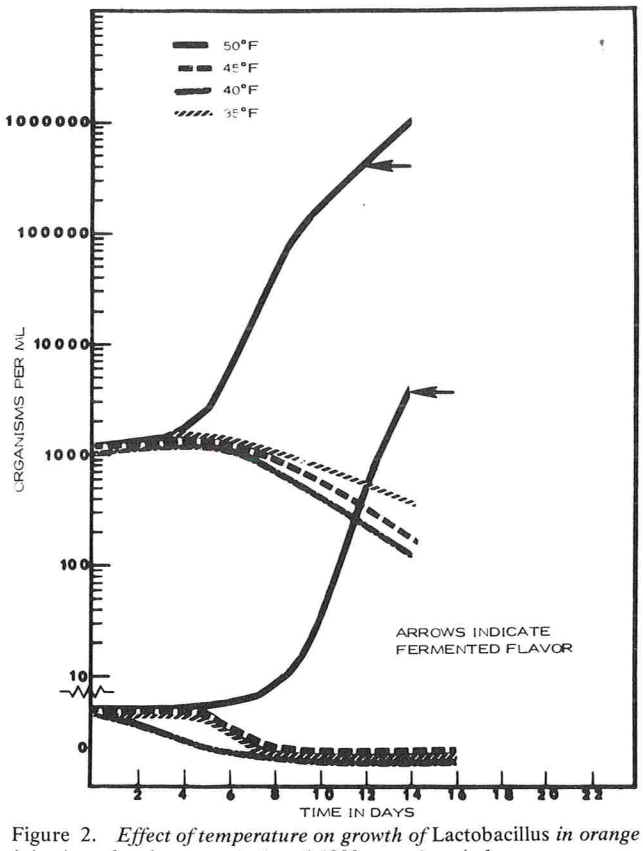

Figure 2. *Effect of temperature on growth of* Lactobacillus *in orange juice inoculated to contain 1 and 1000 organisms/ml.*

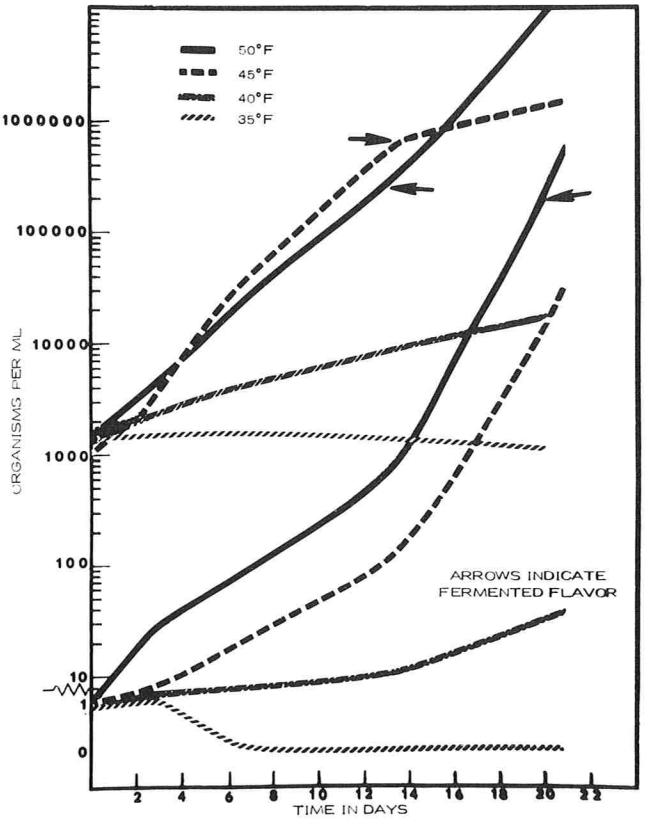

Figure 3. *Effect of temperature on growth of* Leuconostoc *in orange juice inoculated to contain 1 and 1000 organisms/ml.*

The *Leuconostoc* grew at a very slow rate at 40 F, having a generation time of 102 hrs. (Table 2). Berry et al (*2*) reported *Leuconostoc* as well as *Lactobacillus* did not grow but died at this temperature. Our data indicate the *Leuconostoc* organisms remained more or less dormant at 40 F for 7 days, after which they grew at a slow rate, increasing at the higher level of inoculum from 1,000 to 10,000 organisms/ml in 14 days. Above 40 F the rate of growth increased with temperature. At 45 and 50 F the generation times were 42 and 15 h, respectively. (Table 2). Spoilage, depending on level of inoculum, occurred in 13 days to 5 weeks at 40, 45, and 50 F. It was not detected at 35 F.

TABLE 2. *Generation times (h) of yeast,* Leuconostoc, *and* Lactobacillus

Organism	Temperature			
	35 F	40 F	45 F	50 F
Yeast	19.6	14.9	10.7	8.6
Leuconostoc	NG[a]	102.0	42.0	15.0
Lactobacillus	NG	NG	NG	9.6

[a]NG = No growth.

Lactobacillus strains did not grow at 45 F or below and spoilage was not detected. At 50 F they grew rapidly with a generation time of 9.6 h (Table 2), and spoilage was first detected at 12 days.

Data obtained for the test organisms when the product was inoculated at an initial level of 100 organisms/ml is not included as the results were similar to those from the other two levels of inoculum. A comparsion of the growth of yeast and lactic acid bacteria in orange juice at 45 F is shown in Fig. 4.

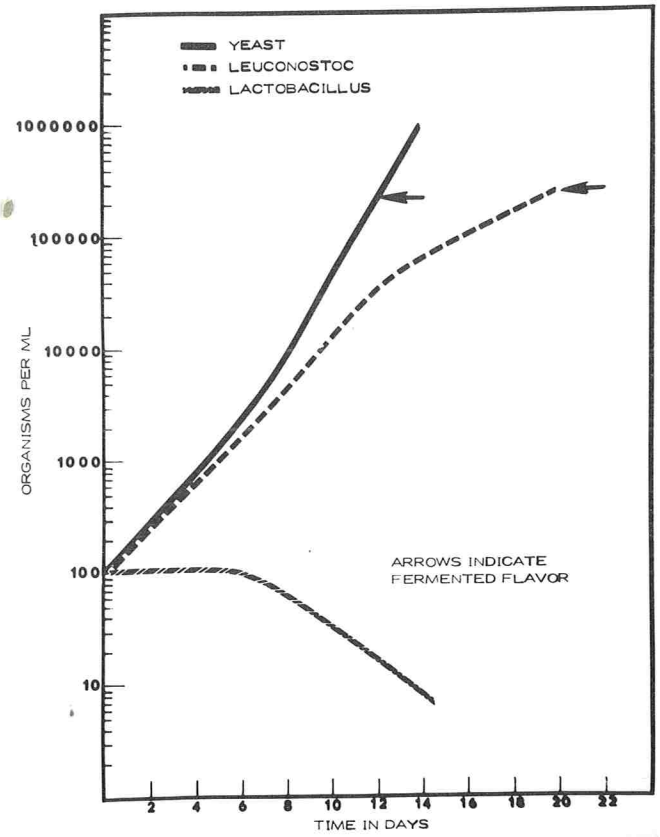

Figure 4. *Growth of yeast and lactic acid bacteria in orange juice stored at 45 F.*

There was no correlation between plate counts and spoilage. With yeasts it more or less depended upon the initial level of inoculum and the incubation temperature. However, with the lactic acid bacteria some interesting assumptions can be drawn. One of the end products produced by these organisms in diacetyl which in orange juice produces off-flavors described as being similar to flavor of buttermilk (*6, 7*). It appears where growth occurred the microbial population found to produce spoilage decreased as the temperature was lowered –9.7 million at 50 F versus 22,000 at 40 F (Table 3). This was true at all levels of inoculum studied. Christensen and Pederson (*4*) found that lactic acid bacteria produce greater quantities of diacetyl under less optimum conditions for growth. This might explain the results obtained in this study. They also reported that certain strains of lactic acid bacteria produce more diacetyl than others. Berry et al. (*2*) noted that of two *Lactobacillus* strains tested, one produced diacetyl at about 165 times the rate of other, although its growth rate was considerably slower. This would also indicate that off-flavors could be produced in orange juice with a relatively low microbial population.

TABLE 3. *Microbial population in orange juice when spoilage first detected*[a]

Temp. (F)	Yeast	*Lactobacillus*	*Leuconostoc*
	—(Microorganisms per ml)—		
35	280,000	NG[b]	NG
40	170,000	NG	22,000
45	270,000	NG	270,000
50	220,000	170,000	9,700,000

[a]Initial inoculum in juice = 100 organisms/ml.
[b]NG = No growth.

At temperatures of 45 F or lower yeasts are the predominant flora responsible for spoilage in chilled orange juice. Lactic acid bacteria grow at a much slower rate or not at all. At 50 F or above these organisms could outgrow yeasts and be the cause of spoilage.

Shelf life

The ultimate goal in processing chilled orange juice is to produce a product with extended shelf life. This is dependent, as the data indicate, on the initial level of contamination, the type of microflora present, and temperature of storage. Rushing and Senn (*9*) reported that the shelf life was significantly longer at 30 F (–1 C) than at 40 F (4.5 C). Patrick and Hill (*8*) noted product stored at 50 F (10 C) and 60 F (15.6 C) spoiled rapidly, but fermentation did not occur in juices held at 30 and 40 F for 3 weeks. They found temperature to be the most important factor in preventing microbial soilage of chilled orange juice. Our data indicate not only temperature, but also the initial level of contamination play an important role. The higher the initial level the shorter the shelf life at a given temperature.

One source of temperature abuse occurs at the retail food stores. Barnard (*1*) in his study on the shelf life of milk found that of 250 samples of milk products checked in display cases nearly one-fourth of the samples were over 45 F with 42% in the range of 41 to 45 F. Bodyfelt and Davidson (*3*), in a similar study, found that of 352 samples checked 28% were over 45 F and 7% over 50 F. It is assumed the results they obtained would also be applicable to chilled orange juice.

It is evident that considerable temperature abuse occurs at the retail outlet. Therefore, one can conclude that to maintain extended shelf life of chilled orange juice it is imperative that the temperature and the microbial population of the product be kept to a minimum.

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Evaluation of a Proportionate Sampling Device to Collect Samples for Milkfat Analysis from Farm Bulk Milk Tanks[1]

R. H. SCOTT and E. D. GLASS
Division of Food Science and Industry
The Pennsylvania State University, University Park, Pennsylvania 16802

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ABSTRACT

Samples of farm bulk tank milk for milkfat analysis were obtained by conventional methods (following 5-10 min of agitation) and, 2 to 3 h later, by means of a prototype vehicle-mounted proportionate sampler (maximum of 15 sec pre-agitation). Two preliminary series of proportionate samples (40 and 80 ml) were tested in duplicate for milkfat content and the mean of each sample compared with the mean milkfat content of the respective conventional sample. Ninety-seven percent and 98.1% (40- and 80-ml samples, respectively) of the paired comparisons were within ± 0.10% milkfat. Statistical analyses of both series of paired comparisons revealed that there was no significant difference between the mean milkfat content of proportionate and conventional samples, ie, the milkfat content of milk samples obtained by the proportionate sampling device accurately represented the milkfat content of milk samples obtained by the conventional method of sampling. An increase in volume of the proportionate sample from 40 to 80 ml did not significantly improve the representativeness of the proportionate sample.

Representativeness of the milk sample used to determine the milkfat content of an individual producer's milk shipment constitutes the basis for accurate payment. Since their introduction in 1938, farm bulk milk tanks have largely replaced the can system in the assembly of market milk. This transition has created a framework within which there is greater potential for inaccurate sampling than existed previously.

Previous laboratory and field studies (*3, 4, 6, 8, 9*) have examined the effects of numerous variables, e.g., agitation time, butterfat content, degree of fullness, and tank configuration on the representativeness of milk samples taken from farm bulk tanks. From a regulatory standpoint, attempts have been made to minimize the effects of these variables by requiring a specified minimum agitation time before taking the milk sample. The 3-A Sanitary Standards for Farm Milk Cooling and Holding Tanks-Revised (*11*) specify a minimum agitation time of 5 min before sampling. In addition, 3-A Sanitary Standards for Farm Milk Storage Tanks (*12*) have recently been published. These standards apply to unrefrigerated bulk storage tanks of at least 1,500-gal. capacity and specify a minimum agitation time of 10 min before sampling.

Unfortunately, existence of regulatory standards does not ensure conformance with those requirements. Several previous stop-watch studies (*2, 5, 7, 10*) have examined milk hauler compliance with minimum agitation times specified by various state regulatory agencies. Significantly, the average observed agitation time in each of these studies was less than the respective state's requirement.

In recognition of the foregoing facts, attention has recently been directed toward development of a vehicle-mounted proportionate sampling device which would withdraw a continuous sample from each producer's milk as it is transferred from the farm bulk tank to the truck tank. Such a device would thus obtain a representative milk sample from a farm bulk tank with a minimum of agitation required before sampling and thereby minimize the effects of inadequate agitation, variation in tank design, variation in amount of milk in the tank, and variation in location within the tank from which the sample is taken. In addition to minimizing the sources of error inherent in the current method of sampling, the reduction in agitation time afforded by a proportionate sampler would constitute a significant economic benefit to the nation's bulk milk haulers.

MATERIALS AND METHODS

Components and operational characteristics of sampler

The prototype proportionate milk sampling device evaluated in this study (Fig. 1 and 2) was manufactured by Scientific Systems, Inc. Sampler components included: a peristaltic Tygon tubing pump, a variable speed motor, a motor speed control with calibrations corresponding to a range of deliveries from 250 to 2,000 gal., an adjustable motor speed reducer, and a sample container holding device capable of receiving either rigid wall vials or plastic bags. The sampler utilized 115 v alternating current as a power source.

Proper functioning of the proportionate sampler was predicated on a

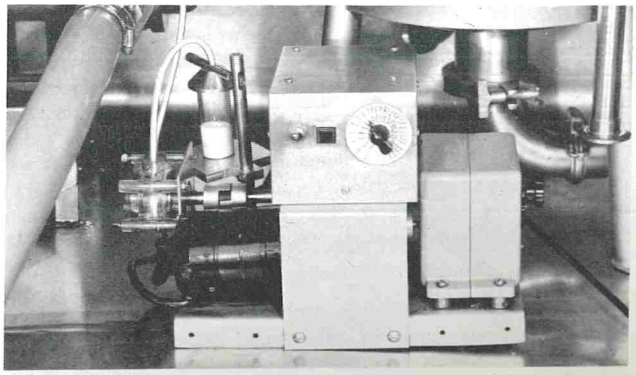

Figure 1. *Proportionate sampling device on inlet side of milk transfer pump.*

[1]*Authorized for publication on October 3, 1974 as journal series paper no. 4667 of the Pennsylvania Agricultural Experiment Station.*

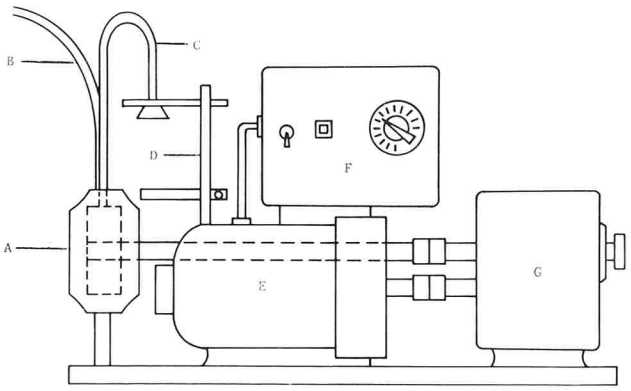

Figure 2. *Schematic diagram of components of proportionate sampling device. A. Peristaltic pump head, B. Tygon tubing to milk probe, C. Tygon tubing to sample container, D. Sample container holder, E. Variable speed motor, F. Motor speed control, and G. Adustable motor speed reducer.*

constant flow of milk in the delivery line. The particular sampler evaluated was initially calibrated to deliver a minimum amount of sample (approximately 40 ml) at a flow rate of 50 gpm over the aforementioned range of expected deliveries. An increase in sample size in 40-ml increments, ie, 40 ml, 80 ml, etc, up to a maximum sample size of 400 ml was also possible by changing the setting on the adjustable motor speed reducer.

Installation and application of sampler

Throughout the entire series of observations reported herein the prototype proportionate sampling device was located in the rear compartment of a milk pick-up tank truck operated by The Pennsylvania State University Creamery. Installation of the sampler within the milk transfer system was based on satisfaction of two main requirements: all milk transferred from each individual farm bulk tank had to be sampled; and the proportionate sampling device had to be completely purged of milk after each individual sampling operation. Preliminary investigations demonstrated that the most suitable location for the sampler was immediately adjacent to the suction (inlet) side of the milk transfer pump (see Fig. 1).

In a typical sampling application, the procedure utilized to collect a milk sample with the proportionate sampling device was as follows: (*a*) the milk hauler determined the gallons of milk to be transferred from the farm bulk tank to the tank truck by means of the calibrated gage rod, (*b*) the expected quantity to be delivered was then set on the motor speed control, (*c*) the size of sample required was determined and the appropriate setting was made on the adjustable motor speed reducer, (*d*) a sample container was placed on the container holding device, (*e*) the milk hauler then activated the milk transfer pump and proportionate sampling device simultaneously, and (*f*) upon completion of milk delivery the sampler was not deactivated until the Tygon tubing was completely purged of milk.

Collection of milk samples

The basic procedure employed to evaluate the proportionate milk sampling device consisted of comparing the milkfat content of proportionate samples of farm bulk tank milk with the milkfat content of samples obtained from the same milk by the conventional method of sampling. Each pair of conventional and proportionate samples was obtained from a lot of milk held in one of five bulk milk tanks owned by milk producers shipping to The Pennsylvania State University Creamery. These farm bulk tanks ranged in capacity from 500 to 3,000 gal.

Conventional samples were collected immediately after the morning's milking operation was completed. Upon arrival at the farm the individual responsible for collection of the conventional sample agitated the contents of each milk tank for a minimum of 5 or 10 min depending on the capacity of the particular tank. After agitation for the required period, a sample of milk was obtained by means of a stainless steel dipper. Samples were taken from the same location within each bulk tank each time. Each sample was immediately transferred to a 125-ml rubber-capped glass bottle and immediately placed in an insulated sample chest containing ice for subsequent transport to the laboratory. Following collection of the conventional sample, agitation and refrigeration systems of each tank were deactivated to allow the milk to remain quiescent until the proportionate milk sample was taken.

The proportionate sample was then taken (as previously described) during transfer of milk from the farm bulk tank to the tank truck approximately 2 to 3 h after collection of the conventional sample. The agitation system on each tank was activated just before beginning each delivery to break the cream layer away from the sides of the bulk milk tank. The maximum time lapse between the start of the bulk tank agitator and the milk transfer pump and proportionate sampler did not exceed 15 sec. Immediately after the proportionate sample was collected, it was placed in an insulated sample chest containing ice for subsequent transfer to the laboratory.

Milkfat testing

Upon arrival at the laboratory conventional and proportionate milk samples were maintained at 40 F or lower until the milkfat tests were done. Usually samples were tested on the day of collection and in all instances within 36 h of collection.

Both conventional and proportionate samples were tested in duplicate for milkfat content by the Gerber method. When individual readings were estimated to be midway between graduations on the Gerber test bottle, results were rounded to the nearest even tenth-percent milkfat. Duplicate analyses were then averaged to obtain a mean milkfat content for each conventional and proportionate sample.

The means of each paired set of proportionate and conventional samples were then compared and a difference calculated. If the mean milkfat content of the proportionate sample was higher than that of the conventional sample, the difference was reported as positive. Conversely, if the mean milkfat content of the proportionate sample was lower than that of the conventional sample, the difference was reported as negative.

RESULTS AND DISCUSSION

Series I

In Series I, settings were placed on the proportionate sampler to collect an expected sample of 40 ml. Periodic determination of the actual volume of proportionate samples revealed that the sample size ranged from 35 to 45 ml.

A total of 102 individual paired comparisons of the milkfat content of proportionate and conventional milk samples obtained from five different farm bulk tanks was made. A frequency distribution of the difference in milkfat content of the 102 paired comparisons in this series is presented in Table 1. In 65 of the comparisons (63.7%) there was no difference noted in the milkfat content of the proportionate and conventional samples. In 21 of the comparisons (20.6%) the milkfat content of the proportionate sample was lower than that of the conventional sample and in 16 of the comparisons (15.7%), the milkfat content of the proportionate sample was higher than that of the conventional sample.

The mean milkfat difference (proportionate vs. conventional) for the 102 paired comparisons was –0.0039%. This calculated mean difference was subjected to statistical analysis utilizing Student's t-test (*1*). The t-value obtained for the difference between the

TABLE 1. *Milkfat Test Differences*[a] *between Samples Obtained by Conventional Means and a Proportionate Sampling Device*[b]

Percent milkfat difference (Proportionate vs. conventional)	Number of comparisons	Percent of comparisons
+0.15	2	2.0
+0.10	4	3.9
+0.05	10	9.8
0.00	65	63.7
–0.05	11	10.8
–0.10	9	8.8
–0.15	1	1.0
TOTALS	102	100.0

[a]Mean percent milkfat difference = $\frac{-0.40}{102} = -0.0039$

[b]The sampling device was installed on the inlet side of the milk transfer pump and calibrated to collect a 40-ml sample.

mean milkfat content of the proportionate and conventional samples was not significant ($t = 0.794$, $P > 0.05$ that the difference was caused by random variation), i.e., the observed mean difference in milkfat content of proportionate and conventional milk samples was well within the range expected in normally distributed population samples.

Series II

In Series II, the proportionate sampler was adjusted to collect an expected sample size of 80 ml. Periodic determination of the actual volume of proportionate samples revealed that the sample size ranged from 70 to 90 ml.

A total of 52 individual paired comparisons of the milkfat content of proportionate and conventional milk samples obtained from five different farm bulk tanks was made. A frequency distribution of the difference in milkfat content of the 52 paired comparisons is presented in Table 2. In 38 of the comparisons (73.1%)

TABLE 2. *Milkfat test differences*[a] *between samples obtained by conventional means and a proportionate sampling device*[b]

Percent milkfat difference (Proportionate vs. conventional)	Number of comparisons	Percent of comparisons
+0.20	1	1.9
+0.15	0	0.0
+0.10	1	1.9
+0.05	7	13.5
0.00	38	73.1
–0.05	2	3.8
–0.10	3	5.8
TOTALS	52	100.0

[a]Mean percent milkfat difference = $\frac{+0.25}{52} = +0.0048$

[b]The sampling device was installed on the inlet side of the milk transfer pump and calibrated to collect a 80 ml sample.

there was no difference noted in the milkfat content of the proportionate and conventional samples. In five of the comparisons (9.6%) the milkfat content of the proportionate sample was lower than that of the conventional sample and in nine of the comparisons (17.3%) the milkfat content of the proportionate sample was higher than that of the conventional sample.

The mean milkfat difference (proportionate vs conventional) for the 52 paired comparisons was +0.0048%. This calculated mean difference was subjected to statistical analysis utilizing Student's t-test (*1*). The t-value obtained for the difference between the mean milkfat content of the proportionate and conventional samples was not significant ($t = 0.776$, $P > 0.05$ that the difference was caused by random variation), ie, the observed mean difference in milkfat content of proportionate and conventional samples was well within the range expected in normally distributed population samples.

In Series II, 47 comparisons (90.4%) of the difference in milkfat content of proportionate and conventional samples were within ± 0.05% and 51 comparisons (98.1%) were within ± 0.10%, as compared to 84.3% and 97.1% respectively in Series I. These facts coupled with a reduction in sample standard deviation from 0.0496 in Series I to 0.0446 in Series II (see Table 3) were indicative

TABLE 3. *Summary of Statistical Analyses of Test Results*

Series	Number of comparisons	Mean percent milkfat difference	Standard deviation	t-Value[a]
I	102	–0.0039	0.0496	0.794
II	52	+0.0048	0.0446	0.776

[a]Series I—t-value not significant at 0.05 level
Series II—t-value not significant at 0.05 level

of an improvement in the central tendency of the milkfat difference associated with the increased volume (80 ml) of the proportionate sample.

The difference between the variances obtained in Series I and Series II was subjected to statistical analysis utilizing the standard F-distribution (*1*). The resulting F-value for the difference between Series I and Series II variances was not significant ($F = 1.24$, $P > 0.05$ that the observed difference between variances was caused by random variation). Thus while increasing the size of the proportionate sample from 40 to 80 ml resulted in a somewhat smaller standard deviation, the effect of the increase in sample size was not statistically significant.

ACKNOWLEDGMENT

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Physico-Chemical Characteristics of Composite Flours

M. W. PULLE and K. INO[1]

Department of Agricultural Chemistry, Faculty of Agriculture, University of Sri Lanka, Peradeniya Campus, Sri Lanka

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ABSTRACT

Physico-chemical parameters that influence dough attributes and baking quality were investigated in single and composite flours. Considerable variation in the starch and protein components was observed in the different formulations of wheat and substituent flours. Incorporation of kurakkan, sorghum, or manioc flour increased gelatinization temperature, viscosity, and amylose content irrespective of the extent of substitution. Although increases in amylose content were within tolerable limits, changes in gelatinization temperature and viscosity characteristics necessitate use of chemical agents and modified technology for preparation of acceptable products. A marked reduction in protein content was revealed in manioc-wheat composites, wherein nutritive fortification should comprise an additional requisite.

In the baking industry, wheat flour has been utilized as the single carbohydrate entity for preparation of acceptable leavened products. The present trend towards dwindling international wheat supplies associated with marked price increases (*5*) necessitate the use of composite flours for preparation of bakery items. Incorporation of the starch component of substitute cereal grains, yams, and roots in formulating suitable composite flours has thus assumed current importance. To cope with the problem of increased bread consumption, especially in countries where domestic wheat requirements are dependent on an import market, feasibility studies have been conducted to explore the usefulness of substituent flours (*11, 16*).

Ruiter and Kim (*15*) have reported the use of 5-10% non-wheat flours for preparation of acceptable bread. Substitution at higher levels with various flours is also cited in the literature (*3, 4, 12, 14*). These investigations essentially comprise, either technical improvements in the bread making process or use of chemical modifiers to minimize variation in characteristics of final products. Rupture of the starch granule is the prime consideration in utilization of flour for dough preparation. With a significant reduction in the gluten content realized in composite flours, knowledge of starch composition and gelatinization aspects constitute the essential factors in preparation of bread and other bakery products.

The nature of bakery products is influenced by an interrelated effect of constituent composition of flours and physical properties of water-flour mixes. Thus, studies on rheological and chemical characteristics of various water-flour composites and gelatinization temperatures are reported in this paper.

MATERIALS AND METHODS

Samples

Kurakkan[2], sorghum, and manioc served as the substituent flours. Kurakkan and sorghum flours were obtained from the Central Agricultural Research Institute, Gannoruwa, Sri Lanka, Wheat and manioc flours were obtained from the Ceylon Institute of Scientific and Industrial Research, Colombo, Sri Lanka. An extraction rate of 70% was uniformly attained for the different substituent flours.

Composite flours were formulated at the following levels of substitution: wheat-kurakkan (80:20, 60:40), wheat-sorghum (70:30, 60:40, 40:60) and wheat-manioc (60:40), respectively.

Moisture

The Air-oven method according to the official methods of the AOAC (*1*) was used to determine the moisture content.

Protein

Protein was determined by the standard micro-Kjeldhal method (*1*).

Amylose

Amylose was determined according to the method reported by Whistler (*19*).

Gelatinization temperature and viscosity

Measurements were carried out in a Brabender Viscograph (Brabender, OHG, Duisburg, Germany) (*8*). The rising temperature system was adapted. Essentially, this involved the continuous measurement of the resistance to stirring of a 10% suspension of flour in water, wherein controlled radiation heating at a constant rate of 1.5 C/min was achieved throughout the experimental temperature range. Weights of samples used were as follows: manioc: 35 g, wheat-manioc: 45 g, wheat, sorghum and various levels of composite flours: 55 g.

Gluten

The determination of gluten followed that reported by Pearson (*10*).

RESULTS AND DISCUSSION

Physico-chemical parameters of single flours are summarized in Table 1, and their gelatinization temperatures and viscosity characteristics are illustrated in Fig. 1.

Single flours

Wheat. Gelatinization temperature, maximum viscos-

[1]*Present address: Department of Agricultural Chemistry, Faculty of Agriculture, Obihiro Chikusan University, Obihiro-city, Hokkaido, Japan.*

[2]*Kurakkan* (Eleusine coracana) *or finger millet is an important cereal crop cultivated on a large scale in Sri Lanka, India, and Malaysia. In these countries, kurakkan grain and flour constitute an indispensable item in the dietary pattern of the population.*

ity, and amylose content of wheat flour as indicated in Table 1, agreed within the range of values reported by

TABLE 1. *Physico-chemical parameters of single flours*

Sample	Gelatinization temperature (C)	Viscosity[1] (Brabender units)	Moisture (%)	Protein (%)	Amylose (%)
Wheat	55.0	425	12.4	10.5	17.4
Kurakkan	70.5	645	12.5	9.3	20.6
Sorghum	71.5	620	11.3	9.5	24.0
Manioc	70.0	540	10.7	0.9	21.4

[1]Values indicated relate to maximum viscosity.

Whistler (*18*). However, in each instance, the results obtained for all three parameters were confined to the lower limits. Since it has been demonstrated (*18*) that gelatinization in starch is associated primarily with the function of amylose, the 17.4% amylose content contributed towards the comparatively low viscosity value of 425 B.U. Earlier work has shown (*17*) that wheat flour possessing a maximum viscosity of 500 B.U. is suitable for bread preparation. Further, when the protein content (10.5%) is compared to that of a strong wheat flour such as Canadian wheat containing 14-15% protein (*18*), it should be considered that with respect to various physico-chemical parameters, poor quality wheat flour (Indian wheat type) was utilized in this investigation.

The composition of wheat has a decided influence in the formulation of composite flours and resultant dough attributes. Dendy et al. (*4*) have reported that the tolerable limit of the substitution percentage depends on the quality of available wheat flour. Similar observations have been made by Ruiter (*14*) who indicated that an increased amount of non-wheat component could be incorporated in dough preparations containing high-protein wheat flour.

Kurakkan, sorghum, and manioc flours. In contrast to wheat flour, gelatinization temperature and viscosity characteristics of non-wheat flours gave higher values (Table 1). Hart et al. (*6*) have pointed out that viscosity improves physical characteristics of bread, particularly in regard to textural qualities. The amylose contents of all three substituent flours were comparatively high and the figures obtained for kurakkan, sorghum, and manioc showed an average increase of 3% over that for wheat flour. Analysis of sorghum flour for amylose content was in agreement with the values cited in the literature (*2, 7*). Thus, the desirable physico-chemical attributes of the substituent flours could be satisfactorily utilized in formulation of composite flours.

The protein content of non-wheat flours averaged 9.4% for kurakkan and sorghum which imply that these flours may be used in bread preparation without resort to nutritive fortification. However, use of manioc clearly suggests that some other protein components such as defatted oil seed, soya bean, or coconut must be used to improve the nutritive value and quality of baked products.

Even with adequate fortification, addition of these substituent flours to wheat flour will cause reduction of gluten, leading to deviation of bread characteristics such as reduced loaf volume, softer crumb, impaired texture, and flavor considerations.

The status of wheat flour in relation to the substituent flours can be visualized from Fig. 1 with reference to

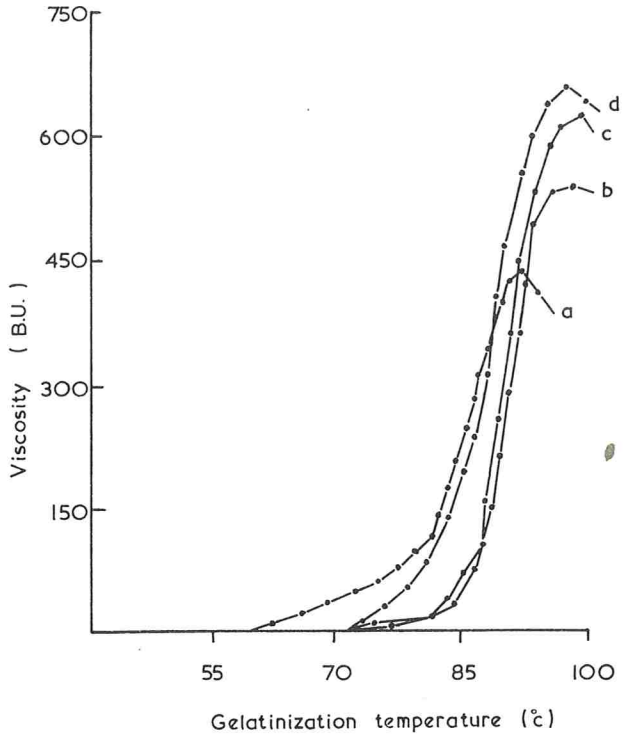

Figure 1. *Gelatinization temperature and viscosity of single flours. a: wheat flour, b: manioc flour, c: sorghum flour, d: kurakkan flour*

gelatinization temperature and viscosity characteristics. Although the maximum viscosity attained in the non-gluten flours were higher than that of wheat, the progression was found to be variable. With kurakkan flour, an increased viscosity was evident throughout the viscosity measurements, but sorghum and manioc flours showed an initial depression but accelerated exponentially to reach the maximum value. This observation can be correlated with the higher amylose content of the substituent flours.

Composite flours

Physico-chemical parameters of composite flours are summarized in Table 2, and their gelatinization temperatures and viscosity characteristics are illustrated in Fig. 2-4.

As evident from data in Table 2, the parameters gave intermediate values between those obtained for wheat and non-wheat flours, irrespective of the extent of substitution. Incorporation of non-wheat flours in composite mixtures could thus be effectively formulated to achieve desirable physico-chemical attributes in dough preparation.

When kurakkan flour served as the substituent, the two formulations analysed showed an increase of 1.5 C in gelatinization temperature from 20-40% substitution.

Elevation in viscosity from 440-465 B.U. and amylose content from 18.4-19.3% from a 0.4% reduction in pro-

TABLE 2. *Physico-chemical parameters of compsite flours*

Sample[1]	Gelatinization temperature (C)	Viscosity[2] (Brabender units)	Protein (%)	Amylose (%)
w-k(1)	56.5	440	9.9	18.4
w-k(2)	58.0	465	9.5	19.3
w-s(1)	59.5	660	9.9	18.5
w-s(2)	61.0	680	9.5	18.8
w-s(3)	65.5	700	9.2	20.9
w-m(1)	61.0	735	7.0	19.9

[1]Sample identification: w-k(1), wheat-kurakkan (80:20); w-k(2), wheat-kurakkan (60:40); w-s(1), wheat-sorghum (70:30); w-s(2), wheat-sorghum (60:40); w-s(3), wheat-sorghum (40:60); and w-m(1), wheat-manioc (60:40).
[2]Values indicated relate to maximum viscosity.

tein were also noted at these levels of subsitution. These results indicate that kurakkan is less effective for improvement of the physico-chemical parameters of the composite flour even at the 40% level of substitution. Therefore greater incorporation of kurakkan would be required to improve these parameters. Studies conducted in this direction reveal that further reduction in protein content presents a limiting factor in the preparation of acceptable bakery products.

Utilization of sorghum flour at 30, 40, and 50% levels of substitution also followed the same trend shown by wheat-kurakkan composites with regard to identified parameters. Variations were more marked, considering the values obtained for sorghum flour alone (Table 1). This range of substitution showed an increase in gelatinization temperature by 6.0 C; 40 B.U. for viscosity and 2.4% in the amylose content. For the wheat-manioc combination, parameter variations extended beyond satisfactory limits. The extremely high maximum viscosity of 735 B.U. was among the criteria that suggested the non-feasibility of incorporating manioc flour at preferred levels of substitution, using the acceptable methods of bread preparation.

The relationship between gelatinization temperature and viscosity measurements for the composite flours is given in Fig. 2-4. The viscogram obtained for single flours is also included in these figures so the reader can conveniently follow the deviation pattern. Attainment of maximum viscosity is achieved by gradual increments throughout the measurements for kurakkan and sorghum flours. With the manioc composite, the usual amount of sample could not be used since values were so high that they reached outside the measurement limits. Thus, a low weight sample was used in the analysis.

In the context of the current food situation especially in developing nations, the desired objective would be use of non-wheat flours at the highest possible levels of substitution in bakery product preparations. Consequently, deviations in physico-chemical properties of composite flours need further investigation. Miller et al (*9*) have shown that very high amylose content decreased the acceptability of sorghum bread. Depression of loaf volume and baking quality of rice bread as a result of high viscosity was demonstrated by Tanaka (*17*). Observations of these workers clearly indicate the necessity for modified baking technology or use of chemicals in an attempt to counteract the limiting factors of composite flours.

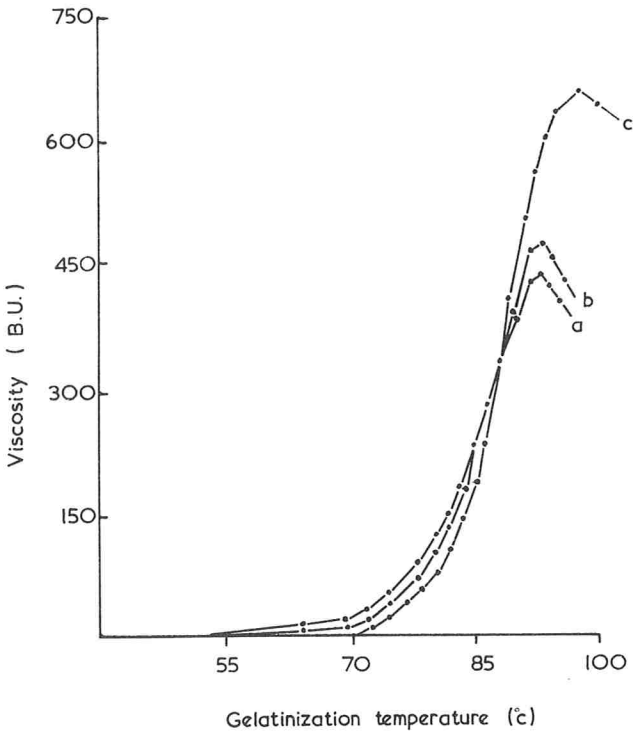

Figure 2. *Gelatinization temperature and viscosity of kurakkan and wheat-kurakkan composite flours. a: w-k(1), b: w-k(2), c: kurakkan flour*

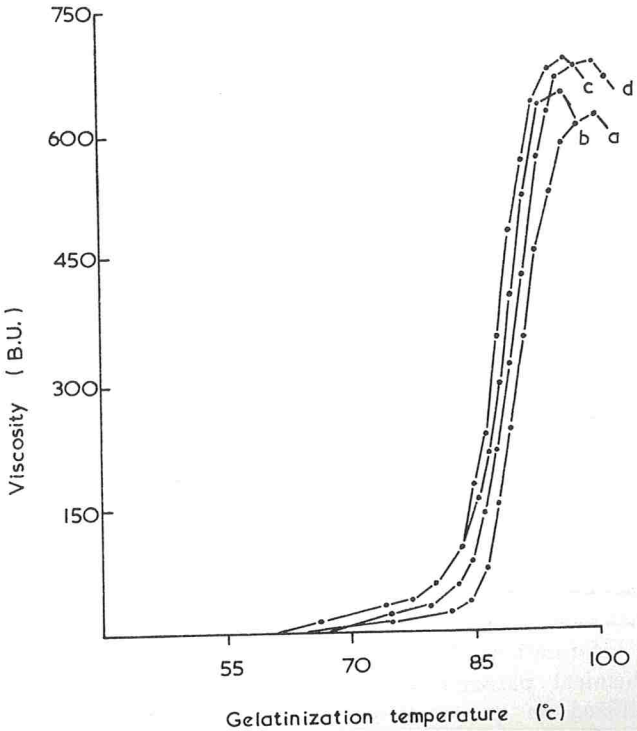

Figure 3. *Gelatinization temperature and viscosity of sorghum and wheat-sorghum composite flours. a: sorghum flour, b: w-s(1), c: w-s(2), d: w-s(3)*

Pulle (*12*) reported the production of acceptable

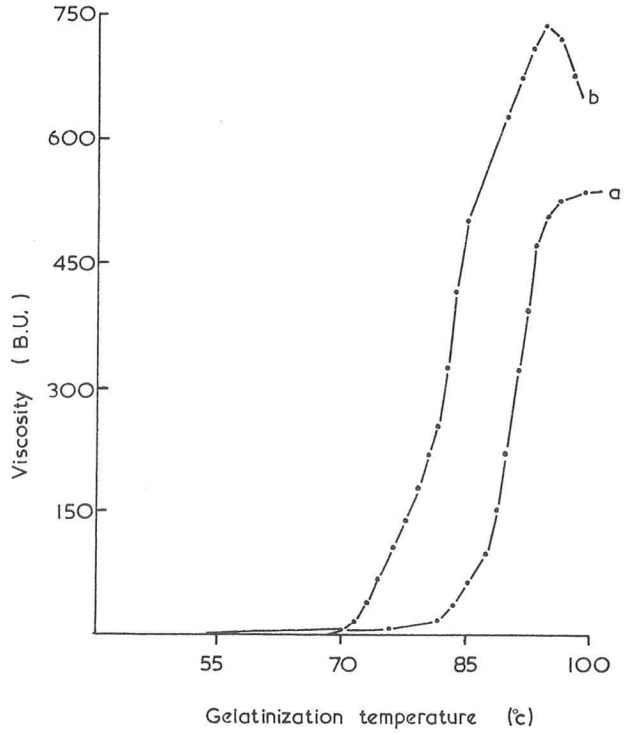

Figure 4. *Gelatinization temperature and viscosity of manioc and wheat-manioc composite flours. a: manioc flour, b: w-m(1)*

sorghum-wheat bakery product preparations at the 40% level of substitution by means of a modified 100% Sponge Method. In this procedure, ingredient composition particularly that of yeast, sugar, and shortening was increased, while the fermentation and remix times were prolonged. Consumer acceptance and preference evaluated by taste panels, indicated favorable results for general eating quality, texture, tenderness, flavor, and other aspects. Quality of finished products could however be markedly improved by addition of surfactants such as glyceryl-monostearate or soya bean lecithin which are more effective in obtaining greater volume, softer crumbs, and a more regular texture (*15*). Tanaka (*17*) has pursued the problem enzymatically and reported that *a*-amylase, responsible for break-down of amylose could be satisfactorily used to reduce the high viscosity of composite flours and produce increased loaf-volume products. Gas produced as a result of dough fermentation can be more effectively retained by the addition of gums (*6*). As such, the low gluten content of composite flours could be conserved as a result of inclusion of compounds which aid gas retention.

Information obtained from experimental physico-chemical parameters of water-flour composites was utilized in preparation of bakery products. With emphasis on bread making, various leavened and unleavened bakery items were prepared from 48 composites of wheat and substituent flours (*13*). In this investigation, use of glyceryl-monostearate, greater incorporation of yeast, and extended fermentation times were required for preparation of acceptable products.

Modifications employed for preparation of sorghum-substituted products are also applicable to manioc composite flours. However, extremely high viscosity and nutritional quality pose two significant limitations. Dendy and Clarke (*4*) have circumvented these limiting factors and reported that a bread of wheat-cassava starch (1:1) became satisfactory with addition of soya bean protein concentrate or coconut, enzyme, and swelling agents.

CONCLUSIONS

Optimum utilization of composite flours in preparation of various leavened and unleavened bakery products can be effectively ascertained through a comprehensive study of the components that contribute towards dough attributes. Incorporation of high levels of substituent flours in the wheat—non wheat admixture although economically beneficial, results in deviations of accepted characteristics of the finished products. Identification of the physico-chemical parameters and their effects on preparation of dough and bakery products would enable use of modified technology with respect to ingredient composition and procedural techniques.

With the accelerated impetus towards wide-scale cultivation of these substituent crops, use of chemical modifiers, dough fermentation, and baking processes figure prominently for preparation of the most suitable bakery items. Since consumer acceptance and preference would comprise the final parameter, results of a taste panel survey would reveal the actual status of the products in the dietary pattern of the populus.

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Influence of "Stabilized" Ferrous Sulfate on the Flavor of Pasteurized Milk

B. J. DEMOTT

Food Technology and Science Department
University of Tennessee, Knoxville, Tennessee 37901

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ABSTRACT

Raw milk containing "stabilized" ferrous sulfate had an oxidized flavor after pasteurization. Negative correlation coefficients were found between the cooked flavor and the oxidized flavor present in those samples containing the added ferrous iron.

The Food and Nutrition Board, National Academy of Science-National Research Council, in 1968, recommended a dietary allowance of iron intake of 6 to 18 mg daily for various healthy population groups in the United States (*5*). A recent survey conducted by the Public Health Service showed that over 95% of preschool children and women of child-bearing age had iron intakes below these recommended standards (*10*).

Breakfast cereals, flour, and bread have been fortified with iron in an effort to overcome the insufficient iron content of the American diet. Amine and Hegsted (*1*) found that lactose was associated with greater iron retention than was either sucrose or glucose. Fortification of milk with additional nutrients is not a new concept; vitamin D-fortified milk has been on the market since the early 1930's. In Kon's (*7*) words, "The main recognized shortcomings of milk are that it is deficient in iron and low in Vitamin D."

The effect of added iron on flavor of milk is of significance. Processors are justifiably skeptical about addition of iron to milk. Metallic contamination of milk on the farm or in the plant has been responsible for oxidized flavor in pasteurized milk. Under present sanitary conditions, milk comes in contact with only stainless steel, glass, or plastic and there is little opportunity for iron contamination.

If recommended procedures are followed carefully, the influence of added iron upon taste is negligible. Edmonson et al. (*4*) showed that ferric ammonium citrate could be added to milk with no objectionable flavor resulting if the iron-fortified milk was then pasteurized at 81 C for 16 sec. Heat treatment produces anti-oxygenic sulfhydryl groups. Demott (*2*) showed ferric pyrophosphate or ferric phosphate to have only a slight influence on flavor of pasteurized milk. Such milk samples had less cooked flavor than the control and the iron-fortified milk was an effective prophylactic against iron deficiency anemia in rats.

When food-grade ferric pyrophosphate was added to raw milk, about two-thirds of the iron was recovered in the casein precipitated at pH 4.6 from either raw or pasteurized milk. Casein was precipitated by adding 10% acetic acid and 1 N sodium acetate. Approximately 80% was recovered in the total protein fraction obtained by precipitation with trichloracetic acid from raw or pasteurized milk (*3*).

Loh and Kaldor (*9*) reported that casein isolated from milk of rats by centrifugation contained about two-thirds of the iron in milk and that iron in casein was not derived from a soluble iron containing whey protein.

Persons suffering from iron deficiency anemia are usually given medication containing ferrous sulfate. Biological availability to the chick and the rat of various forms of iron has been compared to that of ferrous sulfate (*6*). In general, iron from food sources was less well utilized than the more available inorganic iron sources, but no difference was noted in iron absorption when ferrous sulfate was added to the food before or after processing (*6*).

Chemical and other companies serving the food industry, recognizing the potential for iron fortification of food, have marketed products suitable for such use. One such product, a "stabilized" ferrous sulfate (Bio-Iron; Mallinckrodt Chemical Works, St. Louis), though not necessarily recommended for use in milk, was used in this investigation to determine its suitability for fortification of milk.

MATERIALS AND METHODS

Using the manufacturer's label as a guide, 17, 35, or 66 mg of the iron preparation were dissolved in 5 ml of warm water and mixed with one liter of raw milk at 4 C. The added iron was equal to 5, 10, or 20 ppm elemental iron. The mixture was allowed to remain at 4 C for about 16 h, then heated at 62.5 C for 30 min. Milk was cooled in an ice water bath, stored at 4 C for 16 to 20 h, and tasted by 6 to 12 judges. The randomly numbered samples contained in identical glass bottles, were placed on a laboratory table and each judge was invited to score the samples. Judges, previously trained to distinguish between cooked and oxidized flavors, were asked to evaluate each sample for oxidized and cooked flavor, using as a guide: 0, none; 1, slight; and 2, definite.

RESULTS AND DISCUSSION

Eight trials were conducted and the means are reported in Table 1. Using the mean of all judgements on a particular sample as one evaluation, an analysis of variance was done. Duncan's multiple range test (*8*) was

TABLE 1. *Influence of "stabilized" ferrous sulfate upon the flavor of pasteurized milk*

ppm Added iron	Mean flavor scores*	
	Cooked	Oxidized
0	0.64[a]	0.25[c]
5	0.59[ab]	0.94[d]
10	0.50[ab]	0.81[d]
20	0.45[b]	1.27[e]

* 0 = None, 1 = Slight, and 2 = Definite. Means in a column followed by the same letter are not statistically different (P>.05)

used to determine differences between average flavor scores at the various levels of added iron. Cooked flavor was more pronounced in samples containing no added iron, as compared to samples containing 20 ppm added iron. All samples containing added iron were found to have cooked flavor scores which were not statistically different ($p > 0.05$).

Those samples containing added iron were noted for a higher degree of oxidized flavor than were the samples containing no added iron. Samples containing 5 or 10 ppm added iron did not taste significantly different, but the samples containing 20 ppm added iron were more oxidized than the samples containing less or no added iron.

Correlation coefficients between oxidized and cooked flavor on samples containing various amounts of added iron are shown in Fig. 1. Negative correlation coefficients showed that as the oxidized flavor increased due to added iron, the degree of cooked flavor decreased.

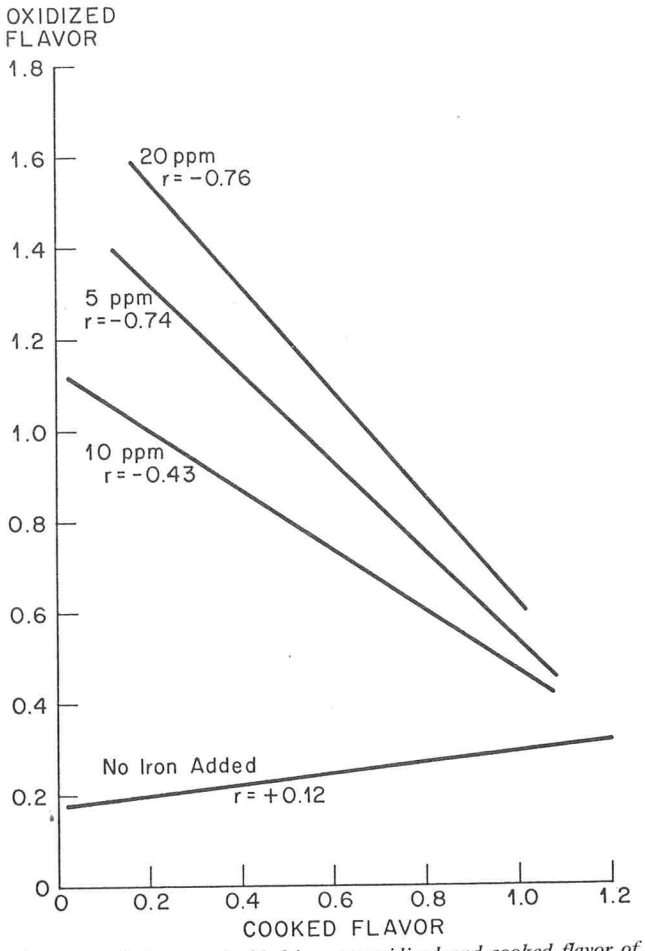

Figure 1. *Influence of added iron on oxidized and cooked flavor of milk. 0 = none; 1 = slight; 2 = definite*

Each of these correlation coefficients was examined statistically (*11*) to determine if the value was significantly different from zero. The correlation coefficients on those samples containing 20 ppm or 5 ppm added iron were significantly different from zero at the 5% level of confidence. The correlation coefficient of −0.43 for those samples containing 10 ppm added iron and the correlation coefficient of 0.12 on those samples having no added iron were not significantly different from zero. The high correlation coefficients between cooked flavor and oxidized flavor in those samples containing 5 and 20 ppm iron seems inconsistent with the correlation coefficient of −0.43 between these two flavors on those samples containing 10 ppm added iron. Though no data were collected in this study on oxidation-reduction potentials, this property may be a factor in these experiments. Sulfhydryls produced by heating milk protein serve as reducing agents and thus prevent milk from tasting oxidized and causing it to taste cooked. Iron, even in the ferrous form, will cause milk to taste oxidized (*2*). This principle of adequate heat treatment was used by Edmondson et al. (*4*) to prevent oxidized flavor in milk to which they had added ferric ammonium citrate. Thus the balance between forces causing oxidized flavor and those causing cooked flavor is delicate. One might speculate that the balance was approached in the present study at 10 ppm added iron, a point where some judges tasted oxidized and others tasted cooked flavors.

Data reported in this investigation indicated that the "stabilized" form of ferrous sulfate was not a suitable form of iron to be added to fluid milk if the milk is to be pasteurized under conditions comparable to those used in these studies. Ferrous sulfate is the form in which iron is usually administered for the correction of iron-deficiency anemia in humans. However ferric phosphate and ferric pyrophosphate have been shown to be effective in the prevention of anemia in rats and such forms of iron have but little influence on flavor of milk (*2*).

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Dr. Alexander B. Morrison Keynote Speaker at Annual Meeting

Dr. Morrison was born in Edmonton, Alberta. He obtained his B.Sc. and M.Sc. at the University of Alberta, his M.S. at Michigan, his Ph.D. at Cornell University, and is a Diplomate of the American Board of Nutrition.

In 1956 he moved to Mead Johnson and Company, Indiana, as a group leader in nutritional research. He joined the Food and Drug Directorate in 1959 as a chemist, and became Chief of the Nutrition Division in 1963. In 1966 he became Chief of the Pharmacology Division, and was promoted to Director of Research Laboratories in 1968.

Dr. Morrison was appointed Deputy Director-General of the Food and Drug Directorate in 1969, and Director-General (Research and Operations) in 1971. In 1971, he was appointed Assistant Deputy Minister (Health Protection Branch).

Dr. Morrison is the author of some 90 papers on various aspects of nutrition, biochemistry, toxicology and pharmacology. He is a Fellow of the Chemical Institute of Canada, a Borden Award Winner (1963) of the Nutrition Society of Canada, and a member of numerous institutes and societies. He was the President of the Nutrition Society of Canada for 1971-72. Dr. Morrison is visiting professor of pharmacology at the University of Toronto and during the summer of 1970, was a visiting professor of Toxicology at Albany Medical College of Union University, Albany, New York. In 1973 he completed the course in applied epidemiology and biostatistics given by the Centre for Disease Control, Atlanta.

Everett Biggs to Speak at Annual Meeting

Everett Biggs, Deputy Minister, Ontario Ministry of the Environment, will be speaking at our annual meeting in Toronto, Ontario on Wednesday, August 13, 1975.

Mr. Biggs has had extensive experience in Agriculture as Dairy Commissioner, Assistant Deputy Minister/ Marketing and as Deputy Minister of Agriculture and Food from 1961 to 1972. In this position, Mr. Biggs was involved with the extensive development of various Agricultural product Marketing Boards.

During this period he became increasingly involved in the effects on the environment of intensive food production practices. When asked to assume his present responsibilities, Mr. Biggs took with him a broad spectrum of experience and knowledge of environmental factors involved in food production.

Ontario has been in the forefront of the development of knowledge respecting environmental deterioration and procedures and methods for gaining control of some of these negative factors.

Mr. Biggs' presentation to our annual meeting this summer should be of vital interest and concern to all members.

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Filth in Foods: Implications for Health[1]

J. RICHARD GORHAM

Food and Drug Administration
Washington, D.C. 20204

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ABSTRACT

Filth is defined in this context as any objectionable matter contributed by animal contamination of a food product, such as insect, rodent or bird matter, or any other objectionable matter contributed by insanitary conditions. The Federal Food, Drug, and Cosmetic Act insists upon high levels of sanitary practice in the food industry as a means of both preventing filth from getting into food and preventing any disease that may be associated with such filth. There are three categories of pest-food relationships: (*a*) accidental (e.g., bird feathers, bat feces), (*b*) opportunistic (e.g., foraging by ants, rats), and (*c*) obligatory (i.e., pest survival largely dependent upon food gathered and cached by man). Food pests or fragments thereof may act as direct agents of disease by causing dermatosis, allergy, myiasis, and toxicogenic effects (the latter as yet unproved in man). Food pests may also serve as mechanical or biological vectors of human pathogens. In contrast to the sort of mainline vectoring done by malaria mosquitoes, food pests, where they are involved at all, usually transmit pathogens only along pathways that are peripheral and supplementary to epidemiologically more important routes of transmission.

THE FOOD LAW

The meaning of the Federal Food, Drug, and Cosmetic Act, as it applies to food sanitation, has been defined in publications of the Food and Drug Administration (*48, 102*). We may safely conclude from these official statements that it is not necessary to demonstrate a cause-and-effect relationship between extraneous materials in foods and disease to substantiate an enforcement action under the Act. Most enforcement actions are based on evidence of extraneous material in the food product and/or on evidence that storage or processing was done under insanitary conditions.

Yet prevention of disease is clearly one of the objectives of the Act and inherent in the Act is the idea that this objective is best achieved by conducting every aspect of food handling under the most sanitary conditions attainable. In short, the employment of "good manufacturing practices" (GMPs) is a technique of preventive medicine.

FOOD, FILTH AND HEALTH

Insects as food

Those members of the human family still innocent enough to be classed as hunter-gatherers do not, as many of us would, categorically reject insects, bats and rodents as human food (for examples see *16* and *28*), although they may shun certain animals or parts thereof because of their intrinsic or reputed poisonous qualities. Even today, as in past centuries, insects are routinely enjoyed as condiments or delicacies in the diet of large segments of human society, especially in the "emerging" countries (*15*). Because of this history of entomophagy with impunity, it has been suggested (*20*) that no legal restraints should be placed on occurrence of insect fragments and similar contaminants in food, save only that the label should accurately report their presence. It would be left to the discretion of the consumer to buy or not to buy.

Food sanitation and infant mortality

As food supplies dwindle with increasing populations, it may well be necessary to reconsider sanitary standards in the food industry. Certainly large segments of the world's population, living today under generally unsanitary conditions, attach little or no significance to the presence of insects in food or to the remarkable aggregations of flies and cockroaches so often associated with foods; the technological trappings that complicate their otherwise simple lives make them no less oblivious of the Germ Theory than the Arunta of Australia or the Masarwa of Africa, whose insect-eating habits have been so graphically described by Bodenheimer (*15*).

Such societies are often charcterized by a high infant mortality rate, largely a reflection of the effects of virtually universal infant diarrhea, exacerbated by an insanitary environment (*42*) and inadequate nutrition (*105*). Adults in these societies are armed with an impressive array of antibodies, but even these defenses can be lowered by aging, malnutrition, and a variety of mental and physical stresses. Visitors to such societies, likely coming from more sanitary surroundings, quickly learn to admire the immunity of their hosts but often fail

[1] *FDA Project Number 04182, "Health Significance of Insects in Food," Microanalytical Branch, Division of Microbiology, Bureau of Foods. This discussion is restricted to filth originating from or disseminated by arthropods, birds, rodents, bats, and other mammals. The term "filth" is included within the meaning of "extraneous materials," which means any foreign matter in product associated with objectionable conditions or practices in production, storage, or distribution; included are filth (any objectionable matter contributed by animal contamination such as rodent, insect, or bird matter; or any other objectionable matter contributed by insanitary conditions), decomposed material (decayed tissues due to parasitic or nonparasitic causes), and miscellaneous matter such as sand and soil, glass, rust, or other foreign substances (bacteria excluded) (49).*

to appreciate that the price paid for it was a high infant death rate.

In contrast, the lower infant mortality rates extant in much of Western civilization have been purchased in part by a heavy investment in preventive medicine, including an abiding allegiance to GMPs in the food industry. Pathogens are still here, even in our highly sanitized and artificially immunized society; that they are sometimes deterred in reaching new hosts is largely the result of good sanitation in the food industry. At least one dependable indication of whether or not the food industry is adhering to GMPs is provided by quantitative analysis of food to detect extraneous matter (*49*).

Competition for food

Compared to the amount of information available on foodborne illnesses in general, it would appear that relatively little is known about filth-associated illnesses. There are a few good examples of filth-associated disease and some of these will be mentioned subsequently. In most instances, however, the evidence of cause-and-effect is circumstantial or hypothetical and must be viewed with appropriate circumspection.

Human foods are attractive to a wide variety of animals. Competition for nutritive substances is keen and continuous. Pests of the food industry may be counted upon to take full advantage of every opportunity to convert human food to their own use (*9*). To prevent this, nothing less than constant vigilance is required of the food industry. But even under the best of circumstances it is difficult to consistently provide the consumer with food products completely free from contamination by food pests.

Food pests

The steps required to bring a crop from farm to family may be few or many depending on variables of product, season, and geography. Generally, the fewer the steps, the fewer (or simpler) the pest problems (and vice versa), but even those products requiring the fewest steps—fresh fruits and vegetables—may already be well supplied with pests of garden, farm, and orchard. All of the edible portions of field and orchard crops are affected by an assortment of pests—aphids, bugs, leafhoppers, thrips, caterpillars, maggots, grubs, mites, mice, birds, etc.

After the crop is harvested and started through some sort of processing, the food material encounters two general classes of pests: (*a*) those associated mainly with the food itself (e.g., rice weevil, cheese mite, almond moth, larder beetle, Indianmeal moth, fruit fly), and (*b*) those associated with and often to some degree dependent upon buildings, that is, an artificial environment created by man around the food (e.g., German cockroach, silverfish, house fly, Australian spider beetle, house mouse, Norway rat, pigeon, little brown bat).

Pest-food relationships

In the case of roosting birds and bats, and in those instances where dogs and cats are used for rodent control, the contact between pest and food is largely *accidental*, as when hairs, feathers and excrement chance to fall on unprotected food or food-handling surfaces (*47*). Other pests (e.g., German cockroach, Pharaoh ant, Norway rat) are largely *opportunistic* with regard to food. Their populations fluctuate with the availability of food, but they also require harborage and water. A third category of pest-food relationships could be described as essentially *obligatory*. The food material provides the pest (e.g., warehouse beetle, rice weevil, Mediterranean flour moth) with all the necessities of life. The rationale behind good housekeeping in home and factory immediately becomes apparent. A high standard of sanitation deprives pests of the food reserves they require to tide them over intervals of scarcity between shipments of more desirable foods.

It would be unwise to overlook here the chance that another type of unfortunate event may also occur, namely, the inadvertent insertion of pests into packages of food. Or, still another, the placement of clean foods into a container in which a pest has taken refuge. In other words, quality control must be linked with good housekeeping to form a consolidated line of defense against the pervasive opportunism of food pests.

Pest prevention

Prevention of pest infestation is generally most taxing with pests in the "obligatory" category; the long-standing ecological intimacy of pest and food is disrupted only with difficulty. Preventing infestation by pests of the "opportunistic" category is somewhat less difficult but certainly not easy. These pests are the product of a prolonged association with man; they have persisted tenaciously in that associationin spite of the best efforts of man to part company with them. Preventive techniques, usually consisting of the denial of access to roosting sites, are the least difficult to employ and are often used successfully against the "accidental" category of pests.

Pest invasion and quality control

Evidence of contamination of foods by pests in all three categories may be expected to appear at any stage in the journey from field to kitchen. However, after foods have been sealed in packaging materials other than metal or glass and are resting in a dry condition in a warehouse, grocery or pantry, only those pests that possess the morphological tools to breach the defenses of the package and the physiological tools to cope with the internal milieu of the package may be expected to prosper. Other pests, less well endowed, may follow in the footsteps of the primary invaders.

AGENTS AND VECTORS

Food pests may adversely affect man either by direct action (as agents) or by indirect action (as vectors).

Transmission routes

Two types of vectors are apparent: (*a*) mechanical vectors, effecting transmission of a pathogen by its

simple removal, either on the body surfaces or in the gut, from one point to another (this act, however, must have some epidemiological significance for a new host to qualify as transmission); and (*b*) biological vectors, in which the pathogen enters the gut (but may migrate from there to other parts of the body), multiplies or develops (or at least arrogates significant life support), and passes on (but not necessarily directly or immediately) to a susceptible host. This transfer of the pathogen to a new host may be accomplished by ingestion of the entire vector or some infected portion thereof, or by ingestion of, injection of, or contact with some material, usually food or water, contaminated with pathogen-bearing excreta or egesta. Transfer by contact implies that the pathogen must actively penetrate some external defense of the host or else take advantage of some existing breach such as a break in the skin.

In all instances where food pests may be actually or theoretically involved as mechanical or biological vectors, the role they play is relatively minor. The pathogens have other, more efficacious routes. For example, salmonellosis would doubtless persist as an important disease even if there were no flies, cockroaches, ants, or rats. But the presence of these potential vectors increases the probability that salmonellas will successfully meet new hosts. Also, the presence of these pests usually indicates an insanitary environment (*110*), one in which the nonvector mediated chains of transmission are more likely to be successfully forged.

FOOD PESTS AS DIRECT AGENTS

Dermatosis

Straw itch mites (*Pyemotes ventricosus*) prey on the larvae of several kinds of insects, among which are some food pests—bean weevil, pea weevil, and Angoumois grain moth (*2*). These hosts normally provide the mites with all the water and nutrients they require. But the mite populations are, for reasons unknown, given to rapid expansions. The mites may tolerate a scarcity of food, but they are keenly susceptible to dehydration. When that occurs they urgently seek new sources of water. Any person coming within the sphere of their peregrinations is very likely to be attacked, the resulting dermatosis being caused by insertion of the mite mouthparts into the skin (*32*).

Injectant allergens

The best known allergic responses to arthropods are those caused by bites and stings (*34, 91, 101*). Allergens entering the human body by injection are referred to as injectant allergens. Straw itch mite dermatosis is an example of this phenomenon. Other routes of access to the human body are available to offending allergens: dermal (but not injected), pulmonary, and oral. The study of food contaminants as ingestant allergens is complicated, of course, by the fact that when certain foods, even though wholesome and pure, are consumed they may produce allergic symptoms (*92*).

Contactant allergens

The Indianmeal moth (*Plodia interpunctella*) has caused contact dermatitis in Bulgarian walnut shellers (*52*). Several species of food-associated mites also serve as contactant allergens. No penetration by mouthparts is involved here; merely direct contact between the skin surface and the mites (especially the body fluids of crushed mites) is all that is requred to produce a transient dermatitis (*18*). These mites are associated with a long list of food products, some of which are cheese (*Acarus siro, Tyrophagus putrescentiae*), copra (*T. putrescentiae*), bran (*Suidasia nesbitti*), and dried fruits, jams, sugar (*Carpoglyphus lactis, Glycyphagus domesticus*) (*109*).

Inhalant allergens

The fact that food pests can function as inhalant allergens is best demonstrated by instances in which allergic symptoms (rhinitis, asthma) developed in persons working in an insectary where food pests were reared [*Sitophilus granarius* (*33*); *Trogoderma* spp. (*87*); *Leucophaea maderae* (*14*)]. Bernton and Brown (*14*) suggest that particulate matter from live or dead and disintegrated cockroaches may cause asthma. Marchand (*75*) substantiates this idea with his report of successful desensitization of asthmatics with roach extracts. He also suggests that inhaled particles of bat feces may cause asthma (*75*).

There appears now to be no doubt that a major factor in the cause of "house dust allergy" are mites of the genus *Dermatophagoides* (*76*). These mites are found most commonly in houses, especially in bedrooms. But, as they feed mainly on desquamated human epidermal scales, they may be found any place that is frequented by man. Dermatophagoid mites have as yet no special connection with the food industry, but at least two other mites, *Acarus siro* and *Glycyphagus domesticus,* both definitely associated with food, may also be inhalant allergens (*120*).

Ingestant allergens

The inadvertent ingestion of insects and mites, or fragments thereof, present as contaminants in foods, is commonplace (*89*) and generally no untoward effects result. That the human body often responds at least subclinically to these insults has been conclusively demonstrated by Bernton and Brown (*12*). They recorded positive skin reactions to extracts of food pests in 30% of 230 allergic persons and in 25% of 194 "non-allergic" persons. Shown here are the percentages of positive reactions among 333 allergic and non-allergic subjects for each of the pests tested: *Plodia interpunctella,* 24%; larval *Tribolium castaneum,* 23%; adult *T. castaneum,* 14%; *Sitophilus oryzae,* 9.6%; *Drosophila melanogaster,* 9%; *Tribolium confusum,* 6%; and *Rhyzopertha dominica,* 5.7%.

Cockroaches are particularly suspect as ingestant allergens because of their frequent and intimate contacts with human food (*14, 21, 75*). Bernton and Brown (*13*)

have also shown a relationship between degree of sensitization, severity of infestation, and duration of exposure to cockroaches. Since many foods are heated during some stage of processing or preparation, it is important to note that cockroach allergen resists heating at 100 C for 1 h (*11*).

Live arthropods in food

The larvae of several kinds of flies live as parasites in animals (*51*). The passing of this larval phase in a suitable host is an essential part of the life cycle. This kind of invasion of animal tissues is called obligatory myiasis. A similar term, facultative myiasis, denotes the ability of certain fly larvae, which normally live in dead flesh, to also invade living organs or tissues (usually at the site of a wound or some other lesion on the skin).

The fact that people sometimes accidentally consume living insects and mites has already been mentioned (*89*). If fly larvae are so eaten, the phenomenon is called accidental enteric myiasis, distinguishing it from the parasitic myiases mentioned above. If mites are eaten, the phenomenon is called accidental enteric acariasis (*109*); if beetles, accidental enteric cantharíasis; if moths, simply scoleciasis. These accidental arthropodiases bear little resemblance to the orderly host-parasite relationships seen in obligatory or facultative myiasis. Instead of deriving shelter and nutriments from the host, the accidentally-ingested arthropod is more likely to be met with a fatal barrage of mechanical and chemical insults from the unwilling host. Yet a few of these invaders manage to survive for various periods and some even succeed in emerging alive from the host.

Dead arthropods in food

Ingestion of dead arthropods or their dejecta that chance to be present as contaminants in food is a phenomenon that does not fall within the definitions myiasis, cantharíasis, etc., but the presence of such filth in food would, if the food were imported or placed in interstate commerce, constitute a violation of section 402(a)(3) of the Federal Food, Drug, and Cosmetic Act.

Probably all arthropods, whether ingested alive or dead, function in some degree as ingestant allergens. The antigenic capabilities of six common food pest species have been demonstrated in rabbits (*53*).

Scoleciasis

If for no other reason than because the Indianmeal moth so frequently infests candy bars (in the United States, at least), people probably eat more larvae (either alive or dead) of this species than any of the other kinds of arthropods that are likely to be accidentally ingested. This hypothesis is supported by the fact that the highest rate (24%) of positive reactions in the skin sensitivity tests of Bernton and Brown (*12*) was to *Plodia interpunctella.* Nevertheless, scoleciasis is rarely reported (*100*).

Myiasis

In contrast to the meagre record of scoleciasis, there are many reports of accidental enteric cantharíasis and myiasis (*89*). Several kinds of flies deposit their eggs on fresh fruits, especially on imperfections. Drosophilid fruit flies, often associated with tomato products, are probably ingested more frequently than other flies, but no deleterious effects of this have been noted. However, the results of skin sensitivity tests with *Drosophila melanogaster* (*12*) and the speculations of Sturtevant (*106*) on the role of drosophilids as vectors suggest that this group of flies may have some small significance for human health.

Intestinal upsets of considerable severity have been associated with *Muscina stabulans* (*23*) and with *Hermetia illucens* (*77*); both species are known to deposit their eggs on overripe fruit. Larvae of the cheese skipper (*Piophila casei*) are likely to be ingested; at least two cases of bloody diarrhea have been linked to this fly (*90, 111*). These accidental cases are supported by an experiment in which 83% of 60 volunteers promptly developed gastrointestinal disturbances of brief duration after swallowing fly larvae (*Musca domestica*) in capsules (*60*).

Cantharíasis

In another experiment (*79*) human volunteers ate oatmeal spiked with beetles (*Tribolium confusum*) and their dejecta. No untoward effects were observed. The same result followed ingestion of *Sitophilus granarius* (*94*). But again, on the basis of the experiments by Bernton and Brown (*12*), it must be emphasized that such a seemingly innocuous insult, especially when experienced by a young child, may provoke a chain of sensitization reactions that may result, probably at a later stage in life, in overt allergic expression.

Dermestid larvae (*Trogoderma* sp.) were recovered from the feces and from the food (a dry, high-protein baby cereal) of a four-month-old child suffering from ulcerative colitis (*87*). In a similar case, larvae of *Trogoderma ornatum* were found in baby cereal which had been fed to an infant who subsequently suffered acute gastroenteritis (*87*). Particularly suspect in these two cases are the setae with which dermestid larvae are so generously clothed. It is hypothesized that dermestid setae, which are notably tenacious and invasive of soft tissue, may be able to produce numerous foci of physical and antigenic trauma along the alimentary canal. I offer a further suggestion, entirely hypothetical, regarding an additional causative factor in these two episodes: the larval metabolites in hemolymph, excreta and dejecta may have been toxicogenic, producing at least some of the described symptoms.

Toxicogenic effects

It has long been known that certain by-products of insect metabolism impart a disagreeable taste, odor, and appearance to flour and also impair its baking qualities (*103*). In the case of certain tenebrionid pests of grain and flour, these disagreeable characteristics are caused by quinone secretions (*65*). Experimental results with mice offer some evidence that these quinone compounds

may be tumorigenic and toxicogenic (*66, 107*), but these results require further confirmation. Compounds of similar biological potency, namely, tryptophan derivatives excreted by cockroaches (*Periplaneta americana, Leucophaea maderae*), are carcinogenic or mutagenic when applied to mice (*83, 84*). Signs suggestive of direct toxic action were seen at necropsy in rats that had been fed flour infested with mites (*82*). That compounds of such remarkable biological activity are produced by arthropods so intimately and routinely associated with food raises serious question as to their true significance in human health.

FOOD PESTS AS VECTORS

There are three general groups of potential vectors associated with food: (*a*) birds and bats (important because of their indiscriminate deposition of droppings or because pathogen-laden fecal particulates may become airborne, foodborne, or waterborne); (*b*) cockroaches, flies, ants, mice, and rats (important because they habitually and indiscriminately visit sources of pathogens—drains, discarded dressings, floors, sewers (*17*), feces, and sundry other ejecta—and human food or food-handling surfaces, and because they persistently or temporarily harbor pathogens on or within, and shed pathogens from, their bodies; and (*c*) the "pantry pests" (various mites, moths, and beetles that so commonly infest dry foods), not widely considered to be vectors because their life histories are often played out within a rather circumscribed territory surrounding some source of food.

Pathogen dispersal

While it is generally true that the meanderings of pantry pests do not often take them to good sources of pathogens, it is equally true that the more mobile pests (ants, mice, etc.) are capable of routinely bringing pathogens to the home ground of the pantry pests. From that point of contact pantry pests may mechanically disseminate pathogens throughout the food and thus serve effectively as still another link in the chain of fecal-oral transmission.

Some work has been done on the question of pantry pests as mechanical vectors, but the matter remains largely unsettled (*22, 44, 50, 58, 81, 114*). However, the fact that stored-grain insects and mites are competent disseminators of *Aspergillus* spores (*19*) lends credence to the notion that they may also disperse other suitable pathogens. Although conclusions regarding the role of food pests in the epidemiology of foodborne microbial infections must remain tentative for the present, researchers at the University of Minnesota have made important contributions to our understanding of one pest, the lesser mealworm (*Alphitobius diaperinus*), as a disseminator of bacteria, fungi, and viruses (*25-27, 45, 46*). Similar studies of other pest species will be required before their vectoral significance can be properly understood.

Enteric bacterial diseases

The abundant literature on enteric bacterial diseases includes only relatively few instances in which vectors have played significant supportive roles in the chain of transmission, e.g., transmission of salmonellosis by mice (*56*), rats (*104*), cockroaches (*41, 73*), and flies (*55*); shigellosis by flies (*64, 72*); and cholera by flies (*52*). The role of cockroaches in the spread of salmonellosis has been reviewed by Bartlett (*4*). Greenberg (*42*) has comprehensively reviewed the role of filth flies as vectors.

That vectors have not been implicated more frequently in the spread of foodborne enteric pathogens may be in part due to surprisingly low rates of natural infection of the vectors, as least with rats and mice—1.2%, based on isolations from fecal pellets (*116*), and cockroaches—1.24% (*95*).

Hospital infections

Another factor may be that the potential role of vectors is simply discounted out of hand or not even considered by epidemiologists investigating outbreaks of gastroenteritis or other diseases. For example, in the very extensive literature on infections acquired in hospitals, no potential contributory factor is given less attention than vectors. Yet it is possible to find hospitals in which pathogen-laden arthropods routinely encroach upon food, upon surfaces with which food comes in contact, and upon other surfaces or articles presumed to be clean or sterile (*5, 6-8, 40, 43, 69, 98*).

The incident in which *Bordetella bronchiseptica* (cause of porcine bronchopneumonia) was transmitted by ants within a veterinary isolation unit is an especially instructive model for hospital epidemiologists (*6*).

Leptospirosis

Food pests enter the cycle of transmission of leptospirosis in only a very peripheral way. Leptospirosis is a common latent infection of domestic rats and mice (*59, 113*). These animals continuously shed leptospires in their urine. Desiccation, acidity, and salinity are all inimical to survival of the leptospires. Leptospires deposited in water, on a moist medium, on a damp surface, or in an atmosphere of very high relative humidity have some chance of surviving long enough to be infective. The usual routes of infection are oral, dermal (only through breaks in the skin), and through mucous membranes.

In a restaurant situation, leptospires deposited (with urine) on moist, ready-to-eat food of moderate temperature (*80*), or on moist food-preparation surfaces, utensils, and cloths, or in water in which utensils are perfunctorily rinsed, stand some small chance of meeting new hosts. In slaughter-house, meat-packing, or poultry-processing situations, leptospires deposited directly on carcasses or portions thereof, or in water that may contaminate meat or come into contact with receptive surfaces of the human body, also may infect new hosts. It seems unlikely that leptospires in urine shed by rats and mice onto packaged dry products, e.g., wheat

flour, would survive long enough to be infective.

Histoplasmosis

Histoplasma capsulatum, the causative agent of histoplasmosis, is a saprophytic soil fungus (*30*). Pigeon, starling, and bat droppings that accumulate under roosts seem to serve the fungi as well as soil. Any physical disturbance of such substrates launches innumerable spores into the air. The spores may be breathed in or may be eaten with food on which they chance to fall. Although pigeons and starlings may feed on spilled grain or similar foods around some food industry operations, there is no intrinsic connection with food in the epidemiology of this disease. However, when food industry facilities are remodeled or added to, or when ground is cleared for new construction, any histoplasma spores that chance to be disturbed become airborne and settle indiscriminately on nearby surfaces.

Aspergillosis, aflatoxicosis

Molds of the genus *Aspergillus* are saprophytic on a wide variety of substrates. Some members of the genus are able to invade living tissues, including those of the human body. Thus, they are pathogenic as infective agents, as inhalant or contactant allergens, and also because they produce toxicogenic compounds (*1*). Aflatoxin, mainly from *Aspergillus flavus,* is a potent toxin and a suspected carcinogen in man (*119*). Sterigmatocystin, produced by *A. versicolor,* is carcinogenic for laboratory rats (*63*). Food pests, especially insects and mites, mechanically disseminate mold spores in stored grains (*39*). Since *A. fumigatus* and *A. niger* occur as natural infections in cockroaches (*97*), it may be presumed that cockroaches also disseminate mold spores.

Ornithosis

Transmission of the bedsonial pathogens of ornithosis is only slightly more direct than is that of histoplasmosis. The pathogens of ornithosis are present within infected birds (pigeons, house sparrows, and many other species) and are shed in their droppings (*24, 78*). Droppings may fall upon food or food-handling surfaces, thus becoming directly incorporated into a situation in which transmission may occur. Or droppings drying and disintegrating elsewhere eventually release pathogen-laden particles that may contaminate food. Construction procedures mentioned earlier would in this instance also trigger aerial dispersal of the pathogens.

Amebiasis

Both flies (*96*) and cockroaches (*97*) carry natural infections of *Entamoeba histolytica,* the causative agent of amebiasis, but though the circumstantial evidence is suggestive, there has been no objective demonstration that these vectors are epidemiologically significant (*42*).

Toxoplasmosis

Recent experimental work by Wallace (*115*) with *Toxoplasma gondii* in flies and cockroaches makes it possible to construct a hypothetical diagram of the epidemiology of toxoplasmosis (Fig. 1). There are two ways in which food pests may theoretically enter the cycle of transmission: (*a*) by dissemination of the parasites among wild and domestic animal reservoirs; and (*b*) by direct deposition of oocysts on foods consumed by man. Wild and domestic felines, especially house cats, probably play a central role in the propagation of *T. gondii* (*36*), but human infections appear to result mainly from transplacental passage or from ingestion of raw or inadequately cooked meat containing infective tissue cysts (*35, 112*). The possibility of contracting the infection by direct contact with cat feces should not be discounted (*57*).

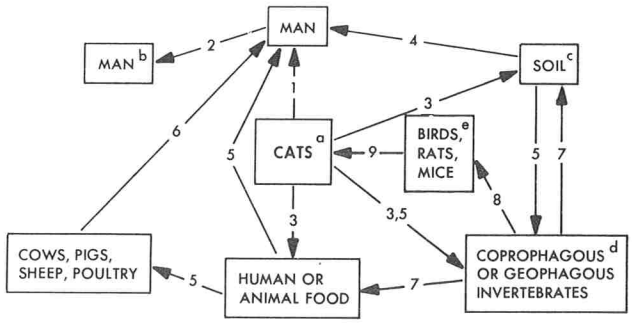

Figure 1. *Diagram of the hypothetical transmission cycles of* Toxoplasma gondii, *causative agent of toxoplasmosis.* [*Based mainly on Frenkel* (*36*) *and Wallace* (*109*).] [a]*Felids in general, but especially* Felis catis. [b]*In utero.* [c]*Sand boxes, gardens, flower beds—any soil containing oocysts.* [d]*Transport hosts (mechanical transmission): cockroaches, flies, snails, slugs, earthworms, beetles, oniscoid isopods.* [e]*Intermediate hosts (biological transmission): de facto transport hosts.* [1]*Contact with cat litter; infection probably by means of airborne oocysts or by hand-to-mouth transfer (only sporulated oocysts are infective).* [2]*Transplacental transmission of tachyzoites.* [3]*Cats shed oocysts in feces.* [4]*Hand-to-mouth transfer of oocysts.* [5]*Infection by ingestion of oocysts.* [6]*Infection by ingestion of tissue cysts (bradyzoites, tachyzoites) in raw or undercooked meat.* [7]*Oocysts shed in feces (no multiplication or development of parasite other than sporulation of oocysts).* [8]*Infection by ingestion of oocysts in or on primary transport hosts.* [9]*Cats prey on small birds and mammals; infection by ingestion of tissue cysts (bradyzoites, tachyzoites).*

Chagas disease

One of the many avenues of transmission in the labyrinthine epidemiology of American trypanosomiasis involves contamination of food by feces of triatomine vectors. The pathogens (*Trypanosoma cruzi*) remain infective in the feces up to ten days after being egested from the bugs (*85*). In many domestic situations in those regions where Chagas disease is highly endemic, there is ample opportunity for food to become contaminated with feces either by direct inoculation from bugs resting in thatched roofs or by means of airborne particulates.

Diphasic milk fever

There are several well-substantitated examples of diseases in which viruses, vectors, and foods are involved. In the first example, diphasic milk fever, the pathogenic viruses are conveyed to human hosts in raw goat milk (*38*). Ticks mediate the transmission of viruses between the goats and certain small mammals, and may also convey (by biting) the viruses to man. The epidemiology of

Q fever, a rickettsial disease, is similar to that of milk fever in at least two ways: the pathogens are shed in milk, and ticks may also transmit the pathogens (*31*). In these milkborne infections the vectors are not food pests nor do they have any direct association with human food. In the next two examples, however, the vectors are food pests and transmission may be effected by direct contamination of food and water by the vectors.

Bolivian hemorrhagic fever

The viruses of Bolivian hemorrhagic fever are shed continuously in the saliva and urine of the vector, *Colomys calossus,* a wild grass mouse (*54*). These mice, which are apparently unaffected by the viruses, regularly enter homes in search of food. When people ingest unheated food or water contaminated during these depredations, infection may result. The virus of lymphocytic choriomeningitis, a disease of house mice and other rodents, may be conveyed to man in a similar way (*10, 71*).

Fowl leucosis

These examples from exotic pathology were introduced here to show that the idea that pathogenic viruses may be conveyed to man via food or food pests is not merely hypothetical.

In this connection a transmission cycle from veterinary pathology is worth noting, even though some details remain unclear. Lesser mealworms, *Alphitobius diaperinus,* become infected with avian leucosis viruses while feeding on chicken litter or on moribund or dead chicks. Experimental evidence (*29*) supports the notion that many chicks that chance to eat infected beetles will develop the symptoms of avian leucosis. Although the beetles may serve as vectors of the virus, other transmission routes (transovarial, airborne droplets, direct fecal-oral) are probably more important.

Enteric viral pathogens

Some attention, long overdue, is now being given to the occurrence and behavior of viruses in foods (*20, 61, 62, 67, 68, 93*). These enteric or foodborne viruses (e.g., enteroviruses, adenoviruses, reoviruses, coxsackie A and B, infectious hepatitis, epidemic viral diarrhea, poliomyelitis, etc.) generally rely, like their bacterial counterparts, on a fecal-oral route of transmission (*20, 93*). Except for flies and cockroaches (*42, 70, 86, 97, 108, 121*), the food pests have been generally ignored as potential vectors of foodborne viruses.

Arthropodborne viruses

Among those viruses requiring a vector, the arboviruses are best known. Neither the arboviruses nor their vectors are of much concern to the food industry, but persons involved in the industry should be aware that many field crops are infected with plant viruses (phytarboviruses) and mycoplasmas that are transmitted from plant to plant by insect and mite vectors (*37, 74, 88*). Certain foods, e.g., coleslaw, reach the consumer bearing live virus particles. These viruses, generally considered to be completely innocuous to man (*99*), are derived either from plant tissues or from the tissues of arthropods feeding on the plants, or both.

Many precisely identified viruses and mycoplasmas (*118*) have demonstrated their ability to thrive in both plant and arthropod systems. Many other viruses and mycoplasmas thrive in both arthropod and vertebrate systems (but, in contrast to the plant mycoplasmas, there is no indication yet that vertebrate mycoplasmas are vectored by arthropods). At the present time only speculative answers can be given to questions about evolutionary ties between these two great groups of viruses transmitted by arthropods (*117*) and to questions about what further evolutionary adaptations, particularly pathogenic ones, may be expected from the arthropod-borne plant and animal viruses and mycoplasmas.

VEHICLES OF IMMUNIZATION

The concept of arthropods as agents and as vectors in the epidemiology of human disease fits comfortably within the framework of traditional medical entomology. But, as I have tried to imply, this concept, when rigorously applied to the question of health significance of food industry pests, tends to become hazy for lack of precise information. There is, however, an additional concept that is even less understood. Besides being agents and vectors, arthropods, as Barnett (*3*) has pointed out, may also serve in a third epidemiologic role, as vehicles of immunization. That is, by transmitting too few pathogens to produce overt infection (*42*) or by somehow attenuating the pathogens before passing them along, the arthropod provokes immunity rather than disease in the host. The peripheral position that arthropods usually hold in the natural cycles of foodborne disease transmission may make it all the more likely that they would function as vehicles of immunization rather than as vectors.

CONCLUSION

To conclude on these notes of uncertainty is appropriate because much of our thinking on this general topic—the relationship of food pests to human health—is shrouded with uncertainty. The uncertainty is largely due to two factors: the scarcity of cases (scarce either because they are in fact rare or just rarely recognized and reported), and the paucity of experimental data on the basic capabilities of food pests as agents and vectors of human disease. To dispel this uncertainty will require the methodical accumulation of a long series of case histories and experimental trials in which the cause-and-effect relationships are clearly discernible.

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Two States have Adopted Water Quality Index

Two states, New York and Michigan, have designated the NSF Water Quality Index (NSF/WQI) for official use in making annual reports to Congress on the quality of their waters. These reports which are submitted via the EPA under Public Law 92-500 must also delineate progress in improving the quality of the state's waters.

Nearly 100 scientists working under the auspices of NSF (National Sanitation Foundation, Ann Arbor, Michigan) have aided in the development of the index according to Robert M. Brown, president.

Water quality reports required by the federal law will answer such questions as: How good is the water in designated lakes and streams? Is it fit to drink? Will it support aquatic life? How does the water quality compare at various sampling points on the same lake or stream?

Selection of Parameters

State and federal water quality management experts were canvassed by mail for selection of index parameters (characteristics affecting water quality), to give their judgments on the effect of each parameter on water quality, and the relative significance of each parameter to other parameters.

The responses established nine major parameters including dissolved oxygen (oxygen in water), fecal coliform bacteria density (an organism in sewage), temperature, turbidity (suspended sediments) and various undesirable chemicals.

Dr. Nina I. McClelland says, "A water quality index number can be established for any water source with testing equipment that is standard for virtually all water departments in the U.S. by measurement of the nine factors."

Among the parameters are those which, by themselves or in combination, aid the water quality expert in determining whether water is safe for human consumption or even surface contact with the body. Some help to determine whether fish and other aquatic life are able to survive in a lake or stream, or what kind of aquatic life survives and in what abundance.

For example, fish, like humans, require a sufficient amount of oxygen to live—some species more and some less. If pollutants rob the water of oxygen they die.

The level of alkalinity in water, or its opposite, acidity, can influence the quantity and quality of aquatic life. Water temperatures that are too high can steal life-giving dissolved oxygen.

Excesses of some chemicals from manufacturing, farming, mining and domestic sources result in pollution. Pollution is then catalogued into seven basic categories—organic, infectious bacterial, toxic, nutrient, mineral, thermal (high temperature), sediment and oil.

Participating Agencies

Working with the Ann Arbor NSF staff in development of the index were the Michigan Department of Natural Resources, U-M School of Public Health scientists, Notre Dame University, the Maryland Department of Water Resources, the Cleveland Clean Water Task Force, the U.S. Army Environmental Hygiene Agency, the Pennsylvania Department of Water Resources, the Ohio River Valley Sanitation Commission and the Larimer County Health Department in Colorado.

As the first state to apply the NSF mathematical index to its waters, New York has been able to show a dramatic improvement in water quality.

On April 15, New York made its water quality inventory report to Congress and in it, through use of the NSF/WQI, demonstrated water quality improvement in eight major rivers.

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Ultra-Pasteurization of Egg Nog with Modern Processing and Packaging Equipment

M. L. AGGARWAL[1]

Yogurt Master, Inc.
Lakeland, Florida 33802

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ABSTRACT

A tubular indirect heat exchange ultra-high-temperature (UHT) processing system coupled with an aseptic packaging machine is described for successful commercial ultra-pasteurization of egg nog. Shelflife of the resultant product is extended manifold over conventionally pasteurized egg nog. Numerous formulations, using various milk ingredients, are presented to suit the geographical location of manufacturing plants, and availability of raw ingredients. Use of processing and packaging equipment in ultra-pasteurization of egg nog has no significant effect on its natural color, flavor, body and texture, and nutritive value.

The concept of preserving milk and other food products by thermal sterilization is not new. An attempt was made in the early 1800's by Nicolas Appert to produce sterilized milk by boiling it, pouring it into glass bottles, sealing them, and then heating the bottles in boiling water. This concept provided the stimulus to food manufacturers worldwide to further explore and exploit its practical applications.

Egg nog, a homogenous blend of milk, cream, sugar, milk solids, eggs, stabilizers, and spices (nutmeg, cinnamon, etc.), is a food product for the holidays. In America it is available to consumers from November through April whereas it is consumed continually in some parts of the world. Egg nog is often fortified with an alcoholic beverage before it is consumed by some persons. It also is consumed as such ("neat") by others. Various types of egg nog are manufactured. An extra-rich product usually contains more than 6% milkfat but to comply with the federal standard of identity egg nog must contain a minimum of 6% milkfat and 1% egg yolk solids. Numerous dairy-food manufacturers prosper from a windfall because of its seasonal popularity.

Despite its popularity and the large volume of egg nog marketed every year, the literature lacks information on formulations and processing techniques. That is no surprise when we realize that the egg nog recipe has been a family secret handed down from generation to generation. Now, because of advances in food technology, the egg nog formulation is no longer a family heritage. However, certain allowances must be made in such formulations when specialized processing procedures are applied to extend the shelflife of the product. In most parts of the country egg nog is normally pasteurized and packaged in disposable paper containers. The shelflife of such a processed product is about one week. Depending on market conditions, this limited shelflife of the product sometimes is adequate but often it is not. Information which follows deals with extension of shelflife for egg nog and could be much sought-after by many dairy processors.

DEVELOPMENT OF FORMULATIONS

There are many ways to manufacture a food product such as egg nog. High quality of ingredients is a definite necessity for fast turnover of egg nog at supermarkets. Since availability of some ingredients is related to weather conditions, supply and demand could force manufacturers to find substitutes to remain economically competitive in the marketplace.

Food manufacturing plants are located all over the country. Some are close to milk producing areas, whereas others are far away. Therefore, a variety of egg nog formulae are needed. A few formulae which have been successfully developed and employed in commercial production of ultra-pasteurized egg nog are given in Table 1.

TABLE 1. *Formulae to produce egg nog with 6% milkfat and 1% egg yolk solid*

Ingredients	Formulae					
	1	2	3	4	5	6
Nonfat dry milk, (lb)	75	—	—	43	61	71
Skim milk, .5% MF[a], (gal)	—	62.5	—	—	—	—
Condensed skim milk, 34% TS, (gal)	—	7.5	—	—	—	—
Whole milk, 3.5% MF, (gal)	—	—	80	—	—	—
Half & half 10.5% MF, (gal)	—	—	—	57.5	—	—
Cream, 18% MF, (gal)	—	—	—	—	33.5	—
Cream, 30% MF, (gal)	—	—	—	—	—	20
Cream, 40% MF, (gal)	15	15	8	—	—	—
Sugar, (lb)	75	75	75	75	75	75
Egg nog base, (Double strength) (gal)	6	6	6	6	6	6
Stabilizers, (lb.)	5	5	5	5	5	5
Vanilla flavor, (oz.)	12	12	12	12	12	12
Yield[b] (gal)	100	100	100	100	100	100

[a]MF = Milkfat
[b]Sufficient water is added to produce 100 gal with each formula.

[1]*Present address: Ohio Processors, Inc., London, Ohio 43140*

Data in Table 1 indicate that milk ingredients such as nonfat dry milk, skim or whole milk, condensed skim milk, half and half, and cream can be used in several combinations to formulate egg nog. Also, there are many sweeteners which could partly replace sugar.

All formulae in Table 1 should include enough water to make 100 gal of the product in a vat before transferring it to the UHT system. Should it be required and/or desired to heat or vat pasteurize egg nog mix before ultra-pasteurization the mix may be homogenized at 1,800 psig and at 140 F and subsequently heat treated to 180 F for 10 min. Heating at this stage improves affinity of stabilizers for fat and protein in the mix. Homogenization preceding pasteurization eliminates the former step as a source of contamination in the product.

UHT PROCESSING SYSTEM

During the past 20 years much has been said and written about various kinds of plate-type UHT systems but very little about tubular heating systems. Therefore, this report describes our experience in processing egg nog with the Cherry-Burrell indirect heat exchange tubular system in conjunction with the Pure-Pak aseptic packaging machine. This automatically controlled UHT system is versatile and is unparalleled in efficiency and rapidity of heating product from 40 to 300 F and cooling it to the desired temperature at a capacity of up to 700 gallons per hour (gph). However, capacities to 2,500 gph are possible and desirable if the filling equipment can simultaneously handle this volume of product.

The main components of this seamless tubular UHT system include supply tanks, a triplex transfer pump, heating and cooling spiratherms, vacuum deaerator, high pressure timing pump, aseptic homogenizing valve, holding tank, and control panel.

The entire operation is illustrated in Fig. 1. Raw product is drawn from a supply tank [1] by a centrifugal pump [2] and transferred by a triplex pump [3] to two regenerator spiratherms [4] where the temperature of the product is raised from about 40 to 175 F. Leaving these regenerators the product enters a vacuum deaerator [5] which removes cooked flavor producing compounds and also reduces the oxygen content in the product, thus stabilizing and improving its flavor. The product is removed from the vacuum deaerator by a centrifugal pump [6] and is sent to two final spiratherm heaters [4] by a high speed timing pump [7]. The product is heated to 300 F and retained at this temperature in a holding tube for 2 sec. The product then passes through two well-water regenerator coolers and is cooled to 140 F at which temperature it is homogenized (at 500 psig single stage for prepasteurized-homogenized product or 1,500 psig first stage and 500 psig second stage for unhomogenized product) by a remote aseptic homogenizing valve [8]. After this the product enters another well-water regenerator cooler and finally is sent to an iced-water cooler to achieve a lower temperature. If the product, for any reason, fails to reach the preset temperature at this point it would be diverted by an air actuated diversion valve [9] to the supply tank for reuse.

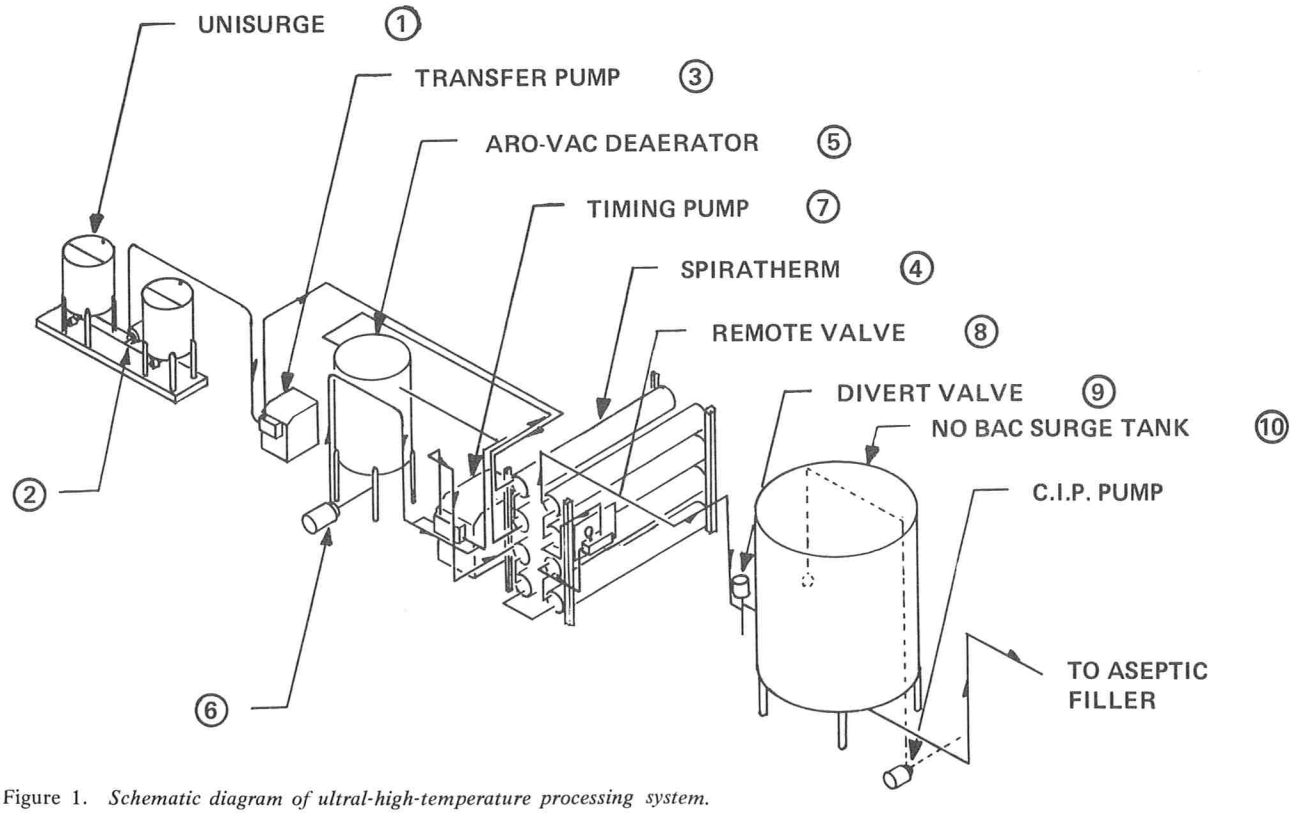

Figure 1. *Schematic diagram of ultral-high-temperature processing system.*

If it is at the required temperature it would go forward into a 1,200 gal pre-sterilized holding tank [10] where the product is further cooled. Sterile air is used to unload and feed the ultra-pasteurized product to the aseptic packaging machine.

PURE-PAK ASEPTIC MACHINE

The Pure-Pak container is composed of five layers. From the outside in, the first, third, and fifth layers consist of polyethylene coating; the second layer is treated virgin pulpwood fabricated into paper stock which gives the container the necessary rigidity. The fourth layer is the aluminum foil which provides the necessary barrier for preventing sunlight and air from reaching products within the container.

The container blanks are packed in conventional corrugated shipping cases, edge sealed, and then sterilized before shipment to the processing plant. Containers are sterilized by a Vacugas process in which material to be treated is placed in a hermetically sealed retort where it is heated above ambient temperature. Air is evacuated from the retort and replaced with a measured volume of ethylene oxide (100%) gas. This treatment requires coordination of: (*a*) the right temperature, (*b*) the right concentration of gas, and (*c*) exposure for the right period. Thus, the Vacugas process provides bactericidal action that destroys both vegetative cells and spores. It has proved a dependable technique for efficient and economical purification and sterilization of Pure-Pak multifoil containers.

The aseptic packaging operation begins with loading the Pure-Pak aseptic machine with pre-sterilized container blanks, heating the container's bottom to 1000 F for 0.9 sec, and then forming and sealing of the container's bottom. The container then is transferred by a mechanical finger onto conveyor chains which carry the open top container under a hydrogen peroxide nozzle. Each container is fogged with 0.1 to 0.2 ml of 35% peroxide for final sterilization of product contact surfaces of the container. The container now enters the filtered air environment where hot air (650 F) entering through a drying nozzle decomposes peroxide into water vapor and nascent oxygen. The nascent oxygen serves as a sterilizing agent. The foil-liner container is aseptic and is now ready to receive the ultra-pasteurized product from the filler assembly. Before operation the filler assembly is sterilized for 45 min with live steam at 45 psig.

This new model "NLL" is provided with a vacuum defoaming device which removes excessive foam from the product and assures adequate sealing at 900 F of the container top. Product containers are coded on the gable top before their departure from the machine. Filling and sealingof the container are done within a stainless steel enclosure that has moving filtered air environment maintained by a high efficiency particulate air (HEPA) filter with a particle efficiency better than 99.97% for particles having a diameter of 0.3μ or larger. Thus, all bacteria and viable spores are eliminated from air in the filling and sealing areas of the aseptic machine. This unique protection for filling and sealing assures extended shelflife to ultra-pasteurized products packaged within the machine. This aseptic packaging machine takes less than 40 sec for the entire process of bottom forming, chemical sterilization, drying, filling, sealing, and coding of a container.

EFFECT OF ULTRA-PASTEURIZATION ON SOME QUALITIES OF EGG NOG

The literature contains reports on various aspects of heat treatment and the qualities of treated milk and its products. An attempt is made in the following discussion to examine the impact of ultra-pasteurization on some qualities of egg nog. Results of combining UHT processing and aseptic packaging equipment in the processing of egg nog have been encouraging and successful.

Color

Color in a genuine egg nog is provided by egg yolk solids contained in the product. Sometimes an artificial color (heat stable) is added to give a richer appearance to the product. Since egg nog contains a large proportion of milk and cream, heating milk to elevated temperature (above 212 F) results in browning of milk (*1*). The extent of color change in milk is related to time-temperature combination used in UHT processing. The higher the temperature and the longer the holding time the more browning occurs in the finished product. Since egg nog is heated to 300 F for a very short time (2 sec) there is no color change in the product.

Flavor

In addition to the characteristic egg nog flavor contributed by spices, an artificial rum flavor (heat stable) is added to enhance the product's flavor. Addtiion of pure vanilla oftentimes improves the flavor of the product. A cooked flavor is often noticed in UHT-treated food products because of liberation of volatile sulfhydryl compounds. This is not much of a problem where the vacuum deaerator is a part of UHT processing system because the deaerator markedly reduces the amount of compounds producing such an off-flavor in the finished product. Cold storage of egg nog after packaging permits oxidation of sulfhydryl compounds which in turn improves the flavor of heat treated milk products (*2*).

Body and texture

A smooth body and texture with a good mouth feel are needed if a food product such as egg nog is to be successful in the marketplace. Since egg nog contains about 25% total solids there is a good chance for sedimentation of solids and separation of fat. To resolve the sedimentation problem, proper selection of stabilizers which have great affinity for fat and protein is necessary. Egg nog contains at least 6% milkfat and its

separation can be virtually prevented by means of adequate homogenization. However, the homogenization pressure is very critical to preserve body and texture of the product.

Shelflife

Modern distribution systems demand a longer shelflife for food products. The shelflife of egg nog that is UHT processed and then aseptically packaged in multifoil paper containers is 90 days when not refrigerated and about 1 year when refrigerated. One of the main sources of contamination, if the product is homogenized after the final heating process, may come from spices if they are not sterilized before being added to the egg nog base. Another equally important cause of "premature" spoilage of the product is nonuniform heating of all particles while in the system. A product as viscous as egg nog must be processed at full operating capacity of the UHT system to insure uniform heating of all particles in the product. In addition, perfect forming, and sealing of containers by the packaging machine are essential to maintain "sterility" of the product, hence to extend shelflife.

Nutritive value

Egg nog contains about 25% total solids including 6% milkfat and is, therefore, high in calories as well as in food nutrients. Many consumers are led to believe that UHT heating removes essential nutrients from foods. Results of a study (*3*) showed that no significant loss of vitamins occured in milk through UHT processing. Thus UHT-processed egg nog with its natural color, flavor, body and texture, and nutritive value is comparable to its pasteurized analogue but has much longer shelflife, and the product can be produced commercially.

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Dairy Remembrance Fund

WASHINGTON, D.C., MAY 21, 1975—Three special student loan funds to assist needy students in dairy and food-related studies in college and universities have been established by the Dairy Remembrance Fund in memory of dairy industry leaders who died during the past year.

The Dairy Remembrance Fund is non-profit, and was initiated in 1953 to financially help students. The special funds memorialize Charles M. Fistere, C. G. Bender, and Edward L. Koepenick, all nationally known leaders in the dairy industry.

Mr. Fistere, an authority on food and drug law, was general counsel for the various trade associations including the Dairy Industry Committee, International Association of Ice Cream Manufacturers, Milk Industry Foundation and the National Association of Food and Dairy Equipment Manufacturers. He also was the Washington counsel to the American Dry Milk Institute and for various other dairy and food companies.

Mr. Bender was executive director of the Georgia Dairy Products Association from 1964 through 1973. He was vice chairman of the Georgia Press Association, and a member of the Georgia Association of Broadcasters.

Mr. Koepenick served for many years as executive vice president of the National Ice Cream Mix Association. Long active in industry activities, Mr. Koepenick was recognized for his skill and organizational talent in developing the programs of the Association.

The fund has in existence 59 loans to qualified students totaling nearly $30,000. Financial gifts in any amount commemorating individuals or signalizing events may be sent to the Office of the Treasurer, Dairy Remembrance Fund, 910 Seventeenth Street, N.W., Washington, D.C. 20006.

Students seeking financial assistance may borrow in amounts usually up to $750, at 2 percent interest, with payment beginning 24 months after completion of college studies.

The Fund is governed by a twenty one member board of directors who voluntarily contribute their time to the Fund activities.

Additional information and application forms for students may be obtained from the Executive Director, Dairy Remembrance Fund, 5530 Wisconsin Avenue, Washington, D.C. 20015.

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An Approach to Solving World Food Problems

W. F. WEDIN

World Food Institute
Iowa State University, Ames, Iowa 50010

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ABSTRACT

Approaches to solving food problems have often been too specific, both here at home and abroad. In developing countries, chronic food problems have often been attacked with a technology, the adoption-diffusion of which, if nonappropriate to mores and customs of the people, has in the long-run been counter-productive. Through the World Food Institute at Iowa State University, we propose to identify problems, analyze them, bring competencies to bear on solving them, provide a continuing feed-in of educated, competent people geared to a problem-solving, interdisciplinary attack, and study the interrelationships to Iowa and the United States. We propose a continuing thrust from our University utilizing pertinent components of the land-grant mission which permitted problems to be solved in Iowa. Through this outward thrust in the broader, international scale, we hope to improve the nutrition and hope for hunger avoidance of humans elsewhere, and simultaneously thereby to increase our own understanding. We look to the peaceful interchange of food-related knowledge which, in the ultimate, knows neither borders nor political leanings.

AWARENESS

Food is a basic need for all people, rich and poor, powerful and weak, young and old, free and oppressed, citizens of this great country and others. That there will be food problems in the future is evident from projections of past events, from an increasing population, from a crunch on energy inputs used in food production-processing-distribution-preparation, and from evidences that an increasing percentage of the world's people are seeking higher quality diets.

Each day those of us here in the United States are made aware of many food-related problems (and opportunities as well) through mass communications which dramatize the despair of a starving inhabitant of the African Sahel or the irritation of the supermarket shopper as prices usually go up, but seldom down. Both extremes can be appreciated by an Iowa farmer as he examines his wilted corn and hears the complaint of the urban golfer who does not want rain on Sunday.

There is small wonder that pessimism has come into vogue (*9*) with respect to food. This ranges from mild concern by the average citizen for our domestic situation to downright hopelessness for helping on a solution of the world food problems.

SITUATION

In its entirety and overriding complexity, most authorities feel that the world food problem will become progressively worse, primarily because an expanding world population will consume all of the gains that are made.

There were 1 billion people on the earth's surface in 1830, showing that the first billion was reached only after 2000 years or more. By 1930, or another 100 years, population doubled to 2 billion; by 1960 or 30 more years, a population of 3 billion was reached. Projections indicate 4 billion by 1975, 4.5 billion by 1980, and 6.5 billion by 2000. World population is doubling every 30 to 40 years, based on present trends.

On a global basis, demand for food is increasing because there are more people, more people live better, and there is a greater awareness of the need for protein in the diet (*4*). Of the total supply of food, the United States is providing more. As evidence for this, Brunthaver cites the fact that grain consumption in the world increased 44% in the last 10 years. There was a 45-million ton increase in grain exports (world basis) during this 10-year period, and the United States provided 32 million tons (or about 2/3) of it. The United States is also providing an increasing share of oilseed and protein meals as indicated by the fact that we provided 45% of the total in 1974 and 52.6% now.

The world food situation is more serious now than it was even 10 years ago. When grain was needed in India in the 1965 to 1967 period, it was possible to help by making large shipments of grain. Now, however, it is well known that world grain stocks are down, and in early 1974 we heard that only enough grain was available to last 27 Days. This causes real concern, particularly for those of agricultural background and endeavor, as we have seen how crops are threatened and often destroyed by nature. An abundant 1974 crop was of crucial importance.

Cochrane (*5*) reviewed how we came into a short food supply and also indicated how it might affect us. World food production increased about 27% between 1960 and 1970. Because of rapid population growth, particularly in less-developed areas of the world, gains in per capita food production were small. The increase was small in spite of the Green Revolution in Asia from 1966 to 1970. Since 1970, the Green Revolution has slowed down, milled rice production in Asia leveled off, wheat production was down in spots, there were increased imports of grain by Japan, western and eastern Europe, and the USSR, and all of these factors contributed to the lowering of grain stocks.

With feed grains for food and livestock feed, plus other commodities, moving in great quantity between countries, with an uncertainty because of bad weather at one or more spots, and with the crunch on energy supply, Cochrane (*5*) may have understated the matter when he said we can not in the United States predict beyond the current year what the situation will be. It appears that we will be faced with a period when the less-developed areas of the world have need for grain produced in the United States on a continuing but irregular basis. Developed areas will also be pulling on our supplies of feed grains and plant protein feeds.

OUR UNITED STATES PLANT AND ANIMAL RESOURCE BASE

The concern in this country as it relates to food is really not whether we will have sufficient food for domestic uses in the next few decades, but rather whether the same choices we have now will still be available at prices that the "average" citizen can afford. In view of the dramatic changes we have seen in food prices within the last year alone, we should examine the plant and animal resource base which undergirds our food supply and allows us, as United States citizens, to enjoy a perfectly adequate diet including foods of both plant and animal origin.

Will changes in our diet be necessary? Will there be shifts away from foods of animal origin? These are only two questions of many about which all of us have been thinking.

On a per capita basis, each person in the United States consumes 1450 lb. of food, 640 of animal origin and 810 of plant origin (*10*). Consumption of beef and poultry products increased while that of dairy products, veal, and eggs decreased since 1959. Lamb and pork consumption remained essentially unchanged. Less flour and cereal products but more sugar were consumed. Vegetable consumption remained the same, and fruit consumption declined. Animal fat consumption went down while that of vegetable oils increased.

Because each of us is being exposed daily to suggestions that grains must go directly to humans, and not animals in this country, it is important to consider what this means nutritionally and economically.

Animal products provide almost 70% of our protein intake—protein noted for its high biological value. Animal products also provide one-third of our total energy intake, half of the fat, 80% of the calcium, 69% of the phosphorus, 60% of the iron, plus significant amounts of vitamins.

Now as we look ahead, we must naturally then be most concerned about plant resources fed to these animals and, therefore our land use (cropland, pasture, and range) and the livestock which convert large quantities of plant protein unusable to man to highly desired products such as milk, meat, and eggs.

Sixty-five percent of the grain (corn, sorghum, wheat, oats, barley, rye—in that order) produced on 157 million acres in the United States ends up as feed for livestock. This is a $15.5 billion contribution to livestock production. Of our grain base, we exported (in 1971) 43% of our wheat, 15% of our corn, and 15% of our sorghum. Percentages of cereals used directly as food in this country were: wheat, 35; corn, 2; oats, 6; rye, 16; and barley, 3 (*10*).

The ruminant livestock industry in this country depends on our acres of pasture, forage, and range to a greater extent than commonly thought. We have 760 million acres of pasture and rangelands and this provides 54% of all the nutrients used by livestock, including poultry. This contribution ranges from a 73% contribution in the beef industry, to 0% in the broiler industry. In spite of trends to heavy grain feeding during the past two decades when grain was cheap, the contribution of pasture, forage, and range to overall dairy production was 64%. In total, livestock contributed $35 billion to our agricultural economy (of a total $60 billion). The beef industry contributed $18 billion and dairy $7 billion.

While we need not be pessimistic about our potential to produce food here in the United States, we perhaps should look objectively at some of the optimistic projections being made. A United States Department of Agriculture projection study, reported in the Farm Index (*8*), suggested that if needed, we could increase United States cropland 56% by 1985. Increases in most plant and animal commodities would be possible, based on certain assumptions regarding availability of inputs, favorable prices, and that necessary soil-conserving practices would be used.

Projections of this order could very well be too optimistic. Inclement weather has an important effect on crop production, as do the cost and availability of fertilizer and other inputs. In addition, return of land once retired from crop production will obviously bring land in that is less productive. We must not sacrifice long-term land use objectives for a short-term gain of increased but transitory cropland acreages. We must not neglect utilizing plant resources unusable directly to man as food but utilizable for conversion by ruminant livestock. In the beef industry, for example, in the United States, by reducing, not eliminating, the amount of grain fed to ruminant livestock, the industry could become as efficient as the broiler industry in converting grain to animal products unusable by man as food (*10*).

RESPONSIBILITY

Our responsibility and our challenge in the United States is great indeed as it relates to helping solve world food problems, so complex and foreboding. Food production surely can be increased in many environments, provided the technology and the necessary inputs are available. There must also be a willingness of people to get the job done.

It has been shown that general economic development in a country is linked to or follows agricultural

development. Therefore, those aspects of development which we experienced as favorable in our country may be of real help to people in developing countries where food problems exist. Not all of our technologies are transferable, by any means, and there are, no doubt, instances where inappropriate technology has been introduced. We must be careful that our technologies are indeed appropriate.

An aspect of agricultural development of concern in the long run is energy expenditure. In relation to food, feed, and energy, Borgstrom (*3*) pointed out that we are using our global resources at an accelerating rate. On a world basis, he indicated that we double our use of resources every 14 years, yet human numbers double only every 30 years. As the world population doubles, industrial activities quadruple. While the figures may be disputed, calculations of Borgstrom (*3*) suggest that when all of the costs of energy for increasing yield are counted (fertilizer, pesticides, power), they exceed the corresponding gain in yield by 2.5 or 3 times.

There are considered evaluations of many which run counter to the pessimistic outlook. Pino (*6*) enumerated the necessity and benefits of agricultural development, both for the developing country and for us. He pointed out that we will, through interchange and flow of scientific information, increase understanding, one of the prerequisites of peace. Officials of the Agency for International Development (AID), such as Bernstein (*2*) and Baird (*1*), have both stressed the seriousness and likely continuation of world food problems. But they also emphasize the importance of constructive and positive action and help on our part here in the United States. This emphasis is particularly important for those within the land-grant university framework where a mission of research, education, and extension has brought the findings of the laboratory and experimental station both to the student in the classroom and to the man on the farm. We know those benefits. It has brought the United States to one of the highest stages of agricultural development of any country in the world.

THE LAND-GRANT UNIVERSITY'S OPPORTUNITY

Within our society, as we know it from an agricultural viewpoint, we have come to learn that universities are keepers, synthesizers, and transmitters of knowledge. Further, this knowledge virtually knows no borders, particularly as set in today's world, drawn closer by satellite and other rapid means of communication. It seems imperative that in our universities we have a strong international dimension so that we can continue to play our role in knowledge dissemination.

This mission is being tested and explored at several of our land-grant universities. But much of the support for these programs of technical assistance in agriculture and food-related problems has come from foundations, from AID, from the countries concerned, and so on, with little from funds appropriated within the state. Because this was true, i.e., operating on monies geared to specific contracts of short duration, the international dimension often did not become an integral part of a land-grant university's program. While it is true that the main thrust of a state university's concern must be to its own people, it is also true that each state's citizen is also both a United States citizen and a world citizen. nd, of course, this world is brought closer and closer together day by day.

THE WORLD FOOD INSTITUTE AT IOWA STATE UNIVERSITY

Iowa State University's outstanding scientists and teachers have never shirked from tackling problems. Thus, some of these same faculty members that solved problems in Iowa are now called to tackle food problems in the larger sphere. But what should the approach be?

From authorities on agricultural development and the solving of food problems, a consensus emerges that our answers have been too simple. A chronic problem may have had temporary help from our recommendation and implementation of a specific technology, yet if nonappropriate to mores and customs of the people, the help may have been counter productive in the long run.

Through the World Food Institute at Iowa State University, we propose to identify problems, analyze them, bring competencies to bear on solving them. provide a continuing feed-in of educated, competent people geared to a problem-solving, interdisciplinary attack, and study the interrelationships to Iowa and the United States. We propose a continuing thrust from our university, utilizing pertinent components of the land-grant mission which permitted problems to be solved in Iowa. Through this outward thrust in the broader, international scale, we hope to improve the nutrition and hope for hunger avoidance of humans elsewhere, and simultaneously thereby to increase our own understanding. We look to the peaceful interchange of food-related knowledge which knows neither borders nor political leanings.

As we begin this task of help, which of the three (research, education, extension) can we omit? Stated in another way, which of these three could have been omitted during the last 50 years in Iowa? We can not generalize here, but rather use the same ingenuity we have used in the past to use the most reasonable one or combination of two or three in solving an identified problem. Because the specialist has often been advanced at the expense of the generalist, the blending of research, education, and extension approaches will likely be necessary to truly attack problem-solving.

Within the World Food Institute at Iowa State University, task forces are being identified for specific problem-solving situations. Let me illustrate with a brief description of our team graduate education task force. We feel that each nation must ultimately have its own or access to diversely-trained people in the production, utilization aspects, and social sciences as related to their own domestic food supply. Availability of these types of people, plus the ability to work together effectively and efficiently in problem-solving, is very important.

In our graduate training of international scholars at Iowa State University, we will be adding an additional emphasis to precondition these students for working together and thus, on return to their own countries, they should be more productive. Sprague (*7*) has pointed out the importance of this type of educational experience.

The salient points of our activity at Iowa State University on team graduate education will be: (*a*) a broadeningof the students's training, yet not sacrificing his required concentration in depth for his own discipline, (*b*) a consideration of problems for study from his own country, primarily at the Ph.D. level, (*c*) a program to acquaint his major professor at Iowa State with problems in the student's home country, and (*d*) a building of linkages among the student's country, his local educational or research institutions, with Iowa State, and with international research centers.

The last mentioned point can blend many of the things we already do well at Iowa State, i.e., working cooperatively among research entities within our national agricultural research system—now blending them into the international research centers. The growing seriousness of the world food problem has brought more focus on the need for technology related to production. Many countries are looking at their research systems and are increasing investments in their indigenous institutions. There is also increased concern and support by outside organizations and institutions, the latter of which have banded together to support international agricultural research centers (*1*). An international research network is evolving and centers of excellence in both developed and developing countries will be involved. High priority research needs are being established. For Iowa State, let me mention only one possible team—international center—country linkage. Corn is a basic human food in many developing countries and we could use it as the common thread for technologies important to its increased production and use (human or animal) in a developing country. In the process, we can learn more about corn to the benefit of Iowa and midwestern United States farmers.

The international agricultural research centers are essential keys to focusing on food production in developing countries. Already these centers have accorded first priority to cereals, but followed closely by research centers on food legumes, root and tuber crops, and ruminant livestock. The research is multidisciplinary and is being viewed in the context of farming systems in which both crops and livestock play an important role. The centers seek to generate, through their own scientists, high priority, international-nature agricultural technology for use in the developing countries and to assist the developing countries to both utilize the technology and strengthen their capability to develop improved technology on their own—to strengthen national agricultural research. At Iowa State University, we feel that we can help the centers in assuring that their efforts reach fruition in certain countries.

As a project of the World Food Institute, a World Food Conference will be sponsored from June 27 through July 1, 1976. This World Food Conference at Ames, Iowa will provide a forum for the international exchange of information dealing with food—an important topic now and bound also to be so in June, 1976. The Conference is scheduled in conjunction with the Bicentennial of the American Revolution. Pre- and post-Conference tours, complementing the World Food Conference program, are anticipated. The Conference, to be held in Ames at the four new buildings of the Iowa State Center Complex, will be within 40 miles (via interstate highway) of another related Bicentennial event in the heart of the nation—The Living History Farms Project—and the Iowa State Fair, in nearby Des Moines, whose summer, 1976, theme will stress world food production.

The 1976 Conference will bring a further awareness of the food situation in the world, will address how our United States plant, animal, and human resource base can be brought to bear on the problem, will consider further what our responsibilities are within the land-grant university framework, and in doing so give added direction and impetus to the World Food Institute at Iowa State University.

ACKNOWLEDGMENT

This paper was presented at the 61st Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, St. Petersburg, Florida, August 12-14, 1974. Journal No. 20, College of Agriculture, Iowa State University, Ames, Iowa 50010.

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LETTERS TO THE EDITOR

Which is correct—the text or table?

DEAR SIR:

The paper entitled "Behavior of *Clostridium perfringens* in Precooked Chilled Ground Beef Gravy During Cooling, Holding and Reheating" by S. Tuomi, M. E. Matthews, and E. H. Marth which appeared in the *JMFT* 37:10, 494-498 is of interest to me.

I find difficulty, however, in comparing the statement (P. 497 "Growth of perfringens"-line 3) with the tabular data in Table 4. The statement reads as follows: "Data in Table 4 indicate that a rapid multiplication of the organism occurred during the cooling period, and resulted in a 30,000 to 40,000-fold increase in population of *C. perfringens.*" If this were true the count after refrigeration, assuming a 40,000-fold increase with sample 1 would be in 400,000,000 cells/g. The data in Table 4 at 82 F, actually show the following:

Sample	*After Inoculation*	*After Refrigeration*
1	10,000	40,000

In *every* example cited in the table, the increase is not of the order of magnitude stated in the statement quoted above (30,000-40,000-fold). It is my contention that the increase is in the order of 3-6-fold. Is my approach to this correct or am I misinterpreting something?

The topic *C. perfringens,* is a vital one and the three or four papers which have recently appeared in the *JMFT* have caught the attention of sanitarians who are attempting to utilize the research data in a practical manner.

On the basis of the data published in this paper, I think some individuals will be misled into thinking that *C. perfringens* cells can increase some 30,000 to 40,000-fold during the 6-h cooling period as described.

Any information you might provide to the readers in the Letter to the Editor section of the Journal to correct the above error, if it exists, will be appreciated.

O. W. KAUFMANN
Cincinnati Training Facility
Division of Federal-State Relations
EDRO, Food and Drug Administration
550 Main Street
Cincinnati, Ohio 45202

The text was correct—the table had an error

DEAR SIR:

We appreciate Dr. Kaufmann's interest in our paper, "Behavior of *Clostridium perfringens* in Precooked Chilled Ground Beef Gravy During Cooling and Reheating." Dr. Kaufmann is correct when he points out that the text and data in Table 4 do not agree.

The problem is in the table; the text is correct as it stands. A corrected version of the table is given in this letter. Use of cells in the logarithmic phase as inoculum and the ideal conditions for growth in the gravy account for the large population of *Clostridium perfringens* that developed in the product.

The corrected table is as follows:

TABLE 4. *Numbers of* Clostridium perfringens *in ground beef gravy during cooling in refrigerator*

Sample[a]	Plate count of *C. perfringens* (cells/g x 10^4) Before inoculation	After inoculation	After refrigeration	Subsequent holding treatment
1	0	1.0	40,000	82 F
2	0	1.0	42,000	
3	0	2.4	78,000	
4			51,000	
5	0	2.1	67,000	
6	0	1.0	62,000	
7	0	1.0	58,000	
8			41,000	
Mean	0	1.4	55,000	
1	0	1.0	36,000	42 F
2	0	1.0	36,000	
3	0	2.4	18,000	
4			11,000	
5	0	2.1	44,000	
6	0	1.0	64,000	
7	0	1.0	54,000	
8			46,000	
Mean	0	1.4	39,000	

[a]Samples 1 to 4 are counts from trial 1, samples 5 to 8 are counts from trial 2.

We thank Dr. Kaufmann for calling the error to our attention so that a corrected table could be published.

SIRPA TUOMI-NURMI
Institute of Food Chemistry and Technology
University of Helsinki
SF-00710 Helsinki, Finland

M. E. MATTHEWS
E. H. MARTH
Department of Food Science
University of Wisconsin
Madison, Wisconsin 53706

J. Milk Food Technol. Vol. 38, No. 7, Pages 428-434 (July, 1975)

Report of Committee on Dairy Farm Methods, 1973-1974[1]

M. W. JEFFERSON,[2] DALE TERMUNDE,[3] J. C. FLAKE,[4] and JAMES B. SMATHERS[5]

ANTIBIOTICS, PESTICIDES AND OTHER ADULTERANTS SUBCOMMITTEE

Adulteration of milk supplies continues to be of concern to the milk industry and the state regulatory agencies. A continued surveillance program must be maintained to assure the general public an unadulterated milk supply.

Response to inquiry by this committee from 44 of the 50 states revealed the following information:

1. Are routine tests being done for adulterants in Grade A milk within your state?

	YES	NO
Pesticides	38 states	6 states
Antibiotics	44	0
Abnormal milk	44	0
Sediment	18	26
Added water	37	4

2. Is milk that fails to comply with Grade A requirements utilized in manufactured milk products in your state?

	YES	NO
Pesticides	—	39 states
Antibiotics	—	39
Abnormal Milk	14 states	25
Bacteria	33	6

3. Is there a problem in your state of milk being adulterated with cleaners and/or sanitizers?

YES: 10 states NO: 33 states

It is the concensus of this Subcommittee that milk adulterated with cleaners or sanitizers will be evident in freezing point determinations. There does not appear to be a need to develop a new test for these adulterants.

4. Would a laboratory quality assurance program for precision of methods for determining butterfat, added water and pesticides in milk be beneficial to your laboratory program?

YES: 34 states NO: 10 states

With approval from the Dairy Farm Methods Committee, this Subcommittee recommends to the National Conference on Interstate Milk Shipments that the state laboratory certification program be expanded to include determination of milkfat, added water, and pesticides.

Education must be continued on the use of antibiotics and pesticides on dairy cattle. The Subcommittee recommends:

1. That each state regulatory agency request the extension service, dairy associations, and veterinarians to stress the proper use of antibiotics on dairy animals.
2. That continued efforts be made to clearly label antibiotics whether formulated by a veterinarian or by a pharmacist.
3. That treatment of dairy animals for slaughter by veterinarians and farmers be in accordance with recommended state and federal meat regulatory programs.
4. That pesticide labels be plainly and simply stated.
5. That continued efforts be made by states toward licensing and controlling of commercial pesticide applicators.
6. That chlorinated hydrocarbons and PCB be used only where residues can be controlled.
7. That state regulatory programs keep close surveillance on the possibility of milk being adulterated with sanitizers and cleaners.
8. That equipment dealers instruct producers on the proper use of all automated equipment including tubular and plate coolers.
9. That state regulatory agencies continue to evaluate milk supplies, especially at the retail level, for antibiotics, pesticides, added water, sediment, and other adulterants.

SUBCOMMITTEE MEMBERS: *A. R. Brazis; W. J. Harper; B. Heinemann; R. L. West; and L. Townsend,* Chairman.

CLEANING AND SANITIZING OF FARM MILK EQUIPMENT SUBCOMMITTEE

I. *Cooling and cleaning temperatures*

A. Installation of a temperature recording device on the bulk tank will be advantageous in observing conditions of both cooling and cleaning cycles. Both areas have a direct effect on milk quality.

B. Recording temperature of pipeline washing solutions will provide accurate records of the entire cycle, as well as frequency of cleaning.

C. Experience continues to prove that to obtain best results in circulation type cleaning, starting temperature should be 160 F and ending temperature (10-min cycle) 105 F minimum. This type of temperature maintenance will provide clean equipment with a minimum amount of detergent.

II. *Water heating facilities*

A. Estimated heater requirements for milkhouse operations

Type	Heater size
Bulk tank—Milking machines	50 gal.
Bulk tank—mechanically cleaned and milking machines	80 gal.
Bulk tank—Pipeline or transfer system	120 gal.
Bulk tank—Pipeline (2-inch diameter or more)	150 gal.

B. In milking parlor operations, it is recommended that two water heaters be provided. One heater should be installed to provide water to the udder washing stations. Capacity should be based on 30 gal. per 100 cows. One heater should be provided for washing equipment in milkhouse. Capacity of this heater should be based on the above estimated requirements.

III. *Maintenance and installation of vacuum systems*

A. Vacuum pumps and regulators should be installed for easy access to observe operation, for ease of maintenance, positioned near floor drain and away from feed stuffs, and be properly ventilated for cooling and to eliminate obnoxious odors.

B. Cleaning of entire system should be done on a once-a-month basis or when foreign matter has been known to enter the system. Follow the manufacturer's recommendations.

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[1]*The Committee dedicates this report to Mr. A. K. Saunders (1908-1974) who served as member of the Committee for over 20 years, and as Chairman from 1962-1973.*

[2]*Chairman of the Committee; Virginia Department of Agriculture and Commerce, 1444 East Main St., Richmond, Virginia 23219.*
[3]*Eastern Assistant Chairman of the Committee; Babson Bros. Co., 2100 South York Road, Oak Brook, Illinois 60521.*
[4]*Consultant and Editor for the Committee; Evaporated Milk Association, 910 Seventeenth St., N.W., Washington, D.C. 20006.*
[5]*Consultant to the Committee; Maryland and Virginia Milk Producers' Association, Inc., 1530 Wilson Blvd., Arlington, Virginia 22209.*

IV. *Cleaning of elliptical tanks*

A. When single manhole tanks are being utilized, it is imperative that a mechanical washer be provided. This washer should include facilities for pre-rinsing, washing, and post-rinsing. Mechanical sanitizing is optional with the producer.

B. Spray device provided with washer should be designed for easy removal and cleaning.

V. *Cleaning of plastic milk tubing.* Preliminary investigation has shown that pre-rinsing plastic tubing with 115 F water (versus lower temperatures) results in less fogging and/or discoloration. It should be noted, however, that rinsing with temperatures over 115 F would be detrimental to cleaning. It is recommended that further investigation be implemented to evaluate the effect of rinsing temperatures on both cleaning and life of plastic tubing.

SUBCOMMITTEE MEMBERS: *J. Burkett, F. M. Copenhaver, C. C. Gehrman, F. Taylor,* and *J. Welch,* Chairman.

EDUCATION SUBCOMMITTEE

The Education Subcommittee has continued to assemble educational material for periodic publication of availability in the *Journal of Milk and Food Technology.* In addition to printed material; this Subcommittee is also collecting additional visual aids (slide sets, strip films, movies, etc.). A complete listing of this material will be assembled for inclusion in the 1974-75 Farm Methods Committee Report.

SUBCOMMITTEE MEMBERS: *S. Barnard, P. J. Dolan, B. Luce, V. S. Packard, R. Richter,* and *V. D. Nickel,* Chairman.

PLASTICS SUBCOMMITTEE

The Plastics Task Subcommittee is studying the effect of pre-rinse temperature, composition, and mechanical procedure on the clarity of flexible plastic tubing used on milking machines. The temporary loss of clarity sometimes experienced in flexible plastic tubing is caused by a small amount of water adsorbed on the inside surface. This water causes a temporary stressing and dislocation of the plastic structure which changes the index of light refraction resulting in cloudiness. The clarity returns when the water leaves and the plastic returns to an unstressed state. This is similar to the appearance of a clear rubber band when it is highly stretched—a "whitening" appears which again becomes clear when the band returns to an unstretched condition.

From limited experimentation on a few farms it was noted that when the temporary loss of clarity occurred, a film of milkfat was found on the inside surface. In general, cleaning conditions were close to recommended procedures, but pre-rinse temperature was low. It is known that a milkfat film will hold some water, perhaps contributing to the temporary opacity. Also, the fat film itself causes a hazy appearance.

A survey made this year indicates that pre-rinse temperature ranges from 55-100 F and at times is recirculated. Milkfat melts at 105 F, so rinse temperature below that does not sufficiently remove the fat. During recirculation, the temperature drops and any milkfat initially removed would be redeposited. It is felt that a poor pre-rinse puts an undue load on the subsequent cleaning to remove all fat and solids.

A program has been initiated on test farms to evaluate the role of pre-rinse temperature, recirculation vs. dumping, and composition of pre-rinse (water, detergency, etc.). Results will be summarized in the 1974-1975 Farm Methods Committee report.

SUBCOMMITTEE MEMBERS: *O. L. Majerus, S. B. Spencer, J. Smucker,* and *B. M. Saffian,* Chairman.

TESTING FOR CLEANLINESS OF MILK PRODUCTION SUBCOMMITTEE

A major goal for this year's work of this Subcommittee was to establish if a relationship exists between sediment testing and abnormal milk detection. It is a fact that when a group of properly warmed universal 1-oz. milk samples are subjected to sediment testing, some will vacuum rapidly, some very slowly, and some will resist passage by fouling the sediment test disc.

Reports have been received from Subcommittee members covering 1240 tests of 1-oz. samples through a 0.1-inch diameter test disc. The findings are as follows:

1. Approximately 20% of the samples resisted filtration and thus the full 1-oz. sample could not be tested.
2. Over two-thirds of the samples resisting filtration showed DMSCC levels in excess of 1,000,000/ml.
3. Approximately one-third of the samples resisting filtration showed DMSCC levels in excess of 1,500,000/ml.
4. Samples resisting filtration generally showed high MWR or WMT reaction.
5. The samples that filtered most rapidly in each group of four samples tested simultaneously generally showed low DMSCC levels and low MWR and WMT values.
6. Sediment level in a milk sample has to be extremely high before it fouls the disc. High DMSCC levels are more likely to be the cause of fouling.
7. Test discs foul and samples tend to resist filtration when the DMSCC value approaches 1,000,000/ml.

There findings indicate that the 1-oz. sediment test is a useful means for twofold milk quality determination. The test determines the degree of milk cleanliness and instances of abnormal milk as evident by disc fouling.

The universal sample system fouling makes such testing and retesting practical. Repeated fouling of a sediment test disc should be a valid reason for a fieldman or sanitarian to give a producer preliminary warning of this fact, and to take steps to determine and correct the cause.

SUBCOMMITTEE MEMBERS: *P. Bergner, G. Cavin, H. Eastman, H.D. Gleason, M. Neff, R. J. Weaver, D. Webber,* and *M. H. Roman,* Chairman.

CIP CLEANING OF MILKER UNITS IN THE PARLOR OR MILKING BARN SUBCOMMITTEE

A. *Objectives*

1. Reduce handling time of milker units before and after milking.
2. Permit operators to attach milker units directly to wash manifold at each stall.
3. Teat cups are in a sealed position on washing unit (manifold) so foreign matter cannot enter inflation during washing and storage between milking.
4. Milker units, milk lines, wash lines, and manifold to self-drain.
5. CIP wash manifold provided with self-closing dust and fly protective cover.
6. Physical cleaning of external parts of milking units.

B. *Procedures*

1. After milking, teat cups of units are attached to self-draining manifolds (when manual cleaning is necessary, cleaning should be done in the milk house).
2. When vacuum pulsation is used, pulsate inflations during washing.
3. Washing solutions are circulated from wash tank in the milk room, through wash line, the milker units, and the manifold to the return line, back to the receiver and tank for recirculation.

C. *Additional recommendations*

1. Before installation, draw a sketch of the system including equipment specifications and diagrams denoting water flow.
2. Submit this sketch to the following for approval before installation:
   a. The regulatory agency responsible for the milk supply.
   b. The milk producer's fieldman.

SUBCOMMITTEE MEMBERS: *R. L. Appleby, R. Ayres, C. Luchterhand, J. Reeder, A. E. Tesdal, A. Wisdom,* and *K. Harrington,* Chairman.

CLEANING AND SANITIZING OF FARM MILK PICKUP TANKS AND TRANSPORTS-SILO TANKS-STORAGE TANKS SUBCOMMITTEE

FARM MILK PICKUP TANKERS AND TRANSPORTS

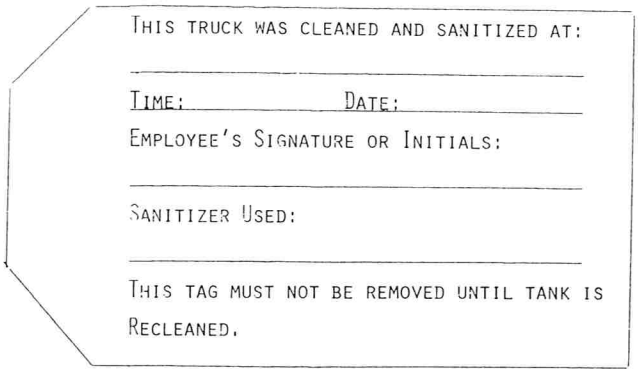
The farm bulk pickup tanker, the backbone of the milk collection

system in the United States, is the vital link in the quality chain from producer to processor. This tank must be cleaned, sanitized, and maintained in a condition where it cannot cause any product deterioration during pumping or transporting. The responsibility for these actions must be clearly defined to reach this objective.

The Subcommittee attempted to determine the preferred procedures and methods for cleaning and sanitizing the pickup tanker. The driver has the direct responsibility to be certain the pump, tank, and other milk contact surfaces are cleaned and sanitized before pumping milk into the truck. The Subcommittee is aware that numerous opportunities for failure are present due to use of relief drivers, deliveries at various times of day and night, and various cleaning facilities provided at different dairies. Sanitarians have found that the following procedures have worked:

I. *Driver responsibility before loading*
   A. The driver must be certain that the tank is completely clean and sanitized before departure for milk pickup.
   B. If the unit is found to be deficient in cleaning, remedial action should be taken to clean, sanitize, and properly drain the unit before loading.
   C. At times units are not used for several days. If a tank has been out of use for over 2 days, it should be rewashed and sanitized before use.
   D. The driver should keep the outside of the unit as clean as practical. Driver appearance should be clean and neat.
   E. If the farmer provides pumps or additional piping beyond that carried on the truck, the driver should check for cleanliness of this equipment before loading and work with the farmer to correct any deficiencies found.

II. *Responsibility of the driver and/or plant personnel following receipt of the load*
   A. The Subcommittee finds that most successful programs clearly define responsibility for cleanliness of the tank interior, manhole area, pump, hose, and pump compartments. Plant personnel normally are assigned responsibility for cleanliness of the tank.
      1. Plant personnel should clean the interior of the tank by hand washing or CIP cleaning. Care must be given to proper sizing of the pumps, solution volumes, and piping to do an adequate cleaning job on tanks of various sizes and dimensions. Built-in nozzles, spray heads, drop-in units, or bottom mounted "Roto-Turn" cleaning systems should be designed, installed, and maintained so that the spray pattern will contact all interior surfaces. Preliminary results of a Florida study indicate that spray head spacing, gallons per minute, and pounds per square inch pressure are critical in a satisfactory CIP system.
      2. Plant personnel should be required to hand wash the CIP ports, manhole covers, gaskets, and other manhole accessories and inspect the tank interior to determine acceptable cleaning.
      3. The regulatory authority should establish a tagging procedure calling for the plant employee to sign that he has cleaned and sanitized his area of the truck. An example of the tag used in one market is shown below:


THIS TRUCK WAS CLEANED AND SANITIZED AT:

TIME: DATE:

EMPLOYEE'S SIGNATURE OR INITIALS:

SANITIZER USED:

THIS TAG MUST NOT BE REMOVED UNTIL TANK IS RECLEANED.

   B. The driver should be required to be certain the pump compartment, hoses, and pump are thoroughly cleaned and sanitized following each delivery.
      1. The proper wrenches, brushes, mat, or soft container necessary to disassemble and wash the pump, valves, hoses, and other accessories, should be available at each delivery location.
      2. The plant should provide a method of cleaning the pump hose by recirculation within a tank containing a hot cleaning solution of proper strength and temperature. This method of cleaning assures internal and external cleanliness of the hose and tends to increase the life of the hose. Where pump hoses are hand washed, the length should be restricted to a length that could be properly cleaned with a brush and stiff handle. A recording device should be installed to assure proper time and solution temperature. Stainless steel baskets may be provided to suspend pump parts in the solution tank to allow cleaning by circulation.
      3. Following cleaning, the pump parts should be assembled and sanitized by spray or circulation of a sanitizing solution. The responsibility for seeing that this is accomplished rests with the driver even though the requirement to do the work in some markets may be assigned to plant personnel.
      4. The driver should be required to sign the truck cleaning tag indicating that the truck and equipment have been cleaned.
      5. The driver must be certain that the sanitizing solution is completely drained.

III. *Responsibility of the dairy plant, reload station, transfer station or receiving station*
   A. The station should furnish the necessary material and facilities to allow the proper cleaning and sanitizing of all tankers.
   B. The station should establish a routine quality control check to assure that the cleaning solutions are in compliance with the manufacturer's recommendations and that personnel are completing the required work. Charts from temperature-pressure recorders on CIP lines may be used to compare cleaning cycles to the load receiving reports as a means of determining compliance with the plant cleaning procedures. Routine laboratory checks of cleaner and sanitizer strength should be a requirement. Swab tests or other tests for micro-organisms may also be used to determine satisfactory compliance.

IV. *Responsibility of the regulatory authority*
   A. Regulatory authorities should meet with plant management and haulers to establish equipment criteria and procedures that will minimize the problems in the market:
      1. Standardize CIP systems in the area to be compatible with all truck units and adequate to handle the largest unit in operation.
      2. Establish location requirements for truck CIP ports so that the equipment at various plants will properly wash all truck units.
      3. Establish a spot check procedure to determine compliance by all personnel involved to include the checking of pressure-temperature recording charts.
      4. Meet with plant management and truck operators to amend procedures to meet new problems with minimum inconvenience and expense to the industry.
      5. Work with all segments of the industry to establish solution temperatures, solution concentrations, line pressures, and facility requirements to make the best use of today's technology.
      6. Require that detailed cleaning-sanitizing regimen be posted adjacent to clean-up pump or make-up tank at each cleaning location and require that pressure-temperature recording charts be checked on a regular basis.
      7. Require that pump compartment door gaskets and dust cover gaskets be maintained in good repair.
   B. The Subcommittee recommends that CIP cleaning systems include the following:
      1. Valve sizes should be standardized in each marketing area.
      2. Proper size CIP pumps for adequate coverage of tanker walls with cleaning solution. Manufacturer's recommendations should be followed to insure proper volumes and pressures in the cleaning system. A pressure-temperature recording device should be installed in the system.
      3. Initial rinse water should be discarded.

4. Proper positioning of the spray ball or tear drop spray head within the tank is critical for complete coverage. Openings in spray balls or tear drop spray heads must be kept clean to prevent deflection of spray jets.
5. Burst wash and rinse cycles are recommended to allow the return pump to keep flooding of long tankers to a minimum and to increase turbulence of the cleaning and sanitizing solutions.

V. *Pump cleaning procedure*

The following cleaning procedure for the tanker pump and pump parts is recommended:

A. Disassemble and rinse the pump and parts.
B. Clean all parts using suitable brushes and cleaning solution by hand or by recirculation.
C. Rinse with potable water.
D. Brush pump housing with an acceptable sanitizing solution.
E. Hand dip pump parts in an acceptable sanitizing solution and assemble the pump.
F. Clean and sanitize the entire pump compartment.

FARM SILO TANKS-STORAGE TANKS

With the movement to larger farm milk storage tanks, the Subcommittee was asked to investigate cleaning and sanitizing procedures that would assure clean, sanitized tanks.

In view of the size of these storage tanks, it is the concensus of the Subcommittee that a properly designed CIP system is a must for uniform cleaning and sanitizing. Due to the various shapes and sizes of tanks available, it is imperative that the CIP system be designed to assure complete coverage of the interior surface of the tank. With the larger surface area being subjected to rapid changes in temperature and the corresponding expansion and contraction of the surface and air in the tank, all tanks must be properly vented during the cleaning process to avoid possible collapse of the walls. Recommended vent sizes are published in the 3-A Sanitary Standards for Silo-Type Storage Tanks Serial #22-03. When washing farm storage tanks that are refrigerated by direct expansion, it is mandatory that solution temperatures be in compliance with manufacturer's recommendations to avoid developing high refrigerant pressures and possible buckling of the interior surface.

The cleaning procedure for farm storage tanks should start immediately after the tank has been emptied. A cleaning regimen developed by the tank manufacturer and the cleaner supplier should be followed. A suggested procedure should include the following:

1. Rinse with cold or tepid water to remove the majority of the milk residue from the tank. This rinse solution should not be recycled. If the tank is not scheduled for cleaning immediately, the tank driver should close the tank to minimize the amount of milk film drying before the complete cleaning procedure.
2. An approved cleaning solution of sufficient volume, concentration, temperature, and under sufficient pressure should be circulated to wash the interior surfaces of the tank. Any parts requiring hand washing should be cleaned at this time. The temperature of the solution and the circulation time should be controlled to avoid the possibility of redepositing soil on milk contact surfaces. The installation of a pressure-temperature recording device would aid materially in the control of the cleaning regimen.
3. Following washing, the solution should be allowed to drain from the tank.
4. Following draining, the tank should be rinsed with cold water and allowed to dry. An acidified rinse could be substituted for this final cold water rinse provided it is compatible with the other cleaning materials.
5. Before the start of filling, the tank should be checked for cleanliness and then sanitized with an approved sanitizer.
6. Filling pipes or other equipment inserted in the tank during the milking process must be removed following each milking, cleaned and sanitized before use at subsequent milkings.
7. Manhole gaskets, sampling devices, or other equipment requiring hand cleaning must be removed, cleaned, and sanitized when the tank is washed.
8. Spray balls or other cleaning devices that may trap foreign matter should be checked on a regular basis to avoid blockage of the spray pattern.

The National Association of Dairy Equipment Manufacturers recommends the following:

1. Don't use steel wool to clean stainless steel.
2. Don't use water with high concentrations of iron, salt, or sulfur.
3. Don't allow bactericides or cleaners to remain on surfaces for over 20 min.
4. Don't allow tools, parts, fittings, or other items to rest on tank surfaces.
5. Don't use cleaners or bactericides in excess of manufacturer's recommendation to avoid surface damage or discoloration.

SUBCOMMITTEE MEMBERS: *G. Briody, M. R. Cooper, H. B. Ellison, C. R. Gilman,* and *B. M. Cook,* Chairman.

SAMPLING OF MILK IN TRANSPORT TRUCKS SUBCOMMITTEE

Collection of a representative sample of milk from a transport tank is easier said than done. The basic problem is achieving proper and thorough agitation of milk in the tank.

Certain factors must be considered relative to the agitation and sampling of milk in transport tankers. These include the following:

1. Immediately before taking a sample, the contents should be homogeneously mixed.
2. The time interval required for mixing large tanks will vary accordind to the following conditions:
   a. The shape and size of tank.
   B. The volume of product held.
   c. The type, location, and force of agitation.
   d. The creaming interval before starting agitation.

Considering these variables, it is necessary to determine the minimum time of agitation required to achieve homogeneity of the milk in the tanker.

A review of previous Farm Methods Committee reports and other sources of information indicates that the following methods of agitation of transport tankers are being used:

1. None.
2. Agitation using hand stirring rod designed for the 10-gal. can. Hand stirring rods range in length from 36 inches up to 6-8 ft.
3. Thief sample made of a long stainless steel rod is used to obtain a core sample.
4. Air agitation:
   a. Sanitary air hose placed in tanker using air velocity to roll the milk for agitation.
   b. Air driven motor to activate a small propeller or agitator placed into the tanker through the manhole.
   c. Air injected through a quick coupling in rear of tanker in an attempt to circulate the milk.
   d. Air line built into the bottom of the tanker where air is blown through stainless steel tube throughout the length of the bottom of the tanker to roll the milk for agitation. The same device is used for CIP cleaning of the tanker. This is the Roto-Twin system discussed later in this report.
5. Mechanical agitation:
   a. Propeller or agitator driven by an electric motor. The unit is placed on the manhole with the propeller down in the milk.
   b. Mechanical agitator built into tanker driven by electric motor mounted on underside of tanker.
6. Circulation of milk by use of unloading pump to pump milk out of the outlet valve and back into the tanker through the manhole. A plastic hose is usually used for this hook-up.
7. Pumping the milk into a plant storage tank and then sampling the milk through the storage tank pet cock.
8. Drip automatic sampling as milk is unloaded.

During the Fall of 1973, the Northeast Dairy Practices Committee published Bulletin 7 titled *1973 Guidelines for Sampling Fluid Milk.*

These published guidelines included a section on tank truck sampling that offers procedures and ideas that could be adopted by milk receiving and shipping stations and plants that are involved in sampling.

The tank truck sampling procedures as outlined in the *1973 Guidelines for Sampling Fluid Milk* are as follows:

1. Collect a sample through manhole by aseptic means immmediately after loading the milk at the last pickup for that load.
2. Drop a high speed agitator (air driven preferred) into the manhole and run for at least 10 min on tanks up to 3,000 gal. capacity. For larger tanks the minimal agitation time should be established by interval sampling and testing for the fat content until it is constant.
3. Connect the end of bulk pickup hose to a clean sanitary pipe in the manhole extending below the level of the milk and circulate the milk on the truck for at least 15 min.
4. Install attachment for air agitation which will agitate the milk for 15 min without causing rancid flavors.
5. Unload the entire tank of milk in an empty storage tank and collect a sample through the clean, sterilized sampling valve.

"The milk in trailer tank trucks that have set for a few hours is difficult to agitate and sample. For tanks of 5,000 gal. and more, practices 1, 3, and 5 seem more satisfactory."

"The use of automatic sample of all milk through a line holds the most promise. The system includes a reciprocal pump and plastic hose which forces a drop of milk into a refrigerated sample container in proportion to the quantity of milk. Adjustment for pumping capacity and size of sample is essential."

"The same precautions are exercised in collecting samples from tank trucks as for farm milk tanks. This included identification of sample as to date, time, truck, and sampler. Bacterial tests should be done before flavor or compositional testing."

Another milk agitation system that may hold promise involves the Roto-Twin system designed to be installed in large tankers for a CIP system. This system also can be used as an air agitation system and may work well as a method of agitating the milk in large tank trucks. It has been reported that a tank full of milk held overnight needs 10 to 15 min of air agitation by the Roto-Twin system and only 3-5 min for a fresh load of milk.

Present information indicates that odor-free, pressurized filtered air (see 3-A Standards) or mechanically driven agitators provide the best means of mixing milk in transport tanks.

SUBCOMMITTEE MEMBERS: *F. Ahalt, W. Arledge, R. A. Belknap, C. Mecham, M. Prescott, H. Uhlman,* and *W. LaGrange,* Chairman.

WATER TREATMENT AND PROTECTION

Water treatment and protection continues to play a very important role in the Dairy Industry. Governmental regulations, industry trends towards more and more mechanization, coupled with environmental water shortages in various areas of our country, have placed an increased complexity on the problem.

Bacteriological testing of dairy farm water supplies and individual water supply systems, has not been revised for a considerable length of time. The *Grade A Pasteurized Milk Ordinance-1965 Recommendations of the U.S. Public Health Service* continues to establish the standards for testing which are only the minimum for frequency of testing. This committee, as well as many other reputable agencies, in past reports, have gone on record to increase the frequency of testing.

The Food and Drug Administration (Public Health Service) is presently preparing an update of these water requirements when used in the processing of milk and milk products. Publication is scheduled for the latter part of 1974 in the Federal Register.

During the past year, the U.S. Environmental Protection Agency, Water Supply Division, has published two manuals, that are updates from former Public Health Service publications. They are as follows: *Cross-Connection Control Manual,* Publication No. 430/9-73-002, and *Individual Water Supply Systems,* Publication No. EPA-430/0-73-003.

Publication No. EPA-430/9-73-002 is a revision of the *Water Supply and Plumbing Cross-Connections* (PHS Publication No. 957, dated 1963). Many of the original illustrations, and much of the original text has been retained. Each chapter has been reviewed for clarity and updated to be in accordance with the latest information. Also extraneous information has been omitted to simplify the reading. Chapter 2 has been updated to reflect the latest incidents of major cross-connections that have been reported.

Publication No. EPA-430/9-73-003 is the successor of Public Health Service, Publication No. 24, 1962. Many important contributions from the original manual has been retained. Many Federal, State, and other private agencies participated in preparation of this revised manual. The manual constitutes the latest improvement in the field, from both printed and actual practice. Appendix D is based on the U.S. Public Health Service Publication No. 1451 *Recommended State Legislation and Regulation,* July 1965. The Food and Drug Administration upon request did reevaluate the effective data that all well seals must terminate above ground level. They did recind the July 1, 1974 date, and required information that proof of installation was before the adoption of the 1965 Pasteurization Milk Ordinance. In addition, bacteriological requirements have to be met and also provisions of Items 8r and 7p have to be approved except when any changes in the system were necessary. The well seal must terminate above ground level.

The Subcommittee on Water Treatment and Protection recommends that the above materials should be obtained and reviewed to eliminate misinformation on construction, installation, and operation of water supplies on dairy farm installations.

SUBCOMMITTEE MEMBERS: *J. A. Black, K. Harvey, G. Ronald, R. Ryan,* and *H. Faig,* Chairman.

WASTE MANAGEMENT SUBCOMMITTEE

The Subcommittee on Waste Management has been charged with the assignment of compiling a listing of all Federal and State animal waste regulations as well as individual state laws, regulations and guidelines or recommendations on animal waste management. It is the goal of this Subcommittee to evaulate and assemble this information from the following standpoints: (1) the degree to which state laws and recommendations meet or exceed minimum Federal permit and effluent limitation guideline standards for animal waste runoff; (2) specific recommendations to dairymen providing guidance for construction of animal waste point source retention and management facilities as well as procedures for meeting future guidelines for non-point runoff control; (3) compatability of waste management systems with established standards for maintaining a sanitary and healthful animal environment in conformance with Grade "A" Milk requirements; and (4) categorizing state animal waste management guidelines according to regional differences, characterizing conditions of management, weather, and other variables affecting individual site construction requirements for animal waste management systems.

All material assembled will be catalogued according to the above categories of information and will be made available to all IAMFES members.

To date, the Subcommittee has assembled all Federal regulations and guidelines on animal waste management. The Subcommittee has also assembled laws and regulations as well as dairy animal waste management guidelines from the following states (an asterisk indicates laws and regulations): Alabama, California* , Florida, Illinois* , Indiana, Iowa* , Kansas* , Maine, Maryland* , Massachusetts, Michigan* , Minnesota* , Missouri* , New York, North Carolina* , Nebraska* , Ohio, Oregon, Pennsylvania* , Tennessee, Texas* , Virginia, Washington, and Wisconsin*

From a compilation of the above information, the Subcommittee will be in a better position to make recommendations on the following problems facing dairymen confronted with the construction of animal waste management facilities:

1. Should a limitation be placed on spreading manure on frozen ground?
2. How should manure be stored until it can be spread?
3. How should specifications be written for stacking areas to limit runoff?

4. What should liquid manure spreading requirements be?
5. Should a limitation be placed on the volume of manure application:
   a. On the surface?
   b. When injected below the surface or plowed under?
6. Should manure flush systems, as are used in many warm climate areas, which distribute the manure to the land through irrigation systems be limited:
   a. As to the volume increase of disposable waste?
   b. By geographical or climatic areas?
   c. By topography?
7. Anerobic and/or aerobic lagoons are used for manure disposal in some areas. Should these be:
   a. Limited to certain geographical areas?
   b. Restricted to certain design criteria?
   c. Regulated as to the disposition of digested waste?

SUBCOMMITTEE MEMBERS: *R. Dawson, R. Ebbert, B. Greene, R. Lock, L. H. Lockhart,* and *J. Adams,* Chairman.

TEAT DIP LABELING SUBCOMMITTEE

The Teat Dip Labeling Subcommittee makes the following recommendations for uniform labeling of teat dip compounds:

1. Color of label: Predominantly uniform pink background with contrasting letters.
2. Illustration of a teat and a dipper superimposed on the label or a sticker for larger packaging.

In addition, it is recommended that this Subcommittee and the National Mastitis Council Teat Dip Committee work closer together to eliminate duplication of effort to obtain common objectives and goals.

SUBCOMMITTEE MEMBERS: *J. Boosinger, F. P. Godfredson, R. Hellensmith, L. H. Lockhart, R. M. Parry, R. Stucky,* and *L. A. Skeate,* Chairman.

FARM METHODS COMMITTEE MEMBERS, 1973-74 AND 1974-75

M. W. Jefferson, Chairman, Virginia Department of Agriculture & Commerce, Bureau of Dairy Services, 1444 East Main Street, Richmond, Virginia 23219.

Dale Termunde, Eastern Assistant Chairman, Babson Bros. Co., 2100 South York Road, Oak Brook, Illinois 60521

J. C. Flake, Consultant and Editor, Evaporated Milk Association, 910 Seventeenth Street, N.W., Washington, D.C. 20006

James B. Smathers, Consultant, Maryland & Virginia Milk Producers Association, Inc., 1530 Wilson Boulevard, Arlington, Virginia 22209

John Adams, National Milk Producers Federation, 30 F Street Northwest, Washington, D.C. 20001

P. F. Ahalt, Bureau of Dairy Services, Virginia Department of Agirculture & Commerce, 1444 East Main Street, Richmond, Virginia 23219

R. L. Appleby, The DeLaval Separator Company, 350 Duchess Turnpike, Poughkeepsie, New York 12602

William L. Arledge, Dairymen, Incorporated, Suite No. 506, Portland Federal Building, Louisville, Kentucky 40202

Richard L. Ayres, Los Angeles County Health Department, Tulare, California 93274

Sidney E. Barnard, Pennsylvania State University, 213 Borland Laboratory, University Park, Pennsylvania 16802

R. A. Belknap, Food and Drug Administration, Dept. of Health, Education and Welfare, 1090 Tusculum Avenue, Cincinnati, Ohio 45226

Phillip Bergner, Alameda County Health Department, 15001 Foothill Boulevard, San Leandro, California 94377

James A. Black, Oregon State Department of Agriculture, 635 Capital Street, Salem, Oregon 97310

Jay Bossinger, Division of Dairy Industry, Department of Agriculture, Mayo Building, Tallahassee, Florida 32304

A. Richard Brazis, Department of Health, Education and Welfare, Food Microbiology Branch, 1090 Tusculum Avenue, Cincinnati, Ohio 45226

Glenn R. Briody, Multnomah County Milk Sanitation Section, 104 S.W. Fifth Avenue, Portland, Oregon 97204

James Burkett, Northwest Iowa Milk Sanitation Unit, 3340 Stone Park Boulevard, Sioux City, Iowa 51104

Glenn Cavin, Cedar Valley Cooperative Milk Association, 1936 Hawthorne, Waterloo, Iowa 50704

Boyd M. Cook, Maryland Cooperative Milk Producers Assoc. Inc., 1717 Gwynn Avenue, Baltimore, Maryland 21207

M. R. Cooper, Bureau of Dairy Services, Virginia Department of Agriculture and Commerce, Box 7, Broadway, Virginia 22815

Floyd M. Copenhaver, Kansas City Health Department, 10th Floor, City Hall, Kansas City, Missouri 64106

Robert Dawson, Babson Bros. Co., 2100 South York Road, Oak Brook, Illinois 60521

Pat J. Dolan, Bureau of Dairy Service, California Department of Agriculture, 1220 North Street, Sacramento, California 95814

Howard Eastman, Bureau of Milk & Dairy Foods Control, California Department of Agriculture, 1220 North Street, Sacramento, California 95814

Roy Ebbert, Associated Milk Producers, Inc., Tri-State Region, 8550 W. Bryn Mawr Avenue, Chicago, Illinois 60631

H. B. Ellison, Chemical Specialties Division, BASF Wyandotte Corporation, 1532 Biddle Avenue, Wyandotte, Michian 48192

Harold L. Faig, Cincinnati Training Facility, Food and Drug Administration, 1090 Tusculum Avenue, Cincinnati, Ohio 45226

Clarence C. Gehrman, Dairy and Food Division, Washington State Department of Agriculture, P.O. Box 128, Olympia, Washington 98501

Charles R. Gilman, Associated Milk Producers, Inc., Southern Division, P.O. Box 7617, Houston, Texas 77007

Harry D. Gleason, Department of Agriculture, Court House Annes, Box 708, Chehalis, Washington 98532

F. P. Godfredson, Kendall-Fiber Products Division, Walpole, Massachusetts 02081

Buck Greene, Knapp Hall, Louisiana State University, Baton Rouge, Lousiana 70803

W. J. Harper, Department of Food Science and Nutrition, Ohio State University, 2121 Fyffe Road, Columbus, Ohio 43200

Kenneth Harrington, Babson Bros. Co., 2100 South York Road, Oak Brook, Illinois 60521

Keith A. Harvey, Environmental Improvement Division, Idaho Department of Health, Statehouse, Boise, Idaho 83707

B. Heinemann, Mid-America Dairymen, Incorporated, P.O. Box 1837 S.S.S., Springfield, Missouri 65805

Russell Hellensmith, MILK, Inc., 8413 Lake Avenue, Cleveland, Ohio 44102

William LaGrange, Iowa State University, 102B Dairy Industry Building, Ames, Iowa 50010

Russell Lock, DeLaval Separator Company, 350 Duchess Turnpike, Poughkeepsie, New York 12602

Leland H. Lockhart, Bureau of Milk & Dairy Foods Control, California Department of Agriculture, L.A. State Office Building, Rm. 7013, 107 South Broadway, Los Angeles, California 90012

Ben Luce, Dairy & Food Division, Department of Agriculture, P.O. Box 128, Olympia, Washington 98501

Clarence Luchterhand, Department of Health and Social Services, State of Wisconsin, P.O. Box 309, Madison, Wisconsin 53701

Omer Majerus, Universal Milking Machine Division, 408 First Avenue South, Albert Lea, Minnesota 56007

Clinton Mecham, Maryland & Virginia Milk Producers Assn. Inc., 1530 Wilson Boulevard, Arlington, Virginia 22209

Melvin Neff, Upper Florida Milk Producers Assn., P.O. Box 6962, 4851 Nolan Street, Jacksonville, Florida 32205

Vernon D. Nickel, St. Louis Department of Public Health, 416 Tenth Street, Crystal City, Missouri 63019

Vernal S. Packard, Jr., University of Minnesota-Institute of Agriculture, Department of Food Science and Nutrition, St. Paul, Minnesota 55101

Richard M. Parry, Dairy Division, Department of Agriculture & Natural Resources, State Office Building, Hartford, Connecticut 06115

Mark L. Prescott, Safeway Stores, Incorporated, Milk Department, P.O. Box 275, Clackamas, Oregon 97015

J. H. Reeder, Maryland & Virginia Milk Producers Assoc. Inc., Route 3, Box 501, Boonsboro, Maryland 21713

Ron Richter, Department of Dairy Science, University of Florida, Gainesville, Florida 32601

M. H. Roman, State of New York, Department of Agriculture, 18 Eugene Street, Lowville, New York 13367

Gene W. Ronald, State Hygienic Laboratory, Des Moines Branch, 405 State Office & Laboratory Bldg., E. 7th & Court, Des Moines, Iowa 50309

Robert J. Ryan, Bureau of Milk and Food Sanitation, State of New York Department of Health, 845 Central Avenue, Albany, New York 12206

Bernard Saffian, Norton Company, P.O. Box 1624, Stow, Ohio 44224

L. A. Skeate, The DeLaval Separator Company, 5724 N. Pulaski Road, Chicago, Illinois 60646

Joseph Smucker, U.S.P.H.S. Food & Drug, 175 W. Jackson Street, Room A-1945, Chicago, Illinois 60604

Stephen B. Spencer, 213 Borland Laboratory, Pennsylvania State University, University Park, Pennsylvania 16802

Richard Stucky, Sep-Ko Chemicals, Division of H. B. Fuller Company, 3900 Jackson Street, N.E., Minneapolis, Minnesota 55421

Fred Taylor, Department of Public Health, Louisville and Jefferson County, 400 East Gray Street, P.O. Box 1704, Louisville, Kentucky 40201

Alvin E. Tesdal, Dairy & Consumer Division, State Department of Agriculture, Agriculture Building, Salem, Oregon 97310

Leon Townsend, Kentucky State Department of Health, 275 East Main Street, Frankfort, Kentucky 40601

Helene Uhlman, Gary Health Department, 1429 Virginia Street, Gary, Indiana 46407

R. J. Weaver, Milk Control District No. 1, Associated Suburban Boards of Health, 75 East Lancaster Avenue, Ardmore, Pennsylvania 19003

Richard W. Webber, Standardization Branch, Dairy Division, USDA, Consumer & Marketing Service, Washington, D.C. 20250

James Welch, Klenzade Products, Division of Economics Laboratory, Inc., Osborne Building, St. Paul, Minnesota 55102

Robert L. West, Bureau of Dairy Service, Department of Agriculture, 2550 Mariposa Street, Room 3080, Fresno California 93721

Aubrey Wisdom, Ross-Holm Milking system, 120 Howard Street, Petaluma, California 94952

Youths Win Miracle Garden Awards
1976 Awards Open To Non-Club Members

NEW YORK, N.Y. . . . The 1975 MIRACLE GARDEN AWARDS, sponsored by Keep America Beautiful, Inc., for the National Council of State Garden Clubs, Inc. (NCSGC), have been awarded to the *High School Gardeners Unit of the Winter Park Garden Club,* Winter Park, Florida and the *Wildlife 4-H Junior Gardeners of the Hanover Garden Club,* East Hanover, New Jersey. Awards will be presented to representatives of the Florida Federation of Garden Clubs and The Garden Club of New Jersey during the 46th Annual National Council of State Garden Clubs Convention, to be held at the Hotel Utah, Salt Lake City, Utah, May 18 through 23, 1975.

WINNERS

This year's winners were chosen from designs submitted to Keep America Beautiful (KAB) by Junior, Intermediate and High School Gardeners of the NCSGC; a member of KAB's National Advisory Council. Winter Park Garden Club's octagon shaped Miracle Garden will enliven the school's heavily trafficked mall, presently a sandy, treeless plot of ground. Its center features towering Italian Cypress trees surrounded by plants of graduated heights and a concrete wall to provide a sitting area for students and passersby. Hanover Garden Club's Wildlife 4-H Junior Gardeners created their award winning Miracle Garden for a barren area of Joseph Luker Memorial Park, East Hanover, New Jersey. This "island of serenity" will feature a bird bath surrounded by a colorful assortment of flowers and various sized shrubs.

MIRACLE GARDEN AWARDS

KAB's MIRACLE GARDEN AWARDS are presented each year to young gardeners for excellence in planning attractive garden spots for under utilized land in their own communities. Transforming neighborhood eyesores into "miracle gardens" is the objective and groups are encouraged to use ingenuity in securing the equipment and materials required to implement their plan.

Departing from previous tradition, the 1975-76 MIRACLE GARDEN AWARDS competition is also open to youth groups who are not members of NCSGC. Winning garden club programs will receive their awards at the 1976 Annual Meeting of the National Council of State Garden Clubs. Non-garden club members will honored at KAB's 1976 Annual Meeting.

Applications and competition rules for 1975-76 MIRACLE GARDEN AWARDS are available from Keep America Beautiful, Inc., 99 Park Avenue, New York, New York 10016. KAB is a national non-profit public service organization founded in 1953 to encourage individual involvement in improving the local environment.

J. Milk Food Technol. Vol. 38, No. 7, Pages 435-437 (July, 1975)

PART ONE OF THE 3-A SANITARY STANDARDS FOR INSTRUMENT FITTINGS AND CONNECTIONS USED ON MILK AND MILK PRODUCTS EQUIPMENT

Number 09-07

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. Instrument fitting and connection specifications heretofore or hereafter developed which so differ in design, material, construction, or otherwise, as not to conform with the following standards, but which in the manufacturer's or fabricator's opinion are equivalent or better, may be submitted for the joint consideration of the IAMFES, USPHS, and DIC at any time.

These 3-A Sanitary Standards are in two parts. This Part One contains the text. Part Two contains the drawings.

A.
SCOPE

A.1
These standards cover the sanitary aspects of instrument fittings and connections for milk and milk products equipment and on lines which hold or convey milk and milk products.

A.2
In order to conform with these 3-A Sanitary Standards, instrument fittings and connections shall comply with the following design, material and fabrication criteria.

B.
DEFINITIONS

B.1
Product: Shall mean the milk and milk products that will be in contact with the fitting or connection.

B.2
SURFACES

B.2.1
Product Contact Surfaces: Shall mean all surfaces which are exposed to the product and surfaces from which liquids may drain, drop, or be drawn into the product.

B.2.2
Non-Product Contact Surfaces: Shall mean all other exposed surfaces.

B.3
Instrument Fittings and Connections: (Referred to as fittings throughout this standard) Shall mean fittings and/or connections that will be installed in milk and milk products equipment and in sanitary pipelines, for temperature, pressure and similar instruments or their sensing elements.

B.4
Permanently Installed Fittings: Shall mean fittings are permanently installed in the equipment by welding or a method provided for in the 3-A Sanitary Standards for the piece of equipment.

C.
MATERIALS

C.1
All product contact surfaces shall be of stainless steel of the AISI 300 series[1] or corresponding ACI[2] types (See Appendix, Section F.), 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
Optional metal alloy may be used but only in applications requiring disassembly and manual cleaning. (See Appendix, Section G for the composition of an acceptable optional metal alloy.)

C.1.2
Rubber and rubber-like materials and plastic materials may be used for O-Rings, seals and parts used in similar applications.

C.1.3
Rubber and rubber-like materials when used for specified applications shall conform to the applicable provisions of the "3-A Sanitary Standards for Multiple-Use Rubber and Rubber-Like Materials Used as Product Contact Surfaces in Dairy Equipment, Number 18-00."

[1]The data for this series are contained in the following reference: AISI Steel Products Manual, Stainless & Heat Resisting Steels, April 1963, Table 2-1, pp. 16-17. Available from American Iron and Steel Institute, 1000-16th Street, N.W., Washington, D.C. 20006.
[2]Alloy Casting Institute Division, Steel Founders' Society of America, 21010 Center Ridge Road, Rocky River, OH 44116.

C.1.4
Plastic materials, when used for specified applications shall conform to the applicable provisions of the "3-A Sanitary Standards for Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment, Number 20-00," as amended.

C.1.5
Single service sanitary-type gaskets may be used.

C.2
All materials having a product contact surface(s) used in the construction of fittings, connections, gaskets and other non-metallic parts to be used in a processing system to be sterilized by heat and operated at a temperature of 250° F 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 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
All product contact surfaces shall be at least as smooth as a No. 4 finish on stainless steel sheets (see Appendix, Section H).

D.2
All permanent joints in product contact surfaces shall be continuously welded. All welded areas of product contact surfaces shall be at least as smooth as the adjoining surface.

D.3
All internal angles of 135° or less on product contact surfaces shall have minimum radii of ¼inch, except that the minimum radii in grooves for standard ¼inch 0-rings shall be not less than 3/32 inch and for standard 1/8-inch 0-rings shall be not less than 1/32 inch.

D.4
Parts of instrument fittings and connections, such as ferrules, having a counter part in the "3-A Sanitary Standards for Fittings Used on Milk and Milk Products Equipment and Used on Sanitary Lines Conducting Milk and Milk Products, Revised, Number 08-09" as amended and supplements thereto, shall conform dimensionally to that standard.

D.5
Fittings, connections, gaskets (if used) and other component parts to be used in a processing system to be sterilized by heat and operated at a temperature of 250° F or higher shall comply with the following additional criteria:

D.5.1
The construction shall be such that all product contact surfaces can be (1) sterilized by saturated steam or water under pressure at a tempeature of at least 250° F or higher shall comply with the following additional criteria:

D.5.2
All fittings to be used in such a processing system shall be permanently installed.

D.5.3
The fittings for instruments that have a product contact surface(s) to be used in such a processing system, not designed so that the system automatically is shut down if the product pressure in the system becomes less than that of the atmosphere and cannot be restarted until the system is resterilized, shall have a steam or other sterilizing medium chamber surrounding the joint at the product contact surface between the fitting and the instrument.

D.5.4
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.6
Fittings and connections for which there are drawings are found in Appendix, Section I, in Part Two of these standards. Dimensions and the contour of fittings and connections shown on the drawings are for reference only and may be changed if they do not affect cleanability. Instrument fittings and connections not illustrated in the drawings shall be considered as being included in this standard, provided they conform to the provisions of this standard with respect to material, finish, fabrication and use of gaskets and have no special requirements for fabrication or installation.

D.7
Non-product contact surfaces shall have a smooth finish, be free of pockets and crevices, and be readily cleanable and those to be coated shall be effectively prepared for coating.

E.
SPECIAL CONSIDERATIONS
The criteria for fittings and connections having special requirements for fabrication or installation will be found in the following sub-sections:

E.1
Pressure sensor tank spuds (see 3-A drawings 3A-101-13, 3A-101-14 and 3A-101-15 in Part Two) shall comply with the following:

E.1.1
The pressure sensor tank spud shall be welded flush to the inside of the tank (vessel).

E.1.2
The pressure sensor tank spud shall have provision to drain leakage of product and if the tank is insulated, leakage shall drain beyond the insulation.

E.1.3
If a drain hole is provided, the pressure sensor tank spud shall be installed so that the drain hole is at the bottom.

E.1.4
When the sensor capsule is in its installed position in the level sensor tank spud, the O-Ring or gasket and diaphram shall form a crevice-free joint.

APPENDIX

F.

STAINLESS STEEL MATERIALS

Stainless steel conforming to the applicable composition ranges established by AISI[1] for wrought products, or by ACI[2] 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 percent. The first reference cited in C.1 sets forth the chemical ranges and limits of acceptable stainless steels 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[3] specifications A 296-68 and A 351-70.

[3]Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

G.

OPTIONAL METAL ALLOY

An optional metal alloy having the following minimum and maximum composition is deemed to be in compliance with C.1.1 herein.

Zinc	-	8% maximum
Nickel	-	19½% minimum
Tin	-	3½% minimum
Lead	-	5% maximum
Iron	-	1½% maximum
Copper	-	the balance

An alloy of the composition given above is properly designated "nickel silver," or according to ASTM[3] Specification B 149-70, may be entitled, "leaded nickel bronze."

H.

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.

I.

DRAWINGS

This APPENDIX is continued in Part Two of these 3-A Sanitary Standards.

These standards shall become effective September 13, 1975, at which time the "3A Sanitary Standards for Instrument Fittings and Connections used on Milk and Milk Products Equipment, Number 09-00," and amendments, and supplements thereto, are rescinded and become null and void.

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New Affiliate Approved

The IAMFES Executive Board met on May 15, 1975 in St. Louis, Missouri at which time a new affiliate was approved for our organization. The Alberta Association of Milk, Food and Environmental Sanitarians joined the International with twelve members. Lawrence McKnight of the University of Alberta's Department of Food Science is president of the Canadian association.

News and Events

Short Course at Rutgers University

The next Ice Cream Manufacturing Short Course held by the Food Science Department of Cook College, Rutgers University, is scheduled for Jan. 5-15, 1976, and will be followed by the annual Dairy and Food Industry Conference on January 16.

Information on both events is available from Dr. Roger Locandro, Associate Dean of Instruction, Cook College, Rutgers University, P.O. Box 231, New Brunswick, N.J. 08903.

AOAC Will Hold October Meeting

The Association of Official Analytical Chemists (AOAC) will hold its 89th Annual Meeting 13-16 October 1975, at the Marriott Hotel, Twin Bridges, Washington, D.C. About 1,400 chemists, microbiologists, physicists, and their administrators will attend, representing national, state, provincial, and local government agencies, universities, and industries in North America and elsewhere. About 240 papers will be given on new techniques, methods, and instrumentation for analysis of drugs, cosmetics, feeds, fertilizers, foods, food additives, pesticides, flavors, beverages, microbiological contamination of foods, mycotoxins, toxicological effects, forensic science materials and related subjects.

Central Institute for Nutrition and Food Research TNO

The Central Institute for Nutrition and Food Research TNO, Zeist, the Netherlands, will organize in collaboration with the World Health Organization, Region Europe, Copenhagen, Denmark, the third postgraduate course in food-microbiology and food-hygiene from September 15 till October 3 this year.

Only university trained people who are or will be, on account of their function, involved in food microbiology and have little practical experience in microbiological methods can participate.

The costs involved will amount to Dfl. 1,250 per participant, including board and lodging for 3 weeks (during the weekend only breakfast).

The program of the course is divided into three parts: (*a*) theoretical classes; (*b*) practical classes and (*c*) some excursions.

Registration has to be sent direct to:

The Director
Central Institute for Nutrition and Food Research TNO
Utrechtseweg 48
Zeist, Netherlands

D. C. Accelerates Planning for Food Protection During Bicentennial Celebration

Anticipating a substantial increase in the tourist population in the Nation's Capital during the Bicentennial celebration, the District of Columbia Environmental Health Administration (EHA) is expanding its food protection program in an effort to prevent foodborne illness and related problems of food service hygiene.

Through a grant from the U.S. Food and Drug Administration, EHA is adding to its staff 10 public health sanitarians, a public health educator and two applied microbiologists.

According to Dr. Bailus Walker, Jr., director of EHA, "these additional health specialists will enable us to provide more intensive monitoring and surveillance of mobile food vendors, and the expected increase in other food service activities such as banquets, state dinners and receptions planned for the Bicentennial celebration."

The District's training program for food service workers is being expanded to provide maximum classroom and on-the-job training for both permanent and temporary food service personnel who will be employed in the Washington food service industry, including the private and public sectors.

Approximately 1.5 million meals per day are currently served in public eating establishments in the Washington area. It is anticipated that this number will increase to 4.2 million during the Bicentennial celebration.

"Our past experience with Presidential Inaugurations every four years would indicate that effective planning, communications, coordination and program development are critical prerequisites for minimizing problems of food service hygiene during periods when food service facilities are taxed to their maximum capacity," Dr. Walker said.

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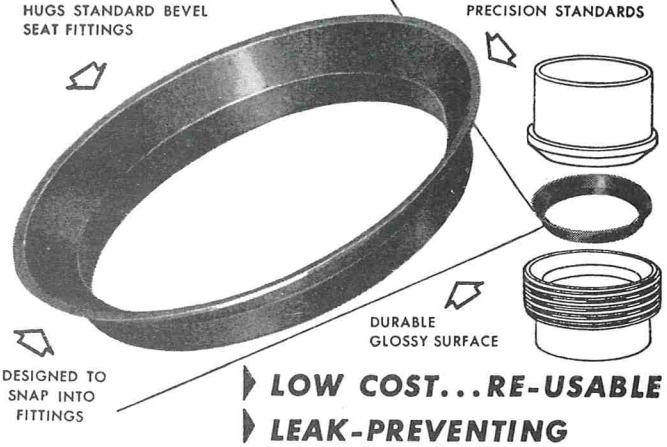

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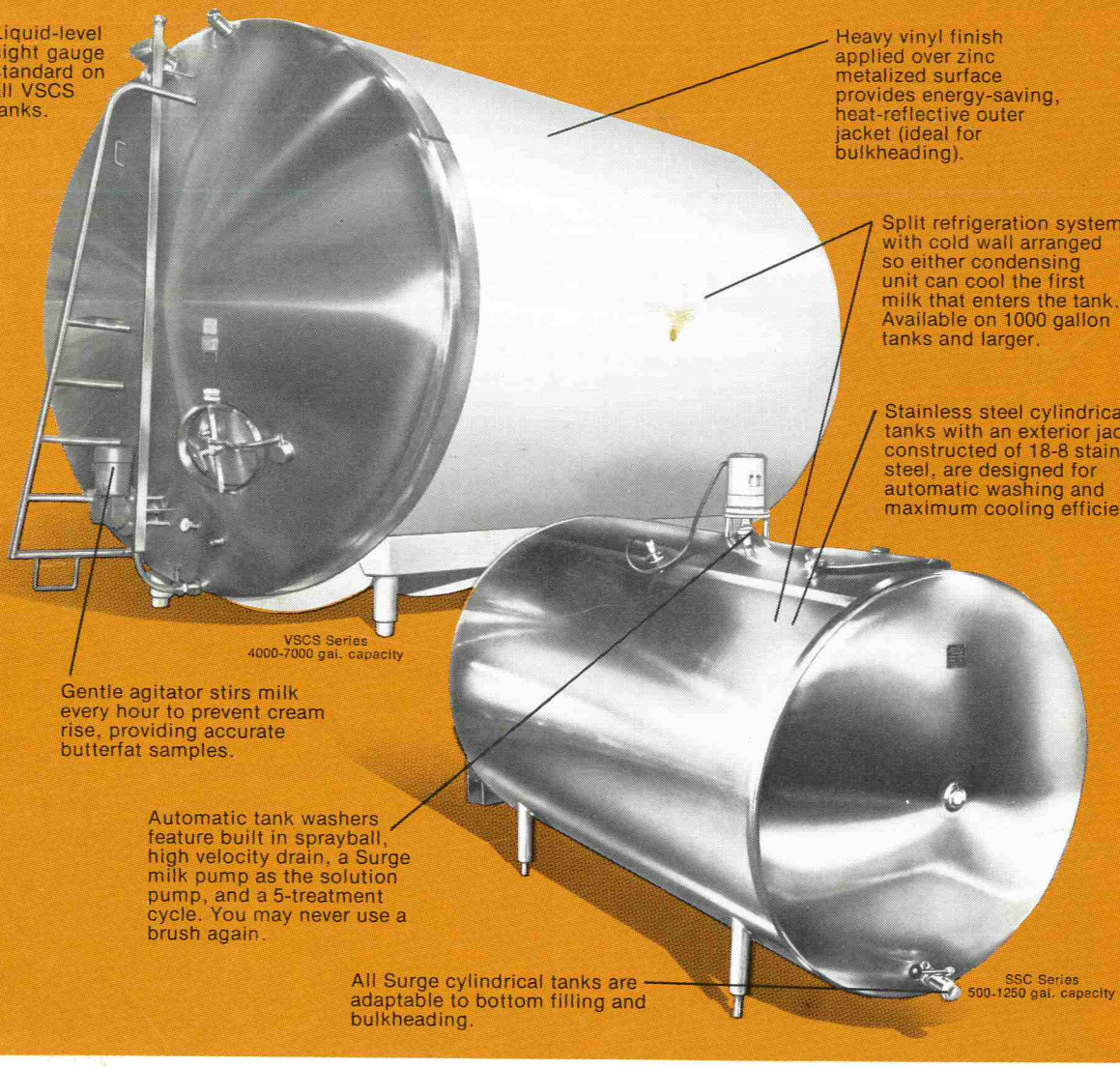

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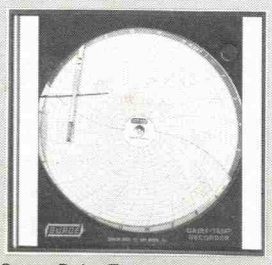

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