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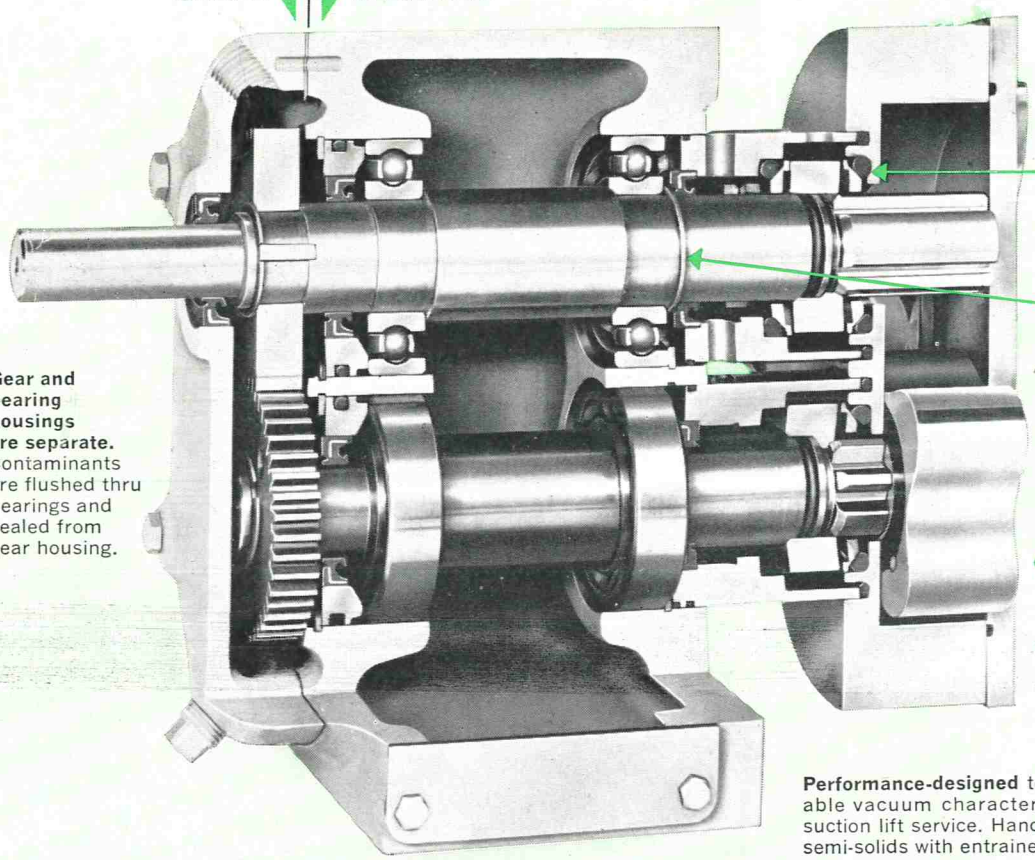

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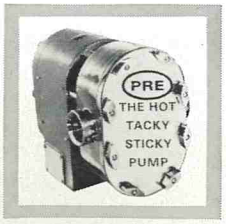

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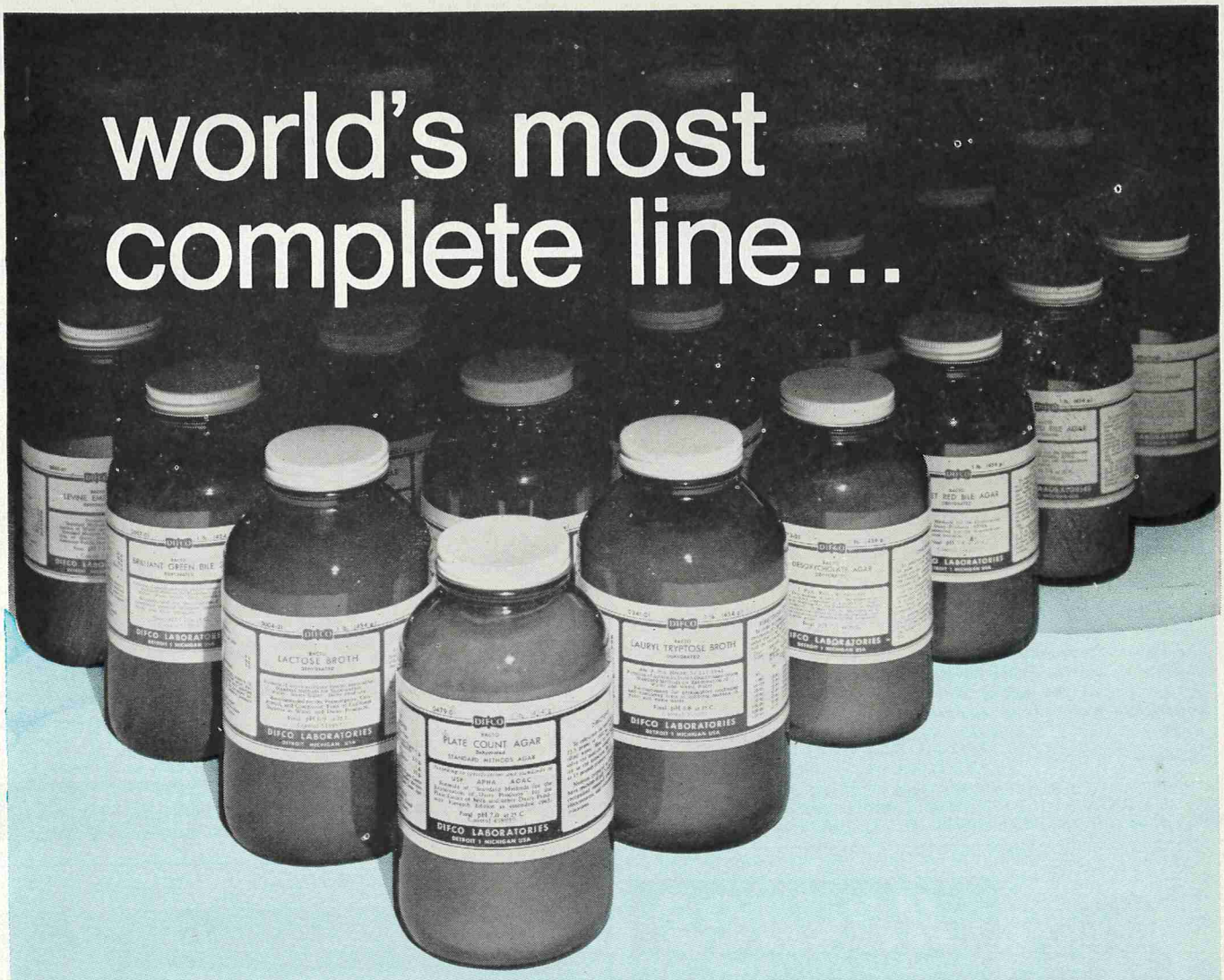

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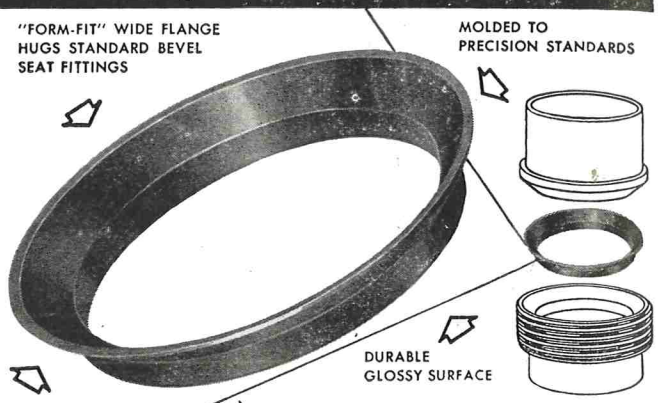

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INCLUDING MILK AND FOOD SANITATION

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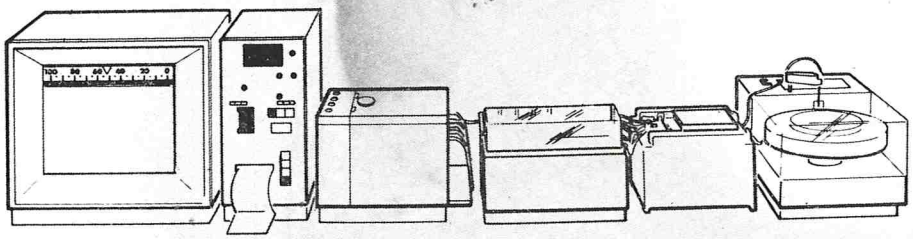

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GROWTH AND ACTIVITY OF LACTIC-ACID BACTERIA IN SOYMILK

II. HEAT TREATMENT OF SOYMILK AND CULTURE ACTIVITY[1]

ANTONIETA GADDI ANGELES[2] AND E. H. MARTH
Department of Food Science and The Food Research Institute
University of Wisconsin
Madison, Wisconsin 53706

(Received for publication July 17, 1970)

ABSTRACT

Soymilk was given different heat treatments and then evaluated as a substrate for acid production by lactic acid bacteria. Unheated soymilk elicited optimal or nearly optimal activity from most test cultures. Heating the medium to 60 C resulted in increased acid formation by *Streptococcus* and *Leuconostoc* species and in a reduction of acid production by *Pediococcus cerevisiae* and *Lactobacillus* species. Extended heating of soymilk at 60 C reduced its suitability as a substrate for acid development by lactic acid bacteria. Acid formation by all cultures was minimal in soymilk heated at 80 C from <1 to 60 min. Responses in soymilk heated at 100 C for short durations were similar to those obtained when soymilk was heated at 80 C. More severe heating at 100 or 120 C progressively improved the quality of soymilk as a substrate. Inhibitory effects noted when soymilk was heated at 80 C coincided with development of a markedly higher concentration of sulfhydryls and/or toxic volatile sulfides in the medium during heating. Beneficial effects of more severe heating were attributed to expulsion of sulfides, a concurrent decrease in concentration of sulfhydryls, and a decrease in the oxidation-reduction potential of the medium.

Soybean foods are generally consumed after they have been subjected to some degree of heat treatment. Heat processing enhances palatability and acceptance and also improves the nutritive quality of such foods *(16)*. Beneficial effects of moderately heating soybean foods result, in part, from destruction of various anti-nutritional factors, e.g., trypsin inhibitors, hemeagglutinins, goitrogenic factor *(3, 4, 16, 23)*, and, in part, from modification of protein, permitting more complete digestibility and utilization of the growth-limiting sulfur-containing amino acids *(13, 17, 18)*. Severe heating of soybean products, however, causes destruction of several amino acids and depression of protein digestibility *(3, 5, 8, 9, 16)*.

When used as a fermentation medium for lactic acid bacteria, there is further reason to heat-treat soymilk prior to inoculation. Heating soymilk reduces or eliminates the microbial flora and resultant competition, and thus insures *(a)* optimal development of the starter organism and *(b)* uniformity in the final product.

Angeles and Marth *(1)* have shown that many lactic acid bacteria grow well in sterilized soymilk and that some produce substantial amounts of acid during a 16-hour incubation period. Since heating is known to cause changes in soybean substrates, it is possible that the suitability of soymilk as a culture medium may be altered through the heat treatment it receives. Experiments were conducted to determine if relationships exist between acid production by the lactic bacteria and degree of heat given to the soymilk. A preliminary report of this work has been presented *(11)*.

MATERIALS AND METHODS

Cultures

The following cultures were used: *Streptococcus lactis* II, *Streptococcus cremoris* 40-990, *Streptococcus diacetilactis* 8-6264, *Leuconostoc mesenteroides* 512F, *Leuconostoc citrovorum* Da_3, *Pediococcus cerevisiae* 1325, *Lactobacillus delbrueckii* Ld_3, *Lactobacillus casei* 1445, and *Lactobacillus pentosus* 124-2. All cultures were transferred in soymilk daily for 3 days before they were used to prepare the 16 hr old inocula used in these experiments.

Soymilk

Soymilk was prepared as previously described *(1)*. Unheated soymilk was dispensed in 10-ml quantities into sterile tubes. Such samples, either unheated or heated by methods described below, were inoculated with 1% of the test culture and then incubated at its optimum temperature. Uninoculated samples which received the same incubation treatment served as controls.

Heat treatments

Tubed soymilk samples were heated to the desired temperature for the required time in a water-bath, or an autoclave. After heat treatment, samples were immediately cooled to about 10 C. They were brought to the proper incubation temperature before inoculation with a culture.

In the first series of experiments, effects of no heat treatment and of treatments at 60, 80, 100, and 120 C were compared. In the second series of tests, soymilk was heated at the same four temperatures for various periods of time as indicated in Tables 1 and 2.

Activity test

The response of a culture when grown in unheated or heated soymilk was expressed as per cent developed acidity after 16 hr incubation. This was determined by titration with NaOH to the phenolphthalein end point *(1)*. Values reported represent the titratable acidity of an inoculated sam-

[1]Published with the approval of the Director of the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin.

[2]Present address: 7432 W. Washington St., Forest Park, Illnois 60130.

TABLE 1. ACIDITY DEVELOPED BY SOME LACTIC ACID BACTERIA IN SOYMILK WHICH RECEIVED DIFFERENT HEAT TREATMENTS[1]

Treatment		Per cent developed acidity after 16 hr			
		S. lactis	*S. cremoris*	*S. diacetilactis*	*L. citrovorum*
Unheated		0.20	0.14	0.24	0.01
60 C	− 5 min	0.23	0.20	0.28	0.14
	−15 min	0.22	0.16	0.26	0.15
	−30 min	0.12	0.13	0.20	0.14
	−60 min	0.17	0.15	0.17	0.16
	−90 min	0.14	0.12	0.13	0.09
80 C	− 5 min	0.0	0.0	0.0	0.04
	−10 min	0.0	0.0	0.01	0.0
	−15 min	0.0	0.0	0.01	0.04
	−30 min	0.0	0.0	0.0	0.0
	−60 min	0.0	0.0	0.0	0.0
100 C	− 5 min	0.0	0.0	0.0	0.02
	−10 min	0.01	0.01	0.01	0.05
	−15 min	0.03	0.01	0.03	0.04
	−20 min	0.06	0.03	0.07	0.07
	−30 min	0.05	0.03	0.06	0.06
120 C	− 5 min	0.06	0.04	0.06	0.08
	−10 min	0.06	0.04	0.07	0.09
	−15 min	0.06	0.04	0.07	0.07
	−20 min	0.06	0.06	0.07	0.09
	−30 min	0.08	0.05	0.09	0.10

[1]Averages of duplicate determinations made in each of two trials.

ple minus that of an identically treated uninoculated sample. Expression of results this way eliminated effects of differences in initial acidity caused by the heat treatments and effects of acid development during incubation not attributable to culture activity.

Determination of sulfhydryl groups and volatile sulfides

Studies on cow's milk have shown that development and liberation of sulfhydryls and of toxic volatile sulfides are responsible, in part, for beneficial and adverse effects on culture activity attributable to heating the medium *(20)*. To ascertain the nature of the relationship between heat history of soymilk and culture activity, the occurrence of these substances during processing was investigated.

The nitroprusside test of Josephson and Doan *(15)* was used to estimate free sulfhydryl groups in soymilk. Volatile sulfides generated in soymilk were estimated by the degrees of blackening on a dried lead acetate (1N)-soaked filter paper placed on the mouth of a tube during heating.

Measurement of oxidation-reduction potential of soymilk

The O-R potential of soymilk was measured with the aid of a platinum electrode, a saturated calomel half-cell, and a Leeds and Northrup portable potentiometer.

RESULTS AND DISCUSSION

Effect of heat treatment of soymilk on acid production by lactic cultures

Responses of lactic acid bacteria in soymilk heated at different temperatures for a constant holding time are shown in Fig. 1 to 4.

The *Streptococcus* species (Fig. 1) exhibited a single pattern of response in the different media. Heating soymilk to 60 C improved it slightly over the raw product. Further heating to 80 C made soymilk almost completely inhibitory for the three species. More severe heat treatment again improved the medium. Acid production increased as heat treatment of the medium increased from 100 to 120 C, but quantitatively, only about one-third as much acid developed as was observed in soymilk heated to 60 C.

TABLE 2. ACIDITY DEVELOPED BY SOME LACTIC ACID BACTERIA IN SOYMILK WHICH RECEIVED DIFFERENT HEAT TREATMENT[1]

Treatment		Per cent developed acidity after 16 hr				
		L. mesenteroides	*P. cerevisiae*	*L. delbrueckii*	*L. casei*	*L. pentosus*
Unheated		0.32	0.32	0.41	0.22	0.78
60 C	− 5 min	0.48	0.22	0.38	0.20	0.59
	−15 min	0.44	0.19	0.34	0.18	0.52
	−30 min	0.39	0.17	0.27	0.13	0.45
	−60 min	0.41	0.17	0.30	0.13	0.44
	−90 min	0.36	0.13	0.29	0.09	0.41
80 C	− 5 min	0.20	0.0	0.07	0.0	0.18
	−10 min	0.20	0.0	0.17	0.04	0.18
	−15 min	0.18	0.0	0.13	0.0	0.17
	−30 min	0.14	0.0	0.12	0.08	0.14
	−60 min	0.15	0.0	0.21	0.0	0.13
100 C	− 5 min	0.14	0.0	0.12	0.0	0.08
	−10 min	0.19	0.02	0.16	0.01	0.11
	−15 min	0.19	0.03	0.23	0.02	0.17
	−20 min	0.24	0.05	0.19	0.05	0.15
	−30 min	0.21	0.05	0.14	0.03	0.09
120 C	− 5 min	0.26	0.05	0.22	0.03	0.20
	−10 min	0.28	0.06	0.28	0.05	0.20
	−15 min	0.27	0.07	0.26	0.06	0.20
	−20 min	0.25	0.06	0.26	0.05	0.24
	−30 min	0.29	0.07	0.27	0.07	0.25

[1]Averages of duplicate determinations made in each of two trials.

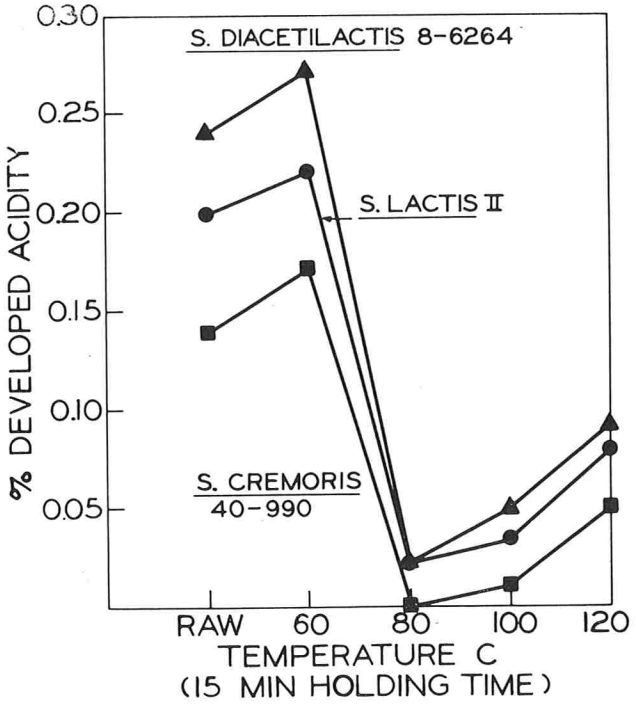

Figure 1. Effect of heat treatment of soymilk on subsequent acid production by *Streptococcus* species.

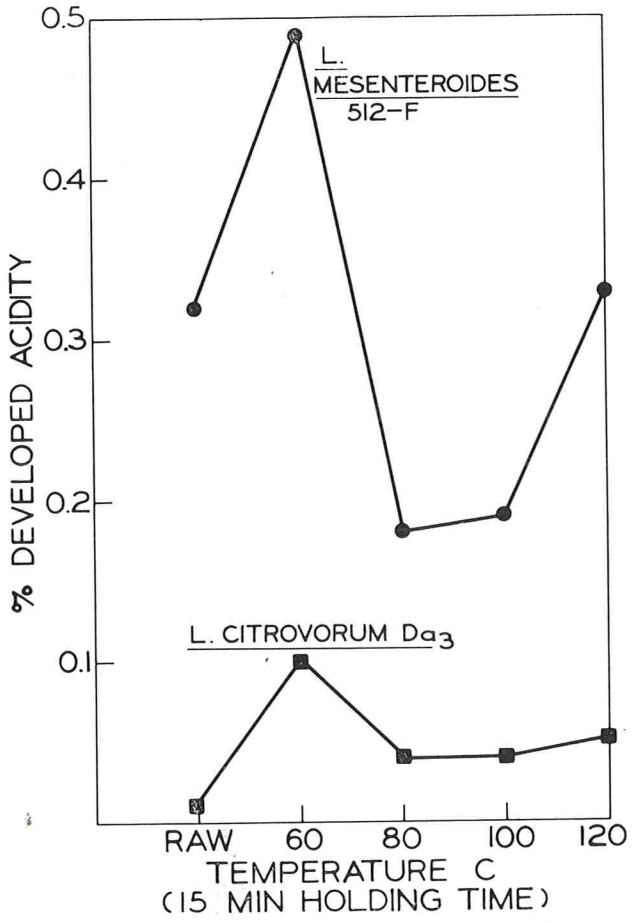

Figure 2. Effect of heat treatment of soymilk on subsequent acid production by *Leuconostoc* species.

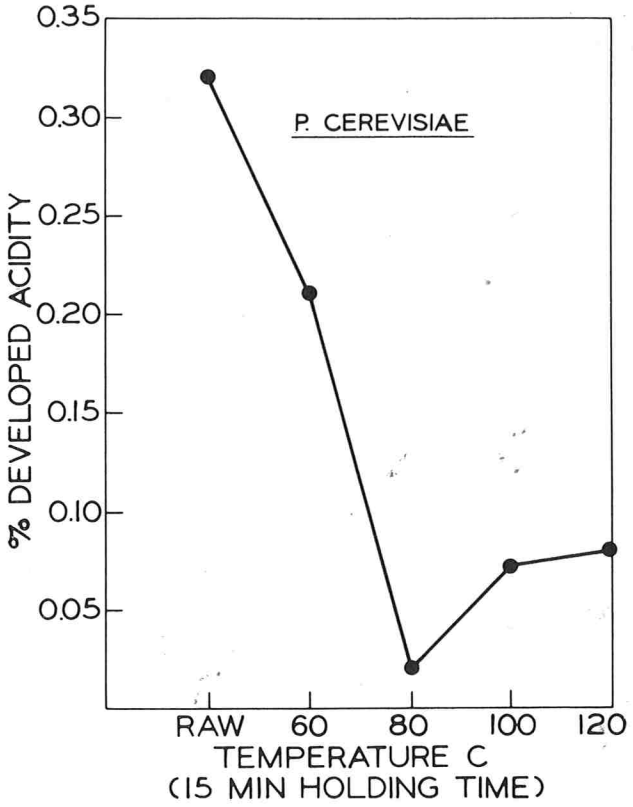

Figure 3. Effect of heat treatment of soymilk on subsequent acid production by *Pediococcus cerevisiae*.

Leuconostoc mesenteroides and *L. citrovorum* (Fig. 2) exhibited somewhat greater activity in soymilk heated to 60 C than in raw soymilk. Heating the medium to 80 C caused a marked reduction in acid production by *L. mesenteroides* but further heating at the next two higher temperatures resulted in an increase. The extent of acid production by this organism in autoclaved soymilk matched its response in the unheated medium, which was about one-half of the maximum produced in soymilk heated at 60 C. Heating the medium to 80 C, likewise, reduced the activity of *L. citrovorum,* although only slightly, but some improvement over the unheated medium was evident with this heat treatment. Additional heating caused no further substantial change in the response of *L. citrovorum.*

Pediococcus cerevisiae (Fig. 3) developed an unusually high level of acidity in unheated soymilk. An increase in heat exposure including heating to 80 C caused a progressive decline in its activity. Activity of this organism was minimal and almost negligible in the medium heated at 80 C. Heating soymilk to 100 and 120 C caused a slight progressive increase in the activity of *P. cerevisiae.* The magnitude of the latter did not, however, approach the noteworthy activity exhibited in unheated or mildly heated (60 C) soymilk.

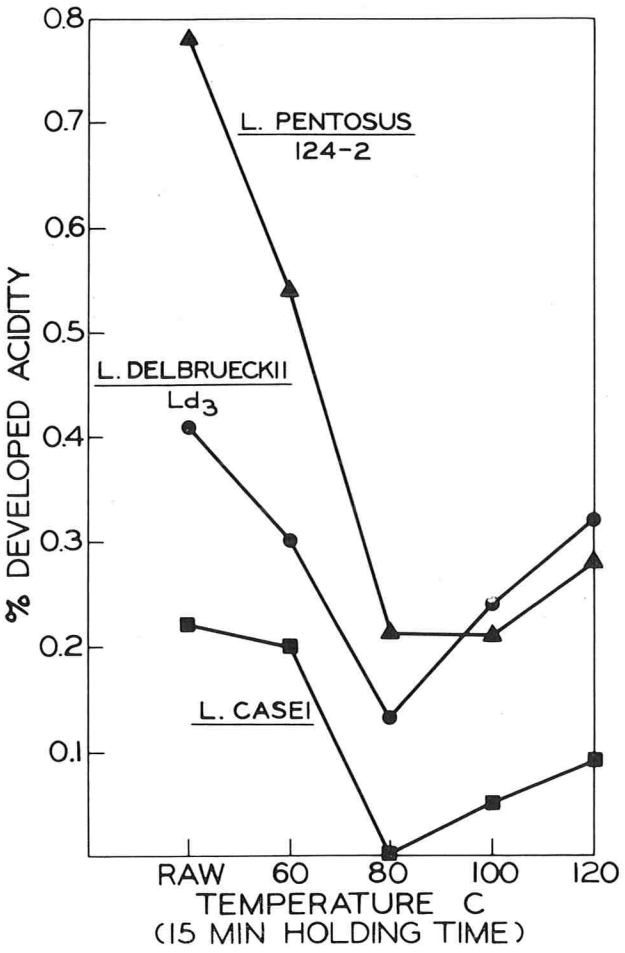

Figure 4. Effect of heat treatment of soymilk on subsequent acid production by *Lactobacillus* species.

The *Lactobacillus* species (Fig. 4) showed a progressive decrease in activity when soymilk was heated at 60 and 80 C. Further heating again improved the medium. Acid production in soymilk which received the more severe heat treatment was appreciably greater than that observed when this medium was heated to 80 C, but comparatively less than that in raw soymilk.

Effects of heating soymilk for different times at four different temperatures on the subsequent activity of lactic acid bacteria are summarized in Tables 1 and 2. These results further substantiate those shown in Fig. 1 to 4. In general, effects of heating at 60 C were time-dependent; the longer the heating time, the less the acid developed in the soymilk. Responses in the medium heated at 80 C were similar for the various time exposures and were for most organisms, the lowest exhibited. Responses in soymilk heated at 100 C for short durations were generally equivalent to those obtained in the medium heated at 80 C, but longer times at 100 C caused increases in lactic culture activity in the medium. Heating the soymilk at 120 C had the same effect as extended heating at 100 C for *S. lactis*, *S. cremoris*, *S. diacetilactis*, *L. citrovorum*, *P. cerevisiae*, and *L. casei*. This treatment enhanced acid formation by *L. mesenteroides*, *L. delbrueckii*, and *L. pentosus*. The effect of heating at 120 C did not seem to be time-dependent; responses at the different time exposures were nearly similar. It is possible that the true effects of various autoclaving treatments, particularly those of short duration, on activity of lactic cultures were masked. The difficulty of exactly controlling heat treatments in the autoclave because of prolonged come-up and come-down times tended to minimize differences in amount of heat given to samples when time exposures were in close proximity to each other.

A wide variation in degree and pattern of response was exhibited by lactic acid bacteria in the different media. This may have resulted from individual differences in environmental and nutritional requirements of each species. Different heat treatments must have, in part, controlled the extent to which these individual requirements were met by the medium.

Nature of relationship between heat history of soymilk and culture response

There is general agreement that certain heat treatments of milk benefit culture growth, whereas others result in development of inhibitory properties *(20)*. Available evidence indicates that beneficial effects of heating cow's milk result from destruction of heat-sensitive naturally-occurring inhibitory substances *(2)*, as well as protein denaturation and accompanying presence of an optimum concentration of free sulfhydryls *(12, 14)*. Inhibition of lactic cultures caused by other heat treatments appears related to an excess of free sulfhydryls and a concurrent increase of toxic volatile sulfides *(12, 14)*. A reduction of volatile sul-

TABLE 3. RELATIVE AMOUNTS OF SULFHYDRYLS IN AND VOLATILE SULFIDES LIBERATED FROM SOYMILK DURING HEATING

Treatment		Sulfhydryls	Volatile sulfides
Raw soymilk		+[1]	
Heated: 60 C	− 0 min	++	−[2]
	−15 min	+++	−
	−60 min	+++	−
Heated: 80 C	− 0 min	+++++	−
	−15 min	++++++	+
	−30 min	++++++	+++
Heated: 100 C	− 0 min	+++++	+++
	−15 min	+++++	++++
	−30 min	++++	+++++
Heated: 120 C	−15 min	++	++++++

[1] + represents intensity of color; the more intense, the more + signs.

[2] − represents no reaction.

fides on further heating creates conditions more favorable for culture growth *(12)*.

Results obtained in this study indicate that the same conditions may exist in soymilk. The heat treatment needed for maximum sulfhydryl formation and a concurrent increase in volatile sulfides in cow's milk, 80-95 C for 30-60 min *(12, 22)*, is approximately the same as that which caused soymilk to become inhibitory. Additional evidence is provided by the data obtained on occurrence of sulfhydryl and volatile sulfides (Table 3).

Results in Table 3 show that raw soymilk gave a slightly positive nitroprusside reaction. This is indicative of naturally-present free or exposed sulfhydryl groups. Heating at 60 C momentarily, and for 15 or 60 min increased the sulfhydryl concentration to nearly the same extent. No volatile sulfides liberated from the medium were detectable during these treatments. Heating to 80 C produced more sulfhydryls with a maximum amount present after a treatment of at least 15 min. This coincided with appearance of released volatile sulfides from the medium. An extended holding period of 30 min at 80 C caused more sulfide liberation, but little or no apparent change in the amount of sulfhydryls. A decrease in sulfhydryl concentration and an increase in expelled sulfides resulted from heating soymilk to 100 C; the longer the holding period at this temperature, the greater this effect. Autoclaving caused a further decrease in the amount of sulfhydryls detected and an accompanying marked expulsion of volatile sulfides from the medium.

The relationship between heat history of soymilk and subsequent culture response in this medium may be depicted as shown in Fig. 5. Stimulatory effects of heating soymilk to 60 C are represented by A-B and can be attributed to appearance of sulfhydryl groups approaching an optimum level. As will be seen later, the stimulatory effect of heating the medium to 60 C was unrelated to a decrease in the O-R potential, a condition which is believed by some workers *(12, 19)* to be responsible for improved growth of lactic cultures in cow's milk which received a mild heat treatment.

The section B-C (Fig. 5) represents the inhibitory effects of heating soymilk to 80 C probably caused by presence of excess sulfhydryl groups and/or appearance of toxic volatile sulfides in the medium.

The beneficial effect of severe heating of soymilk on culture activity is represented by C-D. Data suggest, this is probably caused by a condition wherein the level of sulfhydryls is optimum and sufficient toxic volatile sulfides have been released from the medium.

Results of this study do not indicate whether raw

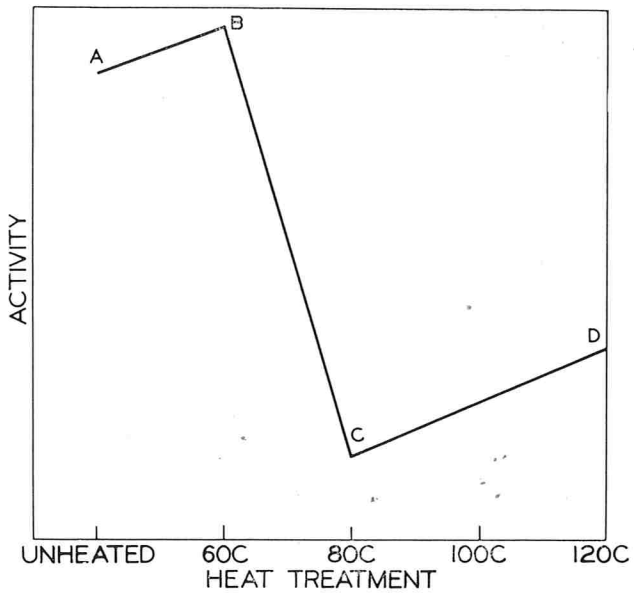

Figure 5. Relationship between heat history of soymilk and subsequent lactic culture activity. A-B = stimulation caused by mild heating exhibited by some cultures; B-C = inhibition caused by heating to 80 C exhibited by all cultures; C-D = stimulation caused by more severe heating exhibited by all cultures.

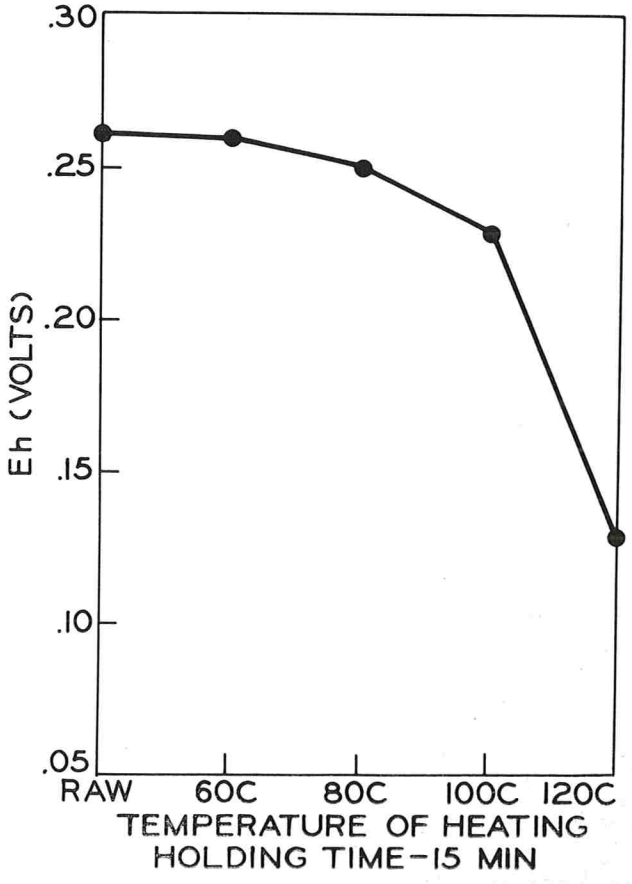

Figure 6. Effect of heating on the oxidation-reduction potential of soymilk.

soymilk contains heat-sensitive substances which are inhibitory to lactic cultures. However, the possibility of heat-induced damage to them or to stimulatory substances must not be excluded. Results of studies on human and animal nutrition have shown that heating may decrease the availability of soybean amino acids through protein-carbohydrate or protein-protein interactions *(16)*. Amino acids found most susceptible were cystine *(21)*, methionine, lysine, arginine, histidine, and tryptophan *(16)*. The resulting modified protein reportedly became resistant to acid or enzymatic hydrolysis and could not be utilized for growth by assay organisms such as *L. mesenteroides* P-60, *Lactobacillus arabinosus* 17-5, *Streptococcus faecalis* R, and *L. casei (6, 7, 8, 10)*.

It has been suggested by some investigators that a reduction in O-R potential which occurs during heating of cow's milk should favor the microaerophilic lactic acid bacteria. When influence of heat on the O-R potential of soymilk was determined (Fig. 6), a reduction in O-R potential was not noted until the medium was heated to 80 C. Beyond this, the potential became progressively lower. This reduction in potential may account, in part, for the observed improvement in activity of lactic cultures in severely heated soymilk.

Data presented in this report should be useful for selecting the appropriate heat treatment to be given soymilk for different manufacturing processes which employ microorganisms. Mild heating at 60 C which reduces the initial flora seems a logical choice for manufacturing purposes. Autoclaving is the next best choice and has particular applications where sterility of the medium is necessary, such as in preparation of mother cultures.

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GROWTH AND ACTIVITY OF LACTIC-ACID BACTERIA IN SOYMILK

III. LIPOLYTIC ACTIVITY[1]

ANTONIETA GADDI ANGELES[2] AND E. H. MARTH

Department of Food Science and The Food Research Institute
University of Wisconsin
Madison, Wisconsin 53706

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ABSTRACT

The following lactic acid bacteria, when tested with the agar-well method, were able to hydrolyze tributyrin and triolein, but not soybean oil: *Streptococcus lactis, Streptococcus cremoris, Streptococcus diacetilactis, Streptococcus thermophilus, Leuconostoc mesenteroides, Pediococcus cerevisiae, Lactobacillus delbrueckii, Lactobacillus casei, Lactobacillus pentosus,* and *Lactobacillus brevis.* Tributyrin only was hydrolyzed by *Lactobacillus helveticus.* Some free fatty acids were liberated by *L. casei, L. delbrueckii,* and *S. thermophilus* in soymilk (1.9% soybean lipids) and in MRS broth fortified with 2.0% soybean oil during a 14-day period of incubation. Although *L. casei* and *L. delbrueckii* were more active in soymilk than was *S. thermophilus,* they released about 10% of the amount of free fatty acids liberated by *Candida lipolytica* during a similar incubation period.

Degradation of lipids is considered to be responsible, in part, for development of flavor in certain fermented foods such as cheese *(18, 21, 27).* Lipolysis in cheeses may occur through activity of lipase indigenous to milk (if not inactivated during processing), microbial lipases, or lipases in other materials which may be added to milk at the time of cheesemaking *(22).*

Fryer et al. *(12)* recently suggested that lipase production probably is a basic property of most microorganisms, varying only in degree. Some lipolytic activity has been attributed to lactic acid bacteria by several investigators *(7, 12, 26, 30, 31).*

Peterson and Johnson *(26)* believed that lipolytic enzymes are intracellular since none of their isolates of *Lactobacillus casei* which were able to hydrolyze milk fat at pH 5 to 6 did so until after autolysis of cells occurred. Otherholm et al. *(25)* demonstrated that lipolytic activity of lactic acid bacteria is associated with two enzymes or groups of enzymes, lipase and esterase. The presence of activity by both types of enzymes in cell free extracts and its absence from the growth medium after harvesting cells supported the conclusion that the enzymes are intracellular. In contrast, Fryer et al. *(12)* and Umemoto et al. *(31)* inferred that the lipase of lactic acid bacteria is not intracellular, but is near the surface of the cell (exoenzyme) and is readily released. This conclusion was based on the observation that the relationship between time and lipolytic activity of these bacteria, as measured by an area of clearing in fat agar around wells of cell suspensions, was linear from zero-time. Lipolytic activity by lactic acid bacteria has been demonstrated primarily with tributyrin or milk fat and, to a lesser extent, with other triglycerides and olive oil but not with soybean lipids.

Angeles and Marth *(3, 4)* have shown that many lactic acid bacteria can grow well in soymilk and that acid production in this substrate is possible provided that it receives the proper heat treatment and, in some instances, is fortified with a suitable carbohydrate. If soymilk and lactic acid bacteria are to be used to produce fermented foods resembling cheese, it would probably be desirable that changes other than acid formation in the medium could be mediated by the microorganisms. Since hydrolysis of lipids is required for production of desired flavors when cheese is made from cow's milk, it is reasonable to expect a similar need when soymilk serves as the substrate. Information on the ability of lactic acid bacteria to degrade soybean lipids is lacking and hence the experiments described in this paper were undertaken.

MATERIALS AND METHODS

Qualitative detection of lipolysis

Microbial lipolytic activity was qualitatively determined using tributyrin, triolein, and soybean oil as substrates in the agar-well assay of Oterholm and Ordal *(24).* The method has been recommended for detection of weak lipolysis, such as that associated with lactic acid bacteria.

Agar plates. The basal medium consisted of MRS broth (Difco) with 1.5% Bacto-agar. The medium was sterilized by autoclaving and then was cooled to 60 C. Three per cent (v/v) filter sterilized tributyrin (Eastman Kodak Co., Rochester, N. Y.), triolein (Nutritional Biochemicals Corp., Cleveland, Ohio), or soybean oil (refined, bleached, and deodorized, by HumKo Products, Memphis, Tenn.) was added to the medium which then was emulsified with a Sorvall Omni-mixer homogenizer (speed setting of 8, 3 min). Fifteen milliliters of this medium (pH 6.5) was immediately distributed into 100 x 15 mm petri dishes and allowed to harden

[1]Published with the approval of the Director of the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin.

[2]Present address: 7432 W. Washington St., Forest Park, Illnois 60130.

while the dishes were on a flat surface. Four evenly-spaced wells were punched in the agar with a No. 2 cork borer (5 mm inside diameter). A very slight vacuum was applied on one end of the cork borer to conveniently draw out the agar plug.

Cell suspensions. Organisms used for these experiments are listed in Table 1. Cultures were propagated in MRS broth containing 0.05% (v/v) filter sterilized glycerol plus 1% (v/v) heat-sterilized low-fat cream (half-and-half, 12% milk fat) or in MRS broth containing 0.3% (v/v) filter sterilized and emulsified soybean oil. The last of three daily transfers (16-hr old) in each of the two media was used to obtain cells for these tests. Cells were harvested by centrifugation. The cell pellet thus obtained was resuspended in 0.5 ml MRS broth which then contained approximately 10^{10} cells per ml.

Inoculation of agar-wells. Three of the four wells in a plate were filled with about 0.02-ml cell suspension. Care was taken that wells did not overflow with inoculum. The fourth well was filled with plain MRS broth and served as a control against false-positive results caused by autohydrolysis of lipid material.

After inoculation, plates were sealed with tape and incubated upright for 24 hr at the temperature optimum for the organism being studied. Disappearance of fat globules and concurrent formation of clear visible zones around the wells (when viewed with a Zeiss stereomicroscope) denoted lipolysis.

Quantitation of lipolysis

Failure of lactic acid bacteria to demonstrate lipolysis when soybean oil and the agar-well assay technique were used prompted testing of another assay procedure; the silica-gel method of Harper et al. *(14).* This method has been employed with success for extraction and quantitation of free fatty acids resulting from lipolytic activity of lactic cultures in fat emulsions *(7).*

Cultures. Three lactic cultures were used for these experiments: *Lactobacillus delbrueckii* and *Streptococcus thermophilus* because of their potential usefulness in making fermented soymilk products, and *Lactobacillus casei* because it has been implicated in flavor development in Cheddar cheese more than any other lactic culture *(21).*

A strongly lipolytic yeast, *Candida lipolytica* NRRL Y-1095, also was used and data obtained with it served as a basis for comparison and as assurance that the method can detect lipolytic changes.

Substrates. Soymilk prepared as described earlier *(3)* was inoculated with 1% of an active culture of the above organisms. Two 20-ml portions of the mixture were dispensed into test tubes and incubated for 14 days at the temperature optimum for the culture. Samples with the lactic cultures were incubated quiescently; those with the yeast culture were shaken periodically. MRS broth, with and without 2% (v/v) added emulsified soybean oil, was treated similarly. Preparation of the emulsion was as described above. No adjustment in pH was made during the incubation period since it was desired to have experimental systems resemble natural conditions.

Extraction and estimation of free fatty acids. A detailed-description of equipment and reagents for the silica-gel method has been given by Harper and Armstrong *(13)* and Harper et al. *(14).*

A silica-gel column was prepared in two sections. The bottom section was composed of a slurry of silicic acid, phosphate buffer, and chloroform. The top section consisted of the acidified sample (pH 1.8-2.0 with H_2SO_4) to which 5 g silicic acid per 3 ml sample was added, ground, and then slurried with 5% (v/v) N-butanol in chloroform. Free fatty acids in the sample were extracted with the latter solvent. Acids in the eluate were titrated wih 0.01 N KOH in absolute alcohol using phenol red as the indicator. Correction of values obtained was made by titration of a blank consisting of uninoculated substrate.

TABLE 1. LIPOLYTIC ACTIVITY OF LACTIC ACID BACTERIA ON TRIBUTYRIN, TRIOLEIN, AND SOYBEAN OIL, AS SHOWN BY THE AGAR-WELL METHOD.

Organism	Incubation temperature (C)	Tributyrin plate	Triolein plate	Soybean oil plate
S. *lactis* II	30	+++[1]	+[2]	−[3]
S. *cremoris* 40-990	30	+++	+	−
S *theromophilus* Mc	45	+++	+	−
S. *diacetilactis* 8-6264	30	+++	+	−
L. mesenteroides 512F	30	+++	+	−
P. cerevisiae 1325	30	+++	+	−
L. delbrueckii Ld_3	37	+++	+	−
L. casei 1445	30	+++	+	−
L. helveticus 1842	37	+++	−	−
L. pentosus 124-2	30	+++	+	−
L. brevis 1834	30	+++	+	−

[1]Zone visible without magnification, three plus signs indicate clear well defined zone.

[2]Zone visible with stereomicroscope, one plus sign indicates a minimal zone.

[3]Minus sign indicates no zone.

RESULTS

Lipolysis in agar-plates

Results of the agar-well assays are presented in Table 1. All the lactic acid bacteria tested were able to hydrolyze tributyrin but not soybean oil when this procedure was used. All but one *(Lactobacillus helveticus)* exhibited slight lipolytic activity towards triolein. When tributyrin was incorporated in the substrate, clearing of the emulsion was plainly visible. In contrast, with triolein present, clearing was apparent only when plates were examined with a stereomicroscope.

These results confirm that lipolysis of tributyrin can be caused by *Streptococcus lactis, Streptococcus cremoris, Streptococcus diacetilactis, L. casei, L. helveticus, Lactobacillus brevis, Pediococcus cerevisiae,* and *Leuconostoc mesenteroides* as reported earlier by other workers *(12, 24, 25)* using the agar-well assay technique. Lipolysis, as detected by the agar-well assay, of tributyrin by *Lactobacillus pentosus, L. delbrueckii,* and *S. thermophilus* and of triolein by lactic acid bacteria has not been reported before.

Lipolysis in soymilk

The lipolytic activity of three lactic cultures in soymilk was determined by measuring free fatty acids in the medium after 14 days of incubation. Results are shown in Table 2. Soymilk used in this experi-

ment contained 1.90% lipid. Values obtained for the blank indicated that there were virtually no free fatty acids in this medium. Increases in content of free fatty acids over that of the blank and obtained when cultures were grown in the soymilk show the extent of lipolysis. *Lactobacillus casei* and *L. delbrueckii* exhibited appreciable lipolytic activity in this medium. Such activity was, however, relatively minimal when compared to that of the strongly lipolytic *C. lipolytica*. *Streptococcus thermophilus* showed negligible lipolytic activity.

Lipolysis in MRS broth with and without added soybean oil

Results on quantitation of free fatty acids released by the three lactic cultures in MRS broth, with and without added soybean oil, are given in Table 3. The increase in titratable acid after 2% soybean oil was emulsified into the medium is small, indicating that the processed oil contained essentially no free fatty acids.

The lactic cultures caused an increase in the content of free fatty acids in MRS broth. It is possible that the origin of these free fatty acids was the Tween 80 (polyoxyethylene sorbitan monooleate), a hydrophilic emulsifier, present in the broth at a concentration of 0.1%. Liberation of fatty acids from water-soluble Tweens is the basis of a method described by Sierra *(29)* for detection of microbial lipolysis. Lentsner et al. *(20)* and Carini et al. *(6)* have shown that lactic-acid bacteria contain lipases which are active on various grades of Tweens, including Tween 80.

When the lactic cultures were grown in MRS broth containing emulsified soybean oil, more free fatty acids were present than in plain broth. A measure of lipolysis of soybean oil can be obtained by subtracting the free fatty acids (FFA) in MRS broth from the FFA in MRS broth + soybean oil (SO) (Table 3). Results are similar to those obtained with soymilk. Both *L. casei* and *L. delbrueckii* exhibited appreciable lipolytic activity, whereas *S. thermophilus* had comparatively less.

DISCUSSION

Use of tributyrin to detect weakly lipolytic organisms has been advocated because it is thought that microbial lipases hydrolyze this substrate more readily than other triglycerides *(12, 24)*, but lipolysis of tributyrin does not always mean that a more complex triglyceride such as milk fat will be attacked by an organism *(5, 10, 15)*. Hydroylsis of tributyrin and milk fat may be similar since the latter contains a high proportion of butyric acid and other short chain fatty acids esterified predominantly at the 1- and 3-positions of the glycerol molecule *(11)*. These linkages generally are most readily attacked by microbial lipases *(2, 17, 18)*. The constancy of tributyrin composition and sensitivity of the substrate to lipolysis *(17)* also favor use of this material for screening of lipolytic organisms and hence it was used in these experiments.

Triolein was used in this investigation because oleic acid is a major component of the triglycerides of milk fat *(16)* and soybean oil *(9)*. Hence information on its sensitivity to lipolysis was thought desirable.

Many factors affect lipolytic activity of microorganisms. The temperature and pH at which organisms are grown have considerable effects on lipase activity *(15, 23, 31)* although the optima for lipolysis may not completely correspond with those for growth *(15, 31)*. In this study, cultures were grown at their respective optimum temperatures: 30, 37, or 45 C. According to Umemoto et al. *(31)*, approximately the same level of lipolytic activity was produced at these temperatures by cell-free extracts of all lactic cultures they studied.

Control of pH during some investigations on lipolysis is important because it affects the stability of the enzyme, the velocity of enzyme-substrate combination and breakdown, the equilibrium point of the reaction, and, if an emulsion, the properties of the substrate-aqueous phase interface *(15, 18)*. No pH adjustment was, however, attempted in this study since, as mentioned earlier, it was desired to have conditions

TABLE 2. FREE FATTY ACIDS IN SOYMILK INOCULATED WITH CERTAIN MICROORGANISMS AND INCUBATED FOR 14 DAYS.

Sample	Free fatty acids[1] Trial I a[2]	Trial I b[2]	Trial II a[2]	Trial II b[2]	Avg	Increases over blank
Blank	0.18	0.18	0.18	0.18	0.18	—
L. casei (30 C)[3]	13.12	13.20	13.50	13.40	13.31	12.95
L. delbrueckii (37 C)	11.98	11.26	11.60	11.85	11.67	11.49
S. thermophilus (45 C)	0.24	0.25	0.24	0.24	0.24	0.06
C. lipolytica (30 C)	127.50	127.50	130.00	129.50	128.62	128.44

[1]Milliliters 0.01 N alcoholic KOH required to titrate free fatty acids extracted from a 20 ml sample.
[2]Replicates.
[3]Temperature of incubation.

which resembled those of natural systems. Umemoto et al. *(31)* observed that greatest lipolytic activity by cell-free extracts of lactic cultures occurred at pH 6 to 8. Little or no activity was observed below pH 4 or above pH 9, although slight lipolysis was noted as either pH value was approached. If the lipase systems of cultures used in this work had pH optima similar to those reported by Umemoto et al. *(31)*, less than maximum lipolysis may have occurred in some instances since the pH of soymilk was sometimes reduced to 4.0 in less than 24 hr. This may explain the limited lipolysis obtained with *S. thermophilus* (fast acid producer) and the greater hydrolysis produced by *L. casei* and *L. delbrueckii* (slow acid formers).

Other factors which can alter the amount of released free fatty acids are size of fat globules in an emulsion and composition of the medium. Hugo and Beveridge *(14)* pointed out that the smaller the globule, the greater the rate of lipolysis up to a given limiting rate for each system. Shah and Wilson *(28)* observed that initial rates of lipolysis were lower with coarse than with fine emulsions.

Composition of the medium can have stimulatory as well as inhibitory effects on lipase production. Although a medium may allow good growth of an organism, it may not contain compounds necessary for lipase production. Certain peptones and protein digests *(1)*, amino acids *(23)*, lipids *(8, 23)*, and ions, e.g., Ca^{++} *(19)*, stimulate lipase production. Differences in quantities of released free fatty acids in soymilk and MRS broth containing soybean oil (Tables 2 and 3) may be attributable, in part, to differences in size of fat globules and composition of the medium.

Results of these studies indicate that some lactic acid bacteria can degrade soybean lipids and hence could contribute to flavor development in fermented foods made to contain such lipids. Additional investigations are needed to develop details of conditions under which optimum lipolysis can be obtained through activity of lactic acid bacteria in soybean lipids.

TABLE 3. TITRATABLE FREE FATTY ACIDS (FFA)[1] IN MRS BROTH WITH AND WITHOUT ADDED SOYBEAN OIL (SO) AFTER INOCULATION AND INCUBATION FOR 14 DAYS.

Organism	FFA										(MRS + SO) − (MRS) = FFA from SO
	MRS					MRS + SO					
	Trial I		Trial II			Trial I		Trial II			
	a[2]	b[2]	a[2]	b[2]	Avg	Increase over blank	a[2]	b[2]	a[2]	b[2]	Avg	Increase over blank	
Blank	12.60	12.36	13.04	13.04	12.76		13.84	13.84	13.68	13.84	13.80		
L. casei (30 C)[3]	42.56	43.00	43.00	43.20	42.96	30.20	81.52	82.00	82.16	81.40	81.76	67.96	37.76
L. delbrueckii (37 C)	44.00	43.56	43.20	43.80	43.64	30.88	82.36	82.48	82.40	82.40	82.40	68.60	37.72
S. thermophilus (45 C)	39.36	37.20	39.20	39.48	38.32	25.56	48.32	48.32	60.80	60.40	54.48	40.68	15.12

[1]Milliliters 0.01 N alcoholic KOH required to titrate the FFA extracted from 20 ml sample.
[2]Replicates.
[3]Temperature of incubation.

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A Research Note

COMPOSITION OF RAW AND PROCESSED SKIMMILK

B. J. Demott

Dairy Department
University of Tennessee
Knoxville 37901

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Abstract

Many processors make a more palatable skimmilk by adding nonfat dry milk solids and/or lactose. Compared to the skimmilk portion of raw milk, processed skimmilk contained more solids not fat and its freezing point was lower. The data do not indicate many, if any, processed samples in the study with added lactose, other than that contained in the added nonfat dry milk solids.

Consumers sometimes object to the flat, watery taste of skimmilk, and processors have attempted to overcome this criticism by slightly concentrating the skimmilk or by adding nonfat dry milk solids and/or lactose to the skimmilk before final processing. During the 12-month period April, 1969 to March, 1970, approximately one-half of the skimmilk sold in the Knoxville market contained added milk solids *(7)*. In certain selected Federal Order Markets, sales of skimmilk with added solids far exceed sales of plain skimmilk *(6)*. Labels on such products often specify what alterations in composition have been made. In this study an attempt was made to determine the differences which exist in the composition of raw and processed skimmilk.

Procedure

During July, August, and September, 1969, 71 samples of raw milk collected from tank trucks or milk storage tanks in Middle and East Tennessee areas were analyzed for solids-not-fat (SNF) by drying, for lactose by the method of Barnett and Tawab *(1)*, for chloride by $AgNO_3$ titration, and for freezing point depression by means of a thermistor type cryoscope. During this same time period, 90 samples of processed skimmilk and modified skimmilk were collected from retail outlets in the same areas and examined in a similar manner. Solids-not-fat, lactose, and chloride concentrations in the raw whole milk were converted to their corresponding concentrations in skimmilk by dividing by 1 – the fat concentration.

Results and Discussion

Table 1 shows correlation coefficients between SNF, lactose, and chloride concentrations and freezing point depressions on raw whole milk and on processed skimmilk. Correlations on the raw milk were so low that no relationship was established. A similar statistical analysis of the relationship between components in processed skimmilk (Table 1) showed all relationships to be positive and highly significant

Table 1. Correlation coefficients between constituents in raw milk and processed skimmilk.

	Lactose	Chloride	Freezing point depression
	Blended raw whole milk		
SNF	−0.01[a]	−0.07[a]	−0.07[a]
Lactose		−0.01[a]	0.02[a]
Chloride			0.02[a]
	Processed skimmilk		
SNF	0.53[b]	0.85[b]	0.63[b]
Lactose		0.46[b]	0.53[b]
Chloride			0.67[b]

[a]—Not statistically significant at $P<0.05$.
[b]—statistically significant at $P<0.01$.

($P<0.01$), meaning that the probability of these relationships occuring by chance alone was less than 1%. Absence of a correlation coefficient of significance, even at the 95% level of confidence on the raw milk and the presence of correlation coefficients at the 99% level on processed milk differs from normal expectations. However, if the addition of components of skimmilk is practiced by some processors and not by others, the range in the concentration of such components among the samples would be greater than is true of raw milk. Wider ranges in SNF concentration, freezing point depression, and chloride concentration in the processed skimmilk than in the skimmilk portion of the raw milk possibly contribute to the larger, more consistent correlations between composition and freezing point depressions in the pasteurized skimmilk because of a relatively smaller error of measurement associated with wide as compared to narrow distributions.

Higher average values in the freezing point depression, SNF concentration, and chloride concentration of processed skimmilk compared to raw skimmilk illustrate that solids were added to many of the samples of skimmilk before final processing. The frequencies of distribution of the lactose concentration in the skimmilk portion of the raw milk and in processed skimmilk were similar. The slightly higher lactose concentration in the processed skimmilk might, in most instances, be attributable to the addition of SNF. A comparison of the ratio of lactose to SNF

concentration between the two milk sources indicate that few, if any, processed skimmilk samples had lactose added, other than the lactose contained in any SNF that might have been added.

Of interest in this respect is the influence of added SNF or lactose on the chloride concentration in the resulting skimmilk. Aqueous solutions containing 10% nonfat dry milk solids or 10% lactose were found to contain 0.132 and 0.005% chloride, respectively. Thus, the addition of commercial lactose to skimmilk contributes a negligible amount of chloride, but nonfat dry milk solids would be expected to increase the chloride concentration in proportion to the amount added.

TABLE 2. CONCENTRATIONS OF SNF, LACTOSE AND CHLORIDE AND THE FREEZING POINT DEPRESSION OF THE SKIMMILK PORTION OF RAW MILK AND OF PROCESSED SKIMMILK.

		Skim portion of raw milk (N = 71)	Processed skimmilk (N = 90)
Freezing point depression	(−°C)	0.532 ± 0.008	0.564 ± 0.050
SNF	(%)	8.61 ± 0.41	9.79 ± 1.14
Lactose	(%)	4.69 ± 0.55	4.95 ± 0.73
Chloride	(%)	0.143 ± 0.005	0.145 ± 0.113
$\frac{\text{Lactose \%}}{\text{SNF \%}}$	x 100	54.6 ± 7.5	50.7 ± 6.0
$\frac{\text{Chloride \%}}{\text{Lactose \%}}$	x 100	3.09 ± 0.39	2.95 ± 0.42

The distribution frequencies of chloride concentration in the skimmilk portion of the raw milk and in processed skimmilk were similar. However, several samples of processed skimmilk contained more chloride than would be expected if none were added before processing. The logical conclusion is that this chloride was added with the SNF, especially since a correlation coefficient of 0.85 (Table 1) was noted between the concentrations of SNF and chloride. The chloride: lactose ratio indicated that few, if any, samples were fortified with lactose only.

The taste of milk, especially low fat milks, can be improved materially by the addition of SNF *(2, 4, 5)*. Pangborn and Dunkley *(9)* report that small increases in lactose concentration (0.33%) can be detected two times out of three, whereas, an increase of 0.6% added SNF is required for the same response. A recent report showed that adult males preferred skimmilk fortified with 2% lactose to plain skimmilk *(3)*. The improvement in the flavor of skimmilk caused by addition of either nonfat dry milk solids or lactose, their relative price, and other merits of lactose as an additive as discussed by Nielsen *(8)*, suggest that more dairy processors, with regard for labeling laws, might well consider addition of lactose as a measure to increase the nutritive value of the product as well as the consumer appeal.

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A Reasearch Note

THE DIRECT MICROSCOPIC SOMATIC CELL COUNT AS A SCREENING TEST FOR CONTROL OF ABNORMAL MILK[1]

W. D. SCHULTZE[2], J. W. SMITH[2], D. E. JASPER[3], O. KLASTRUP[4], F. H. S. NEWBOULD[5], D. S. POSTLE[6], AND W. W. ULLMANN[7]

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ABSTRACT

The Direct Microscopic Somatic Cell Count can be used advantageously in control of abnormal milk to perform simultaneously screening and confirmation of milk samples. Confidence limits computed according to the individual microscope Strip Factor are used to interpret the count made on a single strip of one of the two milk films. The sample is assigned on the basis of the interpreted count to one of three categories: *(a)* less than the legal cell concentration maximum ($P < 0.05$); *(b)* in the region of the cell concentration maximum, and thus subject to confirmation; or *(c)* greater than the legal cell concentration maximum ($P < 0.05$). For samples in categories *(a)* or *(c)* no further counting is required to accept or reject the milk. For samples in category *(b)*, the four-strip confirmatory count may be completed immediately.

The Direct Microscopic Somatic Cell Count in milk (DMSCC) *(2)* was designed to be an accurate confirmatory counting method with good and definable precision. It was to be easily repeatable in exact procedural detail among technicians and laboratories. Specifically, we were acting in response to a need expressed by the National Conference on Interstate Milk Shipments for improved methodology to implement their program for control of abnormal milk. The DMSCC as originally described required the counting of cells in two strips of each of two replicate milk films, and so provided a means of achieving the high precision required of a confirmatory count. This paper reports a way to extend use of the DMSCC. A procedure is described through which a milk sample may be categorized as accepted, rejected, or dubious on the basis of a single strip cell count. Only those samples in the dubious category require additional counting.

According to statistical theory, a single observation (a single strip count, for example) is an estimate of the mean of such observations which may be made on the specified population. The population of concern here consists of stained milk films made from a single sample of milk. The individual observations will vary and provide estimates which are higher or lower than the true mean with equal frequency. If we can obtain a reasonable estimate of the variation among individual observations it is possible to determine the degree of precision achieved by using a single observation or the average of multiple observations as an estimate of the population mean. The precision of an estimate is best described or compared by considering the width of the confidence limits for a selected degree of probability.

In the control of abnormal milk we are interested primarily in determining whether or not the concentration of cells in a milk supply exceeds an established legal limit. The precision of the estimated cell count on milk samples much greater or less than this concentration is of only minor interest. For a given microscope and reticle there is a Strip Factor which can be used to convert the number of cells observed in one strip or the average of several strips to a cell concentration per milliliter. Thus, for any given optical combination the number of cells observed is indicative of the cell concentration in the milk. One such number of cells, the Strip Equivalent (S_E) is indicative of the legal limit established for cell concentration. There is a smaller number of cells which indicates with a high degree of assurance that the cell concentration of the sample is below the legal limit. This number, which we have designated C_L is the lowest single strip count for which confirmation is required. There is also a number of cells larger than S_E which indicates with a high degree of assurance that the cell concentration of the sample is greater than the legal limit. This number, designated C_H, is the highest single strip count for which confirmation is required. The interval C_L to C_H is not great, and it is only within this range that single strip counts must

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[1]A contribution from the Subcommittee on Screening Tests, National Mastitis Council, Inc.

[2]United States Department of Agriculture, ARS, Animal Science Research Division, Beltsville, Maryland 20705.

[3]Department of Clinical Pathology, School of Veterinary Medicine, University of California, Davis, California 95616.

[4]Statens Veterinaere Serumlaboratorium, 4, Odinsvej, DK 4100 Ringsted, Denmark.

[5]Department of Veterinary Microbiology and Immunology, Ontario Veterinary College, University of Guelph, Ontario, Canada.

[6]Department of Large Animal Medicine, Obstetrics, and Surgery; New York State Veterinary College; Cornell University; Ithaca, New York 14850.

[7]Laboratory Division, State Department of Health, P. O. Box 1689, Hartford, Connecticut 06101.

TABLE 1. VALUES OF C_L AND C_H APPROPRIATE FOR A RANGE OF STRIP EQUIVALENT (S_E)

C_L	S_E[1]	C_H	C_L	S_E	C_H	S_L	S_E	C_H
44	65	96	64	89	124	84	113	151
45	66	97	65	90	125	85	114	153
46	67	98	66	91	126	86	115	154
47	68	99	66	92	127	87	116	155
47	69	100	67	93	128	88	117	156
48	70	101	68	94	130	88	118	157
49	71	103	69	95	131	89	119	158
50	72	104	70	96	132	90	120	159
51	73	105	71	97	133	91	121	161
51	74	106	71	98	134	92	122	162
52	75	107	72	99	135	93	123	163
53	76	109	73	100	137	94	124	164
54	77	110	74	101	138	94	125	165
55	78	111	75	102	139	95	126	166
56	79	112	76	103	140	96	127	167
56	80	113	77	104	141	97	128	169
57	81	114	77	105	142	98	129	170
58	82	116	78	106	143	99	130	171
59	83	117	79	107	145	100	131	172
60	84	118	80	108	146	101	132	173
61	85	119	81	109	147	102	133	174
61	86	120	82	110	148	102	134	175
62	87	121	82	111	149	103	135	176
63	88	123	83	112	150			

[1] S_E = Legal maximum cell concentration ÷ Strip Factor

be confirmed by counting the additional three strips as originally specified for the DMSCC. The limiting confirmatory numbers C_L and C_H have been so computed that a milk sample for which the single strip count falls just at either number has a probability of less than 5% of being falsely accepted or rejected, respectively. Because the interval for mandatory confirmation (C_L through C_H) is determined by the Strip Factor, it is characteristic of the individual microscope and reticle combination. Table 1 lists the appropriate values of C_L and C_H for a range of Strip Equivalents.

The control values have been developed as follows: We have previously designated the cell count per single strip which is equivalent to the legal limiting cell concentrations as S_E. The lower confirmatory number C_L, for which S_E lies at the upper 95% confidence limit, is expressed through the relationship $S_E = C_L + 1.645 \sqrt{S^2/n}$ *(1)*, where C_L is treated as a mean. But since only one observation has been made, $n = 1$. S^2 is the sample variance appropriate to the value of C_L. Our experience in several large cell counting trials *(3, 4)* indicated that the mean should be multiplied by a factor of 1.45 (reflecting a 12% coefficient of variation). This estimate of variance based on research laboratory experience is apparently too low to forecast performance in the field. A collaborative study performed in routine testing laboratories by the Division of Microbiology, U. S. Food and Drug Administration, produced an average coefficient of variation of 19% (R. B. Read, Jr., *unpublished data*). In conformity with their findings, we have substituted 3.61 C_L for s^2, yielding the equation $S_E = C_L + 1.645 \sqrt{3.61\ C_L}$. This cannot be solved directly for C_L and must be approached by an iterative procedure.

C_H is the upper confirmatory number for which S_E lies at the lower 95% confidence limit. It is computed from the relationship $S_E = C_H - 1.645 \sqrt{3.61\ C_H}$. Again, solution for C_H is by iteration.

In applying this quality control strategy to the control of abnormal milk, samples are prepared for the DMSCC in the standard manner of making, drying, and staining duplicate milk films. But now only the horizontal strip of the first film is counted. The count is immediately compared with the limiting confirmatory numbers C_L and C_H specified in Table 1 for the Strip Equivalent. If the count is less than C_L the milk sample is graded acceptable by the counting procedure. If the count is greater than C_H the sample is graded unacceptable by the counting procedure. Only if the single strip count falls within the range C_L through C_H does the milk sample require the confirmatory count. Since the slide is already in position on the microscope stage, it is a relatively simple matter to count the additional three strips required for the confirmatory count.

When the DMSCC is applied in the manner described to the monitoring of milk samples under the abnormal milk control program, both screening and confirmation of somatic cell concentrations are accomplished simultaneously and rapidly. Very few samples will require the counting of more than one strip across a milk film. All estimations of cell concentration are based upon a theoretical one-tailed 95% confidence limit.

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THE EFFECT OF A PHOSPHATE BUFFER AND MAGNESIUM CARBONATE ON QUALITY ATTRIBUTES OF COOKED GREEN VEGETABLES[1]

F. M. Clydesdale, A. W. Goodman, and F. J. Francis
Department of Food Science and Technology
University of Massachusetts
Amherst, Massachusetts 01002

(Received for publication September 21, 1970)

Abstract

Color is one of the major problems in cooked green vegetables, particularly when held on a steam table prior to serving. To improve color retention, two compounds, a phosphate buffer and $MgCO_3$, were added to frozen beans, peas, and spinach prior to cooking and during an hour long hold on a simulated steam table at 180 ± 5 F. Samples were taken after cooking in boiling water and thereafter at 20, 45, and 60 min intervals. Analyses were done for color, ascorbic acid, pH, and texture. Levels of phosphate buffer and $MgCO_3$ used, improved color of vegetables without a disproportionate decrease in ascorbic acid as compared to the control. Since treated vegetables became excessively soft during a steam table hold of 20 min or more, these additives cannot be recommended to maintain color in cooked, whole frozen green vegetables. It would seem, however, that their addition to purees would be advantageous since texture is not an important consideration.

A major problem in thermal processing of green vegetables is the degradation of chlorophylls to pheophytins and the concomitant undesirable change of color from a bright green to a dull olive brown.

Much effort has been expended in an attempt to stabilize these green pigments with varying degrees of success as pointed out by Clydesdale et al. *(5)*.

In general, frozen packs of green vegetables when properly stored produce a well colored product in comparison to thermally processed packs. However, the cooking process and subsequent holding time in hot water markedly affects the color of the final product, which in turn affects consumption. It has been stated by the USDA *(20)* that one of the reasons for the decline in consumption of vegetables is the difficulty in preparing and holding them at optimum levels of nutritive value and palatability.

One of the most popular methods of maintaining green color in thermally processed green vegetables involves imposing elevated pH conditions on the food by addition of approved alkaline substances *(1, 3, 4, 10, 13, 16)*.

Another approach has been the conversion of chlorophylls to chlorophyllides with or without addition of $MgCO_3$, as summarized by Clydesdale and Francis *(7)*. Still another has been the use of High-Temperature Short-Time processing *(9, 10, 12, 19)*.

The only one of these approaches which is applicable to the preparation and holding of vegetables prior to serving would be the use of alkalizing agents since the others demand conditions not normally used in cooking.

Sweeney and Martin *(17)* used citrate-phosphate buffers with pH values between 6.2 and 7.0 and found that progressive increases in color retention were obtained with increased pH. As well, up to pH 7, the buffers decreased the cooking time required for optimum texture and at these reduced times appeared to have no adverse effect on ascorbic acid retention. More recently Sweeney *(18)* used a mixture of magnesium carbonate and calcium acetate to improve the color of green beans. Again it was found that cooking times were reduced and thus ascorbic acid retention was improved.

This work was initiated in order to test the effect of $MgCO_3$ and phosphate buffers on ascorbic acid, color, and pH of frozen vegetables over a wide cooking range. This varied from the minimum time required to soften the tissue to the time the vegetable might be held on a steam table, after cooking, in institutional or cafeteria preparation. Noble *(15)*, working with several green vegetables found that insofar as ascorbic acid is concerned, vegetables can be cooked to the degree of tenderness preferred by the family, thereby encouraging greater consumption. On the other hand, if color is considered very important, only moderate overcooking is possible. It would be advantageous to improve color, but if an alkalizing agent is to be used, it cannot be assumed that the shorter time of cooking will be adhered to in order to improve ascorbic acid retention. Therefore, it was decided to maximize cooking times to simulate practical conditions and find if any gains in color might be offset by losses in tissue firmness and ascorbic acid content due to the previously mentioned additives.

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TABLE 1. THE EFFECT OF A PHOSPHATE BUFFER AND $MgCO_3$ ON THE ASCORBIC ACID CONTENT OF VEGETABLES COOKED FOR DIFFERENT PERIODS.

	Vegetable								
	Beans			Peas			Spinach		
Time	C[b]	P[b]	M[b]	C	P	M	C	P	M
	(Ascorbic acid–Mg/100 g)[a]								
Fresh	22.6	22.6	22.6	18.7	18.7	18.7	25.1	25.1	25.1
Cooked	6.1	5.9**	7.2**	4.7	5.5**	5.1*	8.2	7.6**	9.7**
20 min	4.0	3.7**	5.3**	4.2	3.6*	4.0	6.7	7.0	7.3*
45 min	3.1	4.3**	4.2**	4.0	3.6*	3.9	6.0	6.7*	8.2**
60 min	4.1	4.3	3.1**	4.6	4.3*	3.4**	5.6	6.8*	5.0

[a]All values are averages of duplicates.
[b]C – Control, P – Phosphate buffer added, M – $MgCO_3$ added.
**Significantly different from the control at the 1% level.
*Significantly different from the control at the 5% level.

TABLE 2. THE EFFECT OF A PHOSPHATE BUFFER AND $MgCO_3$ ON THE pH OF VEGETABLES COOKED FOR DIFFERENT PERIODS.

	Vegetable								
	Beans			Peas			Spinach		
Time	C[a]	P[a]	M[a]	C	P	M	C	P	M
	(pH)								
Fresh	6.1	6.9	9.9	6.3	6.9	9.8	6.9	7.0	9.9
Cooked	5.8	6.6	8.5	5.8	6.7	8.6	6.8	6.8	8.7
20 min	5.6	6.5	8.3	5.7	6.5	8.2	6.6	6.7	8.6
45 min	5.5	6.4	8.1	5.6	6.3	8.0	6.6	6.7	8.5
60 min	5.5	6.2	7.8	5.5	6.2	7.9	6.4	6.5	8.4

[a]C – Control, P – Phosphate buffer added, M – $MgCO_3$ added

TABLE 3. THE EFFECT OF A PHOSPHATE BUFFER AND $MgCO_3$ ON THE COLOR OF VEGETABLES COOKED FOR DIFFERENT PERIODS.

	Vegetable								
	Beans			Peas			Spinach		
Time	C[a]	P[a]	M[a]	C	P	M	C	P	M
	(Color; $\tan^{-1}$ a/b)								
Fresh	–33.8	–33.8	–33.8	–40.7	–40.7	–40.7	–36.1	–36.1	–36.1
Cooked	–14.9	–17.1	–21.4	–29.8	–32.2	–36.1	–26.8	–36.1	–36.1
20 min	–10.1	–15.8	–17.9	–23.3	–26.4	–35.9	–25.9	–33.3	–35.9
45 min	– 8.6	–13.1	–19.3	–25.4	–27.3	–34.8	–25.5	–31.3	–34.9
60 min	– 3.9	– 8.6	–13.2	–19.5	–20.5	–33.2	–14.2	–21.9	–34.5

[a]C – Control, P – buffer added, M – $MgCO_3$ added

MATERIALS AND METHODS

Preparation

Sample of frozen green beans, green peas, and spinach were purchased at a local retail market. Three 1000 g batches of each vegetable were prepared and added to 1000 ml of distilled water in a steam kettle. To one batch was added 1 g of basic $MgCO_3$ (Fisher Scientific Co.). This was 2.5 times the solubility limit in water. A phosphate buffer was added instead of water to the second 1000 g of vegetables. The buffer was made from 135 ml of stock buffer solution (monobasic and dibasic sodium phosphate) and 865 ml of water to create a pH of 7.0 according to *Methods in Enzymology (14)*. The third batch was used as a control. The vegetables were boiled until tender and sampled for analysis. Following this, the temperature was reduced to 180 ± 5 F to simulate severe steam table conditions and samples were taken at 20, 45, and 60 min. All samples were frozen at –20 F until analysis.

Analytical methods

Ascorbic acid was determined on drained samples of all vegetables by the Bessey (2) method which includes a correction for drift caused by slow reduction of the indophenol by substances other than ascorbic acid. Spectrophotometric

readings were done with a Hitachi Perkin-Elmer 139 UV-VIS spectrophotometer rather than on an Evelyn photoelectric colorimeter as suggested in the original method. All analyses were carried out in duplicate and results analysed statistically by Kramer's Range Method *(11)*. Instrumental color data were obtained from a Hunterlab Model D25 Color Difference Meter (Hunter Associates Laboratory Inc., Fairfax, Va.). Beans and peas were placed in a large cell, and the spinach leaves were layered. All measurements were made using a large area aperture to decrease the effect of small differences in color between individual pieces of the vegetables. The color data were reduced to the function $\tan^{-1}a/b$ as suggested by Clydesdale and Francis *(8)*. The pH was measured with a Radiometer, model 25, pH meter. Textural differences of cooked and steam-table held vegetables were so great that subjective judgments of two individuals were deemed adequate.

RESULTS AND DISCUSSION

The level of $MgCO_3$ which was added was decided upon after preliminary experiments showed that levels above 0.1% created an unsightly white deposit of $MgCO_3$ on the cooking kettle. In previous work, Clydesdale and Francis *(7)* found that higher levels of $MgCO_3$ could be used in purees which were thermally processed, but this was not true when the vegetables were not pureed. Therefore, it appears that the practical maximum level of $MgCO_3$ which may be used in cooking is 0.1%. The phosphate buffer was used to determine if a lower more stable pH would prevent discoloration as well as the higher pH values obtained with $MgCO_3$.

The ascorbic acid contents of the raw and cooked vegetables are shown in Table 1. Analyses for dehydroascorbic acid were not done because it has been shown by Noble *(15)* that the content is usually very low. Destruction of ascorbic acid was large in all instances. These results show greater destruction than Sweeney *(18)* found in beans but are closer to the values reported by Noble *(15)*. It appears that gross over-cooking by holding on a steam table, although decreasing the ascorbic acid when compared with normal cooking, does not unduly affect the nutritional value of the vegetable because such a large amount was destroyed simply by cooking. This means that the problems associated with holding on a steam table are mainly involved with decreased green color. Further, it is apparent that the additives had little effect on ascorbic acid destruction and in some instances improved the situation slightly.

The pH values of raw and cooked vegetables are shown in Table 2. It is evident that the phosphate buffer was not able to stabilize the pH during cooking although none of the vegetables decreased below a pH of 6.2. Magnesium carbonate maintained the highest pH in the vegetables because of the relatively high initial pH it created.

The color scores of the raw and cooked vegetables are shown in Table 3. The function $\tan^{-1}$ a/b represents the angular function whose tangent is a/b. As such it is a measure of a hue shift from green to yellow with the largest negative values representing the greenest hue. The use of both phosphate buffer and $MgCO_3$ reduced discoloration in beans and $MgCO_3$ produced the best color. Similar results were noted with peas. However, with spinach, $MgCO_3$ produced extremely good results and only a very minor deterioration of color.

As stated previously, textural changes were so gross that subjective examination by two judges was adequate. Both the phosphate buffer and $MgCO_3$ produced a change in texture upon cooking. This change was acceptable for vegetables cooked for a normal length of time, but considered unacceptable for even a 20 min hold on a steam table.

From these results, it is obvious that the levels of phosphate buffer and $MgCO_3$ used in this study improved the color of prepared vegetables without a disproportionate decrease in ascorbic acid as compared to the control. Unfortunately, textural changes were such that this method of maintaining color in cooked whole frozen green vegetables cannot be recommended. However, from the previous work of Clydesdale and Francis *(7)* with $MgCO_3$ in spinach puree, it would appear that the use of $MgCO_3$ at these levels would produce an acceptable product when used with pureed vegetables where texture is not an important consideration.

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REPORT OF THE BAKING INDUSTRY EQUIPMENT COMMITTEE, 1969-1970

Committee purpose

This committee is charged with the responsibility of actively assisting the Baking Industry Sanitation Standard Committee (BISSC) in the formulation of sanitary standards for bakery equipment.

Committee activity

Members of this committee participated in the 1969 Fall meeting held in Washington, D.C. and the 1970 Spring meeting held in Chicago, Illinois. In addition, members of this committee also attended two special meetings on individual standards during 1969-1970.

Standard adoption procedures

When an apparent need for a sanitary standard for a particular piece of bakery equipment arises, this information is brought to the attention of the Chairman of BISSC. The Chairman of BISSC appoints a committee composed of knowledgeable and concerned manufacturers of bakery equipment, and one or more sanitarians as consultants. The committee meets and drafts a proposed standard. This proposed standard is then reviewed by the entire BISSC membership in attendance. Anyone in attendance has an opportunity to express any thoughts, pro or con, regarding the proposed standards. After this revision the standard is returned to the committee for incorporation of all additions and deletions approved at the BISSC meeting. The proposed standard as amended, is circulated by mail for comments. It is again brought before the entire BISSC organization for review at the next BISSC meeting where it is again reviewed by the entire organization.

If the proposed standard is approved for publication an effective date for the proposed standard is determined. The proposed standard in final form is again circulated and, unless there is a serious objection, the standard is published and becomes effective on the determined date.

The route of a standard from inception to completion is slow and arduous. BISSC has planned built in safety checks to insure that all segments of the baking industry have ample opportunity to review and comment on the proposed standards before final approval is granted.

BISSC problems

One of the problems encountered by BISSC is the attempt, by equipment manufacturers, having low levels of sanitation concepts, to write a standard for equipment currently in production, even though the equipment is of poor sanitary design and construction. The thought among such manufacturers is to fit the standard to their equipment rather than to develop a standard to raise their equipment to more acceptable parameters. This attitude is particularly noted among the manufacturers of electrical motors. These manufacturers are objecting to the BISSC requirements for a 2-inch clearance between the motor housing and the mounting surface. Since motors with a 2-inch clearance are not available in all ranges of power, BISSC is permitting this adjustment to be made by the installers with the provision that the jucture of the extension and the legs be sealed.

BISSC is making steady progress in securing the installation in bakeries of BISSC approved equipment.

BISSC and the baking industry generally appreciate the guidance of their sanitation consultants and need the active participation and help of all sanitarians. The members of this committee urge every sanitarian, when reviewing plans for new bakeries, to recommend equipment meeting BISSC standards be specified for purchase. Sanitarians can recommend the use of BISSC equipment being confident that it represents the latest in sanitary design and construction available in bakery equipment.

Copies of BISSC Standards are available from: Mr. Raymond J. Walter, Executive Secretary BISSC, 521 Fifth Avenue, New York, New York 10017, to sanitarians who apply for them on stationery of their official agency.

Vincent T. Foley, *Chairman*, City Health Department, 21st Floor, City Hall, Kansas City, Missouri 64106.

A. E. Abrahamson, City Health Department, 125 Worth Street, New York, New York 10013.

Louis A. King, Jr., American Institute of Baking, 400 East Ontario, Chicago, Illinois 60611.

Fred Vitale, Continental Baking Company, Inc., P. O. Box 731, Rye, New York 10580.

Harold Wainess, Wainess and Associates, 510 North Dearborn Street, Chicago, Illinois 60610.

FACTORS AFFECTING THE VISCOMETRIC METHOD FOR ESTIMATING THE SOMATIC CELL COUNT OF COW'S MILK

L. R. Fell, W. G. Whittlestone, and H. De Langen[1]
Machine Milking Centre,
State Research Farm,
Werribee, 3030, Victoria, Australia

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Abstract

Three factors likely to influence results obtained with a viscometric technique for estimating the somatic cell content of cow's milk are examined, namely, reagent composition, mixing time after addition of reagent and "holding time" before determination of viscosity. Mixing time was the only factor of material signficance.

Further experience with the viscometric method for measuring the viscosity change caused by the addition of California Test Reagent to milk containing somatic cells *(6)* has indicated that the method is suitable for use in milk factories. This would require development of automatic controls in order to eliminate operator errors. Thus there is a need to know the effects of a number of factors on the test. This paper describes the influence of the time taken to mix the reagent and milk sample, the "holding time" after mixing and before determining the viscosity, and the influence of the Blackburn Reagent *(1)* on the test reaction.

Experimental Procedures

A rolling-ball viscometer *(4, 5, 6)* was used to estimate the leucocyte count of milk samples by measuring the California Mastitis Test reaction *(3)*. Ten milliliters each of milk and reagent were mixed in a 25 ml test tube using a roll-tube mixer with an automatic timing mechanism *(6)* for periods of either 20, 40, or 60 sec. There followed a holding period of either 20, 40, or 60 sec before the samples were tested in the viscometer.

Milk samples of high leucocyte count (>5,000,000 cells/ml) and low leucocyte count (<500,000 cells/ml) were collected. A third sample of intermediate cell count was obtained by mixing these two in volumes proportional to the square root of the ratio of their cell counts, giving the geometric mean of the high and low counts. All tests were carried out within 12 hr after collecting the samples. Using different subsamples, viscometer tests were performed three times on each sample at each different combination of mixing time and holding time.

With new samples at a different time the procedure was repeated using two different reagents: a commercial CMT reagent[2] and a reagent described by Blackburn *(1)*, the active ingredient of which is sodium lauryl sulphate.

[1]Ruakura Animal Research Station, Hamilton, N.Z. This work was carried out at the Ruakura Animal Research Station, Hamilton, N.Z.

[2]CMT reagent: National Dairy Association of N.Z.

Table 1. Viscometer test results[1] on three milk samples after different periods of mixing and holding

Sample	Mixing time (sec)	Holding time (sec) 20	40	60
High	20	11.5	13.6	11.1
	40	11.2	17.2	17.6
	60	25.0	28.4	25.2
Medium	20	4.2	4.2	3.4
	40	3.2	3.6	3.9
	60	4.1	4.1	5.2
Low	20	2.5	2.6	2.6
	40	2.7	2.6	2.9
	60	2.7	2.6	2.6

[1]Each value is the mean of three determinations

Table 2. Residual mean squares from analyses of variance of three transformations of viscometer test results

	Sample High	Medium	Low
Viscometer time	11.6507	0.07037	0.02111
Log (viscometer time)	0.0007187	0.0008935	0.0005692
(Viscometer time)$^{-1}$	0.00019277	0.00034631	0.00044263

Results

The time taken for the ball to roll through the milk-reagent mixture was taken as an estimate of the viscosity. Table 1 gives the mean results of three tests on each of the milk samples at each different combination of mixing time and holding time. Neither holding time nor mixing time had much effect on viscosity at low or medium levels of cell count, but at the high level of cell count, viscosity clearly increased with increasing mixing time.

An analysis of variance using these data revealed a large difference in the residual variance at different levels of cell count (Table 2). A lesser difference occurred using a logarithmic transformation of viscometer time, but the residual variance was not entirely independent of the level of cell count. The transformation $\frac{1}{\text{viscometer time}}$, the rate at which the ball rolled through the mixture, was chosen for subsequent analyses because the residual variance was uni-

form at different levels of cell count as Table 2 shows.

The overall analysis of variance for these data is given in Table 3. Level of cell count was the major component of variance. Mixing time, but not holding time was a significant main effect. Several of the interactions were also significant, the "level × mixing" interaction having been evident in Table 1. Although these may be real effects they were added together to give an alternative residual mean square against which the main effects were tested in the second column of the tests of significance. Mixing time remained significant at the 95% level of probability.

TABLE 3. ANALYSIS OF VARIANCE OF VISCOMETER TEST RESULTS[1] ON DIFFERENT MILK SAMPLES AFTER DIFFERENT PERIODS OF MIXING AND HOLDING

	Degrees of freedom	Mean square	Tests of significance		
Level of cell count	2	0.6830	***		***
Mixing time	2	0.00694	***		*
Holding time	2	0.000742	NS		NS
L × M	4	0.003412	***		
L × H	4	0.000245	NS	(20)	0.0016711
M × H	4	0.002027	***		
L × M × H	8	0.0013359	**		
Residual	54	0.00032724			

[1]Rate of movement of rolling ball $\left(\frac{1}{\text{time}}\right)$

***p = 0.001
**p = 0.01
*p = 0.05

Results of the second trial in which two reagents were used are given as viscometer times in Table 4. Large differences between the two reagents were not apparent although the effect of mixing time at the high level of cell count was less for the Blackburn reagent than for the CMT reagent.

The overall analysis of variance for these data is given in Table 5. Level of cell count was the major component of variance. Mixing time was the only significant main effect, the two reagents not being significantly different. The interactions: "mixing × level", "mixing × reagent" and mixing × level × reagent" which were apparent in Table 4 were significant. One interaction involving holding time was significant at a low level and the highest order interaction was also significant. Testing for significance against the mean square of the highest order interaction did not alter the conclusions. Mixing time (p = 0.05), level of cell count (p = 0.001), "mixing × level" (p = 0.01) and "reagent × mixing (p = 0.01) remained significant.

Separate analyses of variance for the two reagents are given in Table 6. There was no major difference in the components of variance for the two reagents.

DISCUSSION

In the design of an automatic viscometer for the estimation of the cell content of milk it is essential to know the conditions of operation having a significant influence on the results. It is apparent from the present study that if a gentle mixing procedure is used there is no need for a holding time before determinations of viscosity are carried out. It is however important to realize that the CMT gel is highly

TABLE 4. VISCOMETER TEST RESULTS[1] USING TWO DIFFERENT REAGENTS

Sample	Mixing time (sec)	CMT reagent Holding time (sec) 20	40	60	Blackburn reagent Holding time (sec) 20	40	60
High	20	8.9	10.2	13.2	19.4	12.8	13.5
	40	26.7	20.4	18.3	14.6	18.6	20.0
	60	28.2	15.0	18.9	14.2	13.5	15.4
Medium	20	6.8	7.2	7.8	8.5	9.1	8.6
	40	8.5	9.2	9.8	9.7	9.5	9.9
	60	11.1	11.5	11.4	7.0	7.6	6.2
Low	20	4.1	4.0	4.1	4.2	4.1	4.8
	40	4.2	4.3	4.1	4.3	4.5	4.1
	60	4.3	4.8	4.2	3.7	3.7	3.9

[1]Each value is the mean of three determinations

TABLE 5. ANALYSIS OF VARIANCE OF VISCOMETER TEST RESULTS[1] USING TWO DIFFERENT REAGENTS AND THREE LEVELS OF CELL COUNT, MIXING TIME AND HOLDING TIME

	Degrees of freedom	Mean square	Tests of significance	
Mixing time	2	0.004262	***	*
Holding time	2	0.000050	NS	NS
M × H	4	0.000569	*	NS
Level of cell count	2	0.43389	***	***
M × L	4	0.01134	**	**
H × L	4	0.000279	NS	NS
M × H × L	8	0.000345	NS	NS
Reagent	1	0.000768	NS	NS
R × M	2	0.012210	***	**
R × H	2	0.000004	NS	NS
R × M × H	4	0.000272	NS	NS
R × L	2	0.000294	NS	NS
R × L × M	4	0.000984	**	NS
R × L × H	4	0.000425	NS	NS
R × L × M × H	8	0.00071413	**	
Residual	108	0.00022270		

[1]Rate of movement of rolling ball $\left(\frac{1}{\text{time}}\right)$

***p = 0.001
**p = 0.01
*p = 0.05

TABLE 6. SEPARATE ANALYSES OF VARIANCE OF VISCOMETER TEST RESULTS[1] FOR TWO REAGENTS

	Degrees of freedom	CMT reagent (Mean square)		Blackburn reagent (Mean square)	
Holding time	2	0.0000317	NS	0.0000216	NS
Mixing time	2	0.01009	***	0.006385	***
H × M	4	0.0006048	*	0.0002361	NS
Level of cell count	2	0.2138	***	0.2204	***
H × L	4	0.0003871	NS	0.0003165	NS
M × L	4	0.0011264	**	0.0009911	**
H × M × L	8	0.0004598	*	0.0005991	*
Residual	54	0.00017977		0.00026562	

[1]Rate of movement of rolling ball $\left(\frac{1}{\text{time}}\right)$

***p = 0.001
**p = 0.01
*p = 0.05

thixotropic and agitation could influence the strength of the gel. It is therefore necessary to standardize the mixing method and to avoid excessive agitation.

The DNA molecule which would seem to be the main component of the CMT reaction is, because of its great length, liable to become oriented along a flow path if flow velocities exceed Reynolds Number. This would have the effect of diminishing the viscosity in the direction of flow, an effect to be avoided in the design of an automatic instrument. Roll tube mixing avoids this effect.

The original viscometer *(1, 2)* used a rolling ball with a tube slope of 26° from horizontal. Kiermeier and Keis *(2)* independently applied the direct falling ball type of viscometer with a fall time for normal milk of less than 190 sec with a ball density of 2.4. Their results confirm the value of a viscosimetric approach to cell estimation using a viscometer with a low shear rate to minimize the effects of thixotropy.

Our instrument with automatic magnetic ball detection lends itself to automation and current work includes development of such an instrument for industry use. Results of the present study suggest that there is no need for a holding time if there is a period of gentle mixing before measurement. This simplifies the final design.

The commonest methods for measuring viscosity of the CMT reaction products such as the Brabant and Wisconsin Mastitis Tests involve batch operations using large numbers of individual tubes. Furthermore such methods, depending as they do on small orifices are liable to give large errors if a few small clots are present in the sample, an effect which is overcome in the rolling ball instrument. The viscometer used in this study lends itself to continuous operation with the complete mechanization of sampling, mixing, and measurement. Simple cleaning-in-place can be applied so that the system involves a minimum of labor and avoids the need for large numbers of individual standardized "small orifice" viscometers.

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CHANGING PATTERNS IN FOOD PRODUCTION AND PROCESSING

HAROLD E. CALBERT

Department of Food Science
University of Wisconsin
Madison, Wisconsin 53706

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ABSTRACT

With the exception of meat packing plants the trend is to fewer but larger production and processing units. Meat packing plants are becoming smaller but more specialized. The broiler industry is producing about 3 billion birds per year. Ten percent of this production is marketed as the ready-to-eat product.

Per capita consumption of most dairy products except cheese and fluid nonfat and low-fat milks is declining. Milk cow numbers will drop to about 11.5 million by 1975 when the nation's annual milk production will be about 114 billion lb. Milk production per cow will continue to increase. There are about 400,000 dairy farms in the U.S. at present compared to 2 million 20 years ago. Large regional milk marketing associations are being organized. Within a few years they will market about 80% of the nation's milk supply. Imitations will continue to plague the dairy industry, but new uses will be found for milk constituents as ingredients in other foods.

Consumption of fresh fruits and vegetables is declining with an increase in per capita consumption of frozen and processed products. Winter production of fresh products for the U.S. market is shifting to Mexico. Unless production of a fruit or vegetable can be completely mechanized, the variety will disappear from the retail market.

High lysine corn has not had good acceptance as a human food. New rice varieties offer hopes for increasing human food supplies. However, their production requires liberal amounts of fertilizer and different farming practices.

New foods will be developed using a combination of plant and animal ingredients. The food industry must find new methods to reduce and handle liquid and solid wastes and must exercise greater control and discretion in the use of agricultural chemicals.

Research and application of technology to agriculture have, in recent generations, given man the potential to emerge from a long epoch in which most of his energies were utilized to produce food. Instead of the man on the land producing only enough food and fiber for himself and his immediate family, in this and other developed countries, he supplies these needs for an ever-increasing number of people.

A modern concept of agriculture must include production, processing, distribution, utilization, consumption, and related activities. Agriculture is now a segment of a complex system that employs supply and energy inputs to produce raw materials and then to process and distribute them. Economies of agriculture and industrial production are interwoven.

To discuss changing patterns in all segments of agriculture in the seventies is a Herculean task that is beyond the scope of this paper. Therefore, this discussion will be limited to those areas of agriculture and associated industries that relate to certain aspects of our food supply, its production, processing, and distribution. Specifically, these remarks will be confined to changing patterns that now appear in the meat and poultry industry, the dairy industry, the fruit and vegetable industry, and the cereal grain industry.

THE MEAT AND POULTRY INDUSTRY

Changes in consumption patterns

The United States is one of the five nations which have the highest per capita consumption of meat. Our total per capita consumption of red meat and poultry has increased from 138 lb. in 1951 to 186 lb. in 1969. The per capita consumption of chicken and turkey is the highest it has ever been in this century and reached 47.7 lb. in 1969. In 1910 it was 15.5 lb. but the rapid upward swing did not start until the end of World War II. Egg consumption remains fairly steady at about 315 to 320 eggs per person per year.

Beef has constituted the main increase in red meat consumption; it rose from 56.1 lb. per person in 1951 to 111 lb. in 1969. Pork consumption has dropped slightly, whereas lamb and veal usage has remained more or less constant. Pork, while normally lower in price than beef, usually is consumed in greater quantity when incomes dip, and suffers from reduced consumption which gives way to beef when incomes rise. Since the United States has enjoyed prosperity and rising incomes in the last 15 to 25 years, an increase in beef consumption would be expected.

Unless there is a dramatic economic change in this country, trends in per capita consumption of meat probably will not change. There might be a slight increase in pork usage, but little change is seen in the per capita consumption of veal and mutton. It is very likely that in the next decade there will be a number of food products developed which are blends of plant and animal proteins.

Changes in meat processing plants

The trend in the meat industry has differed from that in most phases of the food industry since there has been a movement toward decentralization and development of smaller specialized plants rather than

consolidation of many plants into a larger processing operation. Decentralization means lower transportation costs, and in this industry, returns for labor are greater in the smaller operations. During the last 25 years meat packing plants have doubled in number and, in spite of automation, they now employ 40% more people. The dollar value of meat produced has doubled. The number of smaller packing plants has increased faster than the number of larger plants.

The industry has tended to specialize at an accelerated pace. Some plants slaughter only one or two species. Less than one-third of all large commercial meat packing plants now handle all three species. Some plants handle only certain classes, i.e. sexes, ages, or grades. Some companies specialize in carcass boning, fabrication of wholesale cuts, or in fresh and frozen meat distribution. Specialized processes for hides and skins, bones, blood, and other products are now well established.

Packing companies have modestly tended to integrate vertically through ownership of livestock on feed lots, concentration yards, transportation facilities, processing and distribution facilities, and by-product plants. Meat packers are moving into other lines of business, including agricultural fertilizers, feeds, chemicals, and pharmaceuticals.

Changes in red meat production practices

A major trend in beef production is toward confinement feeding to provide the type of meat animal that is demanded by the market. The earlier practice of feeding on range grass for up to about a year and then finishing off the animal with grain is giving way to complete confinement feeding. The confinement-type feed lots are increasing in number and are covering a much wider area of the country. One reason for this is the need to get feed lots closer to sources of feed. Proliferation of this feeding method has been accompanied by engineering developments that result in mechanized operations which save labor.

The trend that has occurred in the beef industry is not so pronounced in the pork industry. There are several problems, such as spread of disease, associated with holding large numbers of swine in confinement feeding.

There has been a gradual transition from the fat-type to a leaner hog carcass. This has not been without problems in terms of type and quality of meat produced. There is a tendency in these leaner animals to a soft, watery type of muscle. Also, these animals tend to be unable to cope with stress or abrupt changes in environmental conditions such as hauling, change of pens, feeds, etc.

Artificial insemination, which has become so popular for use in dairy herds, has been very slow to achieve general acceptance in beef herds. Certainly in the future, the beef industry must utilize either artificial insemination or a program of performance testing of bulls. Artificial insemination has not proven very satisfactory with swine. Some technological developments must precede acceptance of this practice.

Basic feeds used by the meat industry have not changed much. However, the greatest changes have been in handling these feeds and in engineering developments which enabled mechanization of feeding.

Changes in the poultry industry

Generally the little barnyard flock is almost a thing of the past although some 30-hen flocks can be found on farms around small communities. These supply the needs of the farm family and produce enough to provide some chickens and eggs for sale in the neighboring community.

A large broiler industry is developing in many parts of the country. These are highly efficient and highly mechanized operations. They turn out a 3.8-4 lb. bird in 8-9 weeks and produce about 1 lb. of broiler from 2.1 lb. of feed. The efficiency of conversion is still increasing. Some individual broiler houses hold as many as 88,000 birds with several millions of birds on feed in a single operation.

With greatly improved marketing methods it is possible for the consumer to buy dressed broilers for 23 to 29 cents per pound. It is one of the best food buys on the market. Most of these broilers are sold fresh whole or cut in pieces. There has been an increase in sales of the frozen product. Last year over three billion broilers were marketed. Approximately 10% of these reached the consumer as the finished cooked product through such outlets as Kentucky Fried Chicken, Chicken Shacks, Hillbilly Fried Chicken, etc.

Extensive vertical integration is occurring in this industry with the chain store or the final marketing organization owning or operating the production, slaughtering, and processing facilities. This has eliminated many of the middlemen.

Improvements in production and marketing have resulted in increases in the per capita consumption of turkey. Turkey no longer is served just at Thanksgiving or Christmas. Turkey rolls and other types of processed turkey are consumed every day.

Artificial insemination is used extensively in the poultry industry. It is estimated that 90% of the turkey breeding flocks and 15-20% of the chicken breeding flocks are bred by this procedure.

Production of capons and roasting chickens also is increasing. However, because of their high price, 70-80 cents per pound, and their limited demand they represent a very small portion of the total poultry market.

Most of the nation's eggs come from large battery laying operations. In these laying houses hens are in close confinement. Feeding and egg gathering are about as completely mechanized as possible. An increasing amount of the total egg production is being marketed as partially processed products in such forms as liquid, frozen, or dried whole eggs, whites, and yolks. Most of these products are for institutional users and for food processors. Since pasteurization is required to process these products, processing operations usually are separate from producing operations.

Major problems which face the poultry industry as it moves toward these larger operations are disease control and waste disposal. Because of the *Salmonella* problem, use of meat scraps for poultry feed has declined and that of grain products has increased.

The Dairy Industry

Changes in consumption patterns

Use of various dairy products has been changing. The per capita consumption of fluid nonfat and low-fat milks increased from about 14.5 pints in 1950 to 48.7 pints in 1969. During this same period the per capita consumption of cheese increased from 7.6 to 10.6 lb. This increase in use of nonfat and low-fat milks can be attributed to greater awareness by the average consumer of the need to control intake of calories and to the cholesterol scare of several years ago. Improved merchandising and marketing of all types of cheese have helped to improve its consumption record.

On the other hand, the per capita consumption of fluid whole milk has decreased from 266 pints in 1959 to 220 pints in 1969. Fluid cream consumption dropped from 9.3 to 6.0 lb. per capita during the same period. The drop in butter, and in evaporated and condensed milk consumption is even more dramatic. Last year we consumed only 4.7 lb. of butter per person compared with a high of over 18 lb. prior to World War II. The per capita consumption of ice cream and frozen dairy desserts has increased slightly during the last decade. On the plus side of the ledger has been acceptance of such products as sour creams, yogurt, and eggnog. Only in the last few years have these products achieved national distribution; their use is increasing steadily.

Changes in milk production

The number of milk cows in the nation has declined but the average production per cow has increased. It is estimated that by 1975 there will be about 11.5 million milk cows in the United States compared to the present 12,700,000. Total milk production in the United States probably will level off by 1975-80 at around 114 billion lb. The trend indicates that about one-third of our nation's milk supply will be produced in the States of Wisconsin, Minnesota, and Iowa. Another third will be produced in the New England states and California.

Milk is produced by fewer but larger herds. An estimated 400,000 farms sell milk and cream today as compared with the 2 million of 20 years ago. Most of this drop has been in the number of smaller herds—those with less than 20 cows. The number of dairy farms with 20-29 cows has declined less, whereas herds with more than 30 cows have increased both in number and size.

We are seeing a greater degree of specialization and commercialization of our dairy farms. Dairying is no longer a part-time enterprise on many of the farms. An increasing proportion of farms selling milk and cream are commercial operations, and those with sales of over $10,000 annually are increasing in numbers.

Good management and feeding practices have enabled dairymen to increase milk production per cow. Nationaly milk production per cow now is approximately 9,200 lb. annually compared to about one-half of that 25 years ago. Today's dairyman can handle nearly twice as many cows as he did 10 years ago. Labor efficiency—as measured per man hour—has tripled since 1950 and gained by 75% since 1960.

Changes in selling milk from the farm

Large regional associations are being organized to market milk. These cover areas larger than the traditional milkshed, and are being established to give milk producers a greater opportunity to take advantage of market needs. The milk supply of a region will be controlled by the marketing association and will be sold directly by these associations to processors. When certain quantities of milk are needed in given areas, milk will be moved by the association across state lines and across many states, if necessary.

Probably there will be production controls established by the marketing agencies. They will be responsible for handling the surplus and will own or operate processing plants for this purpose. They will attempt to control unwanted surplus. It will mean gradual elimination of Federal Milk Marketing Orders in different areas, because many functions performed by the orders in the past will now be performed by these large marketing organizations. This is leading to a single grade of milk to permit efficient marketing. If there is no demand on a particular day for the full volume of milk, surplus will go into manufactured products. With establishment of regional marketing associations and with all producers in the region becoming members of the association, a pooling of the region's milk supply will result. Producers in the region will receive the blend price for

their milk, regardless of whether it went into the bottle, into cheese, powder, or other products.

Some have predicted that within a few years approximately 80% of the nation's milk supply will be marketed through a few large marketing associations.

Threat of imitations

The question is often raised, is there any future in the dairy industry, because of the situation with imitation and filled products? It is difficult to evaluate this as there are trends to indicate both an increase and decrease in use of various filled and imitation dairy products. The threat of imitations will be with the dairy industry for a long time to come, and probably will get worse. However, the dairy industry does have some factors working for it.

Recent publicity originating in Washington and the state capitals, and comments made by various consumer groups, suggest that the consumer will exert a greater influence in the future than in the past. More attention also is directed to the declining state of nutrition in this country. In the future the consumer is going to be much more aware of the nutritional quality of the foods he is buying. In this respect the dairy industry is in an enviable position. Of all available foods, dairy products offer the best bargains in nutrition.

Certainly there will be improvements in the conventional types of dairy products, and, occasionally, some new form of dairy product will be developed. It must be remembered though, that any completely new dairy product probably can be duplicated using non-dairy ingredients at a lower price. These foods always have a price advantage over the dairy product.

The main research effort in the future will be aimed at finding new uses for individual constituents of milk. These constituents have properties that, as yet, have not been duplicated with other substances. New foods will be developed which will use milk components as important ingredients because of their unique properties.

THE FRUIT AND VEGETABLE INDUSTRY

Like other phases of agriculture, the fruit and vegetable industry is undergoing constant change not only in production and marketing but also in consumption patterns. There has been a gradual decline in the per capita consumption of fresh fruits and vegetables with a marked increase in the use of processed fruits and vegetable products. Fruit and vegetable processing has had and continues to have one of the highest growth rates in the food processing industry, exceeding that for any other food except poultry. The largest increase is in processing of frozen and dehydrated products.

Some changes in this industry are similar to those in other segments of agriculture. There is a trend toward fewer but larger producing and processing units. This is accompanied by a higher degree of specialization and higher capital investment and a move toward more mechanization.

Yields per unit of production are leveling off. The gap between knowledge and application seems to be closing. There has been little increase in yields per acre of most fruits and vegetables in the last 5 years. This means that more research is needed and more knowledge must be developed if yields of these foods are to be increased.

Use of agricultural chemicals is essential for production of high quality fruits and vegetables. Since greater attention is being focused on the environment, many of these chemicals are being subjected to extensive criticism and restrictions in use are possible. Yet the consumer wants high quality, uniform products. If use of these agricultural chemicals is restricted severely, there must be a sacrifice of quality. Nature doesn't p r o d u c e uniform quality apples, peaches, pears, or potatoes. Under these circumstances the consumer must pay more for quality if the producer is greatly limited in the materials that can be used to produce quality products. Biological controls for combating insects, pests, and diseases in fruits and vegetables have been advocated. While the theories may be good, they have not proven to be too effective as yet.

The western part of the United States is expanding fruit and vegetable production. Idaho, Oregon, and Washington have increased potato production by 50% in the past 10 years with production in the eastern part of the country declining. A similar pattern is becoming evident in onion production.

Use of overhead irrigation or sprinkler systems is increasing in the Midwest and West. Cost of installation and maintenance of this system is lower when compared with the traditional method of irrigation. Also, contrary to popular belief, research has shown overhead irrigation requires less water.

Labor and transportation costs have been major factors influencing change in the fruit and vegetable industry. Processing has moved closer to production to reduce transportation costs. This is true even with fresh products where consumer packaging of items such as head lettuce, carrots, radishes, etc. may be done in or near the field. Waste leaves, stems, tops, etc. need not be transported to the consumer.

With the decline in availability of migrant labor and labor's increasing cost, mechanization has been forced on the producer. Many feel that if production and harvesting of a fresh crop cannot be mechanized, the item will disappear from the market within a few years. Fragile fruits and vegetables will be victims of this transition. Fresh raspberries are a

good example. With regard to fresh products, this will mean fewer kinds of commodities with less selection available to the consumer.

Because of weather and the labor market, winter production of fruits and vegetables for the U. S. market has been shifting from California and Florida to Mexico. Now some processing operations to meet the needs of the U. S. market are developing in Mexico. While California is still one of the major producers of fruits and vegetables, there is considerable speculation as to what the future holds. With the increasing population and rapid urbanization in this area, thus removing land from production, what is going to happen to the production of these agricultural products in this area in the future?

Many mergers and consolidations are taking place and corporations not normally associated with agriculture are moving into agricultural enterprises such as production of fresh products as well as processing operations. In addition, organizations that have been in the fruit and vegetable business for years are expanding and diversifying into other businesses.

Consumption of processed potatoes at the expense of the fresh product has increased phenomenally in recent years. This is easily understood since the consumer was relieved of storing a bulky item, and of peeling and preparing the food product. However, there are indications that this trend is reversing. Use of preprocessed potatoes is declining and consumption of the fresh item has been increasing. This can be partially explained by the increase in consumption of baked potatoes and development of some imitation potato products made from cereal grains.

Cereal Grain Industry

Comments in this area will be limited mainly to human foods produced from cereal grains rather than production of these agricultural products.

Breakfast cereals

Cereals or the so-called breakfast foods have been an integral part of the average American's diet for many years. They are made mainly from wheat, corn, oats, and rice; may be rolled, shredded, flaked, puffed, or shot from guns; and may be given a variety of colors. Cereals are a source of carbohydrate and bulk in the human diet as well as a source of trinkets for children.

With the advent of vitamin and mineral fortification plus development of multi-media advertising, cereals have received attention from all segments of the population. These are very competitive products; new modifications, packages and sales gimmicks are developed almost daily. It has required the "hard sell" aimed at all age groups to build volume sales of these products in an extremely competitive business.

Recently the bubble has burst. Testimony in Federal hearings has cast doubt over nutritional claims made for many of these products. Whether these claims are right or wrong remains to be seen. Nevertheless it has created the basis for a creditability gap. How will this affect the sales and consumption of these products?

It is unlikely that there will be any immediate decline in consumption. These products are too much a part of our everyday lives to let the charge of "empty calories" take them from our tables. There probably is some justification for a few of the charges brought against the cereals. However, if their manufacturers take greater pains to make a nutritious product and use better judgment in their advertising claims, the testimony at these hearings will not have any long-range adverse effect on the cereal industry.

High lysine corn

Of all the foods that man consumes, no doubt, most calories in his diet come from cereal grains and products made from them. On a world wide basis, the greatest nutritional problem faced by man is an unbalanced diet; it is high in carbohydrate and low in protein. To partially meet this problem and to improve nutrition of our livestock, attempts are being made to develop a high-lysine corn. Thus the protein from corn would be of higher quality for both human and animal food uses.

To make this corn suitable for human food much more breeding and development must be done. Experience is showing that in most corn-eating populations the high-lysine corn developed to date is completely unacceptable. It does not make good tortillas; its flavor is unacceptable. The protein does not have the strength of that in the traditional corn, and thus the corn does not lend itself to incorporation in foods. An acceptable high-lysine corn is needed badly. As yet we don't have it.

New rice varieties

Development of the new rice varieties, IR-8 and IR-5, by the International Rice Research Institute in the Philippines has received much publicity. They are high yielding varieties and should help solve some of the world hunger problems. Since rice is the major food of about one-half of the world's population, this development offers hope for millions of people.

Yet at least two obstacles must be overcome before this rice can be produced in quantities that will be needed to make an impact in the war on hunger. The first is reluctance of the average peasant farmer to accept change. Just getting him to plant the new variety is no easy task. Secondly, to get the yields that this variety can produce requires liberal application of the proper fertilizer. Use of any fertilizer is strange to many of these farmers. Besides, fer-

tilizer costs money. These people have no money nor any mechanism for developing a line of credit to get money. This is one of the challenges of the decade ahead.

Vegetable oils

Use of vegetable oils—those obtained from soybeans and corn along with other plants—for human food has been increasing rapidly. Technological improvements in refining these oils plus partial hydrogenation to control their physical properties, along with their price advantage have contributed to their increased acceptance by the food processor. The value of polyunsaturates in the diet has been stressed to the consumer. As a result of these factors we will see the per capita consumption of these plant products increase.

Vegetable proteins

Use of plant proteins for human food is receiving much notice in the popular and the scientific press. The reports have caused a flurry of effort to develop grains with a higher protein content and the technology to isolate and convert these proteins into acceptable human foods. Success has been moderate. As yet they cannot compete with animal proteins in nutritional quality. Also there have been limitations in the ability to incorporate them into acceptable foods. When this has been most feasible, it has resulted in products that were too costly to be competitive. Great progress will be made in improvement of plant proteins for human food and in foods made from these products during the next decade. However, we do not foresee that they will completely replace animal proteins in this country for many years to come.

ENVIROMENTAL CHANGES

Before concluding this discussion on changing patterns in agriculture, it is necessary to mention a problem that faces all segments of agriculture. This is the impact of agricultural practices on the environment. The environment, particularly with respect to its pollution, is receiving much current attention. Rightly or wrongly, agriculture has been accused as one of the many environmental pollutors.

Land use, use of agricultural chemicals, and handling of animal and plant wastes are being scrutinized by those concerned with the deteriorating environment. Many critics, while well meaning, have little conception of agriculture and its responsibilities. Certainly, if agriculture is to meet the food needs of our nation and others, it will be necessary to use fertilizers, pesticides, herbicides, and other agricultural chemicals. In the process of producing food, both plant and animal wastes will result.

However, there will be many changes made in methods of handling solid and liquid wastes produced by agriculture and the food industry. Great efforts will be made to reduce their volume. Also, greater controls and discretion will be exercised in the use of agricultural chemicals. Practices relating to these activities will probably undergo greater change in the next few years than any other agricultural activity.

SOLID WASTE DISPOSAL AS A NATIONAL PROBLEM

JOHN H. ABRAHAMS, JR.

Environmental Pollution Control Programs
Glass Container Manufacturers Institute, Inc.
Washington, D. C. 20036

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ABSTRACT

Our pollution problems, including solid wastes, exist because of the indifference of many in industry, in numerous government agencies, and in the general public. As in the other forms of pollution, solid wastes have been a problem throughout recorded history. Even so, there is no valid reason why progress and good conservation practices should be incompatible. Agri-business has emerged as a powerful economic force involving a $350 billion capital investment, of which food processing and distribution account for $90 billion and 23 million people. The United States has the best food bargain in the world—but its social price may include problems from vegetable, animal, and pesticide wastes. The choice of products in our food stores has increased some eight-fold in 30 years, for the benefit of the sophisticated United States consumer. Packaging is a vital link in moving foods and other products conveniently, economically, and efficiently to the consumer. Technology is rapidly being developed to handle and recycle rural and urban wastes for beneficial uses, to reduce pollution, and to conserve our natural resources. Past and present methods are outmoded, inefficient, and wasteful. A long range approach may be a regional system in which waste products from a municipality would be salvaged and recycled, where practical, with organic wastes returned to the land in some beneficial manner.

In recent months this nation has witnessed a tremendous outcry of public concern over environmental quality. One example is last (1970) April's "Earth Day" activities which forcefully reminded all Americans that the land we live on, the water we drink, and the air we breathe must not be taken for granted. Perhaps for the first time, many people are beginning to look at themselves and the world around them from an ecological standpoint. They are awakening to the message conservationists have preached for years —that this good old earth is indeed made of finite stock and it cannot be abused forever.

Ecologists everywhere are encouraged by these trends from apathy toward reality. But I refer to true environmentalists, conservationists, and others who have worked diligently over the years for a cleaner, safer, and healthier world—not those who herald environmental concern for self-serving reasons.

In my field of interest, that of solid waste management, this increasing public awareness is welcome because it provides an opportunity for new approaches to solving our nation's emerging waste disposal problems.

Logic, of course, tells us that there is no valid reason for progress to be incompatible with good conservation practices. But until recently (when considered at all) the two aspects, *progress* and *conservation*, were thought to be on a collision course. The history of our country in this century appears to bear this out. For years our technology has been advancing rapidly, yet most of us have been too busy to worry about its effects upon the environment. Those rare warning voices in the wilderness were not heard above the factory whistles, the rhetoric of election campaigns, or the indifferences of the polluting public.

Solid waste disposal, for example, is a problem as old as mankind, but only in our modern age has it been recognized as potentially serious. It merits national priority not only because of the extreme difficulties to be resolved—ones that average citizens create and perpetuate—but also because of its far-reaching implications with respect to environmental quality and conservation of natural resources.

Any attempts to solve our waste disposal dilemma must necessarily be based upon a realistic understanding of the problem, its causes, and the complexities surrounding it. We need turn the clock back only three decades to see the emergence of socio-economic trends which combine to produce a powerful effect upon our present way of life. Consider the population explosion. Since World War II, there has been unprecedented growth in our population—some 20 million within the past 10 years alone.

A significant parallel to this expanding population has been the movement toward suburban areas. This urbanization process is continuing at an alarming rate. In fact, 70% of our people now live on only 2% of the land. As examples, the population of Prince Georges County, Maryland (part of the Washington, D. C. Metropolitan Area), has increased 80% during the last 10 years, and it doubled in Orange County, California while one-half of the nation's 3,100 counties actually showed population decreases.

Compounding the problems of population increase and urbanization is the fact that the average United States citizen generates about 1800 lb. of solid waste annually. Further, studies have shown that per capita generation of wastes is directly proportional to population density. So, it seems reasonable to conclude that some areas of our country have outgrown existing utilities and services—including, but not

limited to those for disposal of solid wastes. In my own area of Washington, D. C., to cite a specific example, our suburban counties are facing a sewage problem of major magnitude. There also looms the impending national power crisis. In short, practically all problems which traditionally affect large metropolitan areas continue to increase.

The technological explosion has been an economic boom for practically everyone, and the post-war revolution in our nation's scientific and manufacturing skills has opened dramatic new vistas for industry and consumer alike. We have literally been deluged in recent years by a wave of new and improved products designed to meet the more sophisticated needs of a larger, more affluent population.

Thus it is puzzling to find that during this dynamic period in history in which man and his talents have brought our productive resources to an all-time high level, modern technology has had a comparatively negligible impact on waste disposal methods and techniques. The problems went largely unrecognized. With but few exceptions the same tired, worn, antiquated, and inadequate methods used for hundreds of years remained static.

According to Donald N. Frey, Chairman of the Ad Hoc Committee on Solid Waste Management, National Academy of Engineering-National Academy of Sciences: "Much of the problem in solid waste management derives from the continued reluctance of those concerned to come to grips with it and to apply existing technology, systems, and organizational know-how to its solution" *(18)*. Mr. Frey's committee found that, "in general, local operating agencies are not applying available technology on a systematic basis."

And Mr. Frey is not alone in his assessment. A recent study by a well-known research organization reported that more than one-half of the public works officials interviewed believed that there have been few meaningful changes in collection and disposal techniques during recent years. The traditional garbage man and his truck, for example, has been collecting refuse much in the same way for untold decades. In disposal, burning and burying are still the order of the day. But as a principal disposal method, solid waste landfill must be viewed as a short-term solution, particularly in urban areas where the amount of land available is constantly dwindling.

It is obvious that these outdated methods of waste disposal are unable to cope with the wastes of modern society today. Fortunately, the scientific and engineering communities in industry and government alike are beginning to understand the problem. It is complex and serious, but I do not concur with those prophets of doom who predict we will soon be buried in our own garbage. It is my firm conviction that the problem will be solved when the same efficiencies that exist in the manufacturing, production, and distribution of our national output are used to develop newer and better collection systems; when we recycle usable waste materials; and when we manage the situation intelligently with a concerted effort on the part of both government and industry.

OUR GROWING AGRI-BUSINESS

As part of our modern technological revolution, American business geared up for peace-time production as never before. This refers not only to the manufacturing industries, but also to "agri-business" which contributes much towards improving our lives.

Agri-business today is a powerful economic force involving a $350 billion capital investment. Of this amount, food processing and distribution account for more than $90 billion *(8)*. Some 23 million people, including farmers, packers, processors, warehouse operators, wholesalers, and retailers, are employed in an industry which gets food where and when it is needed, in desired forms and at a comparatively low cost. We have food in great abundance with high quality and as Secretary of Agriculture Clifford Hardin recently pointed out, food today is "a better buy than ever before in this or any other country." Food prices, he reported, have risen less than three-fourths as much as all other consumer goods in the past 10 years. Also, Americans pay a smaller share of their income for food than any other people. Only 16.5 cents out of every consumer dollar goes for food, compared to 20 cents in Canada, 37 cents in Western Europe and Japan, 50 cents in Russia, and 60 cents or more in newly developing countries *(9)*.

But what social price, if any, must we pay for these advancements? To cite one example, it is ironic that the same pesticides which helped us achieve this remarkable record are now under attack. It seems catastrophic for our agricultural industry to reduce pesticide use to where insects, weeds, and disease reduce our food output. The U. S. Department of Agriculture stated recently that "pesticides are, have been, and will continue to be major weapons in man's battle for food production" *(16)*. Complicating this is the problem of disposing of pesticide containers and unused pesticides which cannot be dumped or burned without creating a potential pollution hazard. To overcome some of these problems, the USDA is developing new moisture-degrading polymers with controlled rates of release to reduce the rates of application, volatility, drift, and residue, and limit possible pollution *(17)*. Similarly, the Food and Agriculture Organization

(FOA) of the United Nations feels there is an urgent need to develop integrated control measures, including biological control and other alternatives to pesticides *(7)*.

Even agricultural materials, both vegetable and animal wastes, are heavy contributors to the overall solid waste problem. Referring to vegetable wastes, Walter Mercer of the National Canners Association reports that for every 100 lb. of raw food processed in the United States, about 36 lb. end up as waste at the cannery. Of this amount, only 19 lb. can be recovered and reprocessed. The remaining 17 lb. must be disposed of by the canner *(14)*. Under past marketing systems, however, most of the 36 lb. of cannery waste would have gone through to the consumer and ultimately to the municipalities for disposal.

Figures by Mr. Mercer show that about one-half of the annual vegetable and fruit crops are processed. More specifically, he notes that about 90% of all beets are canned; as are 80% of all tomatoes; 60% of peas, green beans, and sweet corn; 75% of all asparagus, lima beans, and leafy vegetables; and 70% of all apricots, cranberries, and pears.

The seasonal nature of many of these crops causes difficulties in providing proper waste disposal. August, September, and October are peak months for canners and frozen food processors and therefore also the peak waste-producing months. Fully 68% of the processors' total annual waste is generated during this period. To study this and similar problems in food distribution systems, the USDA is sponsoring projects to determine effective systems for handling and disposing of trash and garbage at wholesale food distribution centers.

Livestock wastes are yet another problem. Dr. William P. Martin, writing in a recent issue of the *Journal of Soil and Water Conservation*, proposes that the only logical way in which livestock wastes can be used effectively is through the soil system. He maintains that we should use the soil as a medium for both solid and liquid waste utilization, and suggested a soil survey as a means of identifying areas best suited for disposal or reuse *(13)*.

Dr. Hans Lansberg of Resources for the Future, Inc., provides further proof that our solid waste problems can be tied in part to our more affluent society. Dr. Lansberg states that our beef consumption would have risen about 35% in the last 20 years if it were based on population growth alone. However, beef consumption jumped more than 120% during that period, largely because new uses developed for the product met with public acceptance *(10)*.

Little wonder then that our commercial feedlots are creating new environmental problems. But for all its contributions to the solid waste problem, no one among us would seriously consider curtailing our agricultural output. Rather, we are more apt to agree with Secretary Hardin who states: "America's agricultural base, and its increasing integration with industrial enterprise, represents a rather unique national asset that few other countries possess" *(9)*.

To judge how unique that national asset is, you need only stroll through your neighborhood supermarket which handles in excess of 8000 products, most of them food items produced to meet the ever-changing needs of the American consumer. In this respect, agriculture and packaging are closely related. Many foods need special packaging for protection over thousands of miles of transportation or from one growing season to another. Food processing today uses a wide selection of packaging materials, equipment, and techniques to market agricultural products. In fact, the *1969 Yearbook of Agriculture* states: "Packaging has become so vital to the success of a product that the proper material and type of package to be used is generally decided upon simultaneously with the development of the new item" *(8)*.

Besides product protection, foremost among consumer requirements is the desire for convenience. "As we have become more affluent," states the *Yearbook*, "we have not only demanded higher quality foods, but foods with built-in chef service and convenience features. Foods are packaged in containers of various sizes, shapes, and composition to meet family needs and to provide maximum convenience and storage in the home" *(10)*.

But it is more than just convenience. Rutgers University is making studies of various food delivery systems and their effectiveness in middle and low income groups. Some 10.4 million children and adults from needy families will benefit *(11)*. Packaging, therefore, in a very real sense has become agriculture's best ally.

MODERN PACKAGING TECHNOLOGY

The packaging industry today, like agriculture, has been among the most technologically progressive in meeting customer requirements. To cite but one example, consider the single-service container, an innovative marvel that gives our society a freedom and flexibility never before possible. It certainly seems unreasonable that modern packaging concepts with their outstanding contributions to our advanced civilization should be outlawed merely to accommodate old-fashioned and inefficient waste collection systems. Instead, I believe these systems should be upgraded to make them compatible with the new materials now being channeled into the marketplace. Similarly, manufacturers should under-

stand the problem involved in handling these materials after use.

But on the surface there appears to be a sharp difference between the aims of the package manufacturer, who must provide packages that will effectively contain and protect the products of industry, and those of the waste processor, who is ultimately responsible for their disposal. Fortunately, this apparent conflict is reconcilable. Many municipal governments are looking to more modern and effective waste management methods. Technology is fast being developed to separate the many useful components of refuse and processing them for recycling back into the nation's economy. Technology, in fact, is the name of the game.

The Midwest Research Institute, in a recently completed study of the role of packaging in solid waste management *(6)*, reveals that "most of the difficulties created by packaging are due to inadequate technology or the absence of technology in waste disposal." Further, in this report commissioned by the U. S. Public Health Service, it is stated that "one of the real bottlenecks" in waste handling and reuse is the "absence of systems which could selectively and automatically separate wastes."

Certainly part of the problem is that the character of refuse has changed radically in recent years. Once solid waste consisted principally of food waste and ashes from coal burning furnaces. Today these items are no longer major factors, having been replaced by vast quantities of paper, packages, discarded appliances, and the like. Thus the problem is primarily one of materials handling rather than a problem of health control. As such, our programs of the future should be developed and administered by those who are knowledgeable in materials handling technology.

GLASS CONTAINERS AND THE ENVIRONMENT

Glass is an example of a material presenting little or no disposal problems when handled properly and it is no exaggeration to say that for many products, especially agricultural ones, glass makes the ideal package. Because it is chemically inert, it will not react to the materials it contains, thereby insuring purity and freshness. From a marketing and design standpoint, it provides utmost product visibility and can be formed in a limitless number of shapes to suit almost any product.

With respect to pollution, glass also can be considered an optimum packaging material. Not only is the manufacture of glass a relatively clean operation with respect to air and water pollution, it causes no land pollution. Glass is made of highly noncritical raw materials that abound in nature—silica sand, limestone, and soda ash. Sand accounts for 73% of the composition of container glass. Mass production of bottles, therefore, presents no threat to America's natural resources, and properly crushed in disposal processes, glass fragments return to the soil in virtually their original state *(4)*.

It is noteworthy that glass containers create no significant problems in the three most common methods of waste disposal. Scientific studies show that glass fragments contribute to a firm landfill and cause no discernible leaching. Glass bottles break up readily during incineration to help aerate the furnace charge, enhancing the efficiency of the combustion process. In compost, crushed glass provides a valuable soil conditioner.

Further, glass constitutes an average of only about 6 to 7% by weight of residential solid waste. The volume is negligible if the containers are properly ground for disposal. More significant, glass containers are one of the most recyclable of all packaging materials. This is important because a number of scientific studies confirm that the industrial economy of the United States must undergo a shift from a use and discard approach to a closed cycle of use and salvage, reprocess and reuse.

Research carried out by the Glass Container Manufacturers Institute, Inc., (GCMI) and others already has uncovered uses for every bit of waste glass generated in the country now or in the foreseeable future. The most promising immediate outlet for waste glass appears to be in the bottle-making process itself. In fact, no waste glass ever leaves the container plant to be part of the solid waste accumulation. GCMI's studies indicate that crushed glass (cullet) can supply 30% or more of the raw materials needed to make new bottles. This figure has been set as a salvage goal for industry achievement.

This last June 30th, the nation's glass container manufacturers launched an industry-wide bottle redemption program whereby used bottles and jars are purchased to be crushed, melted, and reprocessed into new ones. At present, GCMI member companies are operating a network of nearly 100 bottle redemption centers at glass container plants in some 25 states, coast to coast.

The glass container industry is working closely with the U. S. Bureau of Mines which has successfully developed a process utilizing ore-dressing methods to separate usable materials from incinerator residue *(5)*. Sorted by color and refined, glass from incinerator residue could be used as cullet to make new bottles. In addition, the Bureau's Ceramic Laboratory at Tuscaloosa, Alabama has developed the technology for converting waste glass obtained from incinerator residue into structural products such as bricks, build-

ing blocks, and glass wool insulation.

An even larger potential exists in the use of crushed waste glass as aggregate in "glasphalt," a product being developed by the University of Missouri at Rolla, Missouri, in which glass substitutes for crushed limestone in asphalt for paving streets *(12)*. This research is funded by the Bureau of Solid Waste Management, U. S. Public Health Service, and supported by materials and services furnished by GCMI. Studies show that the need for such aggregate in most cities far exceed the quantity of glass locally available from waste disposal systems *(2)*. The use of waste glass in glasphalt would most likely be limited to patching and maintenance work on roads in and around municipalities rather than in new construction. But this, too, is advantageous because most municipalities have their own hot-batch asphalt plants and need only to remove the waste glass from their own refuse for repair purposes.

Sections of roadway have been paved with glasphalt on the premises of GCMI member company plants at Toledo, Ohio and Winchester, Indiana, with the largest, a road 525 ft long by 20 ft at the University's Rolla campus.

Paving with glasphalt, however, is still considered experimental and research on gradation, mixtures, and binders is continuing. Glasphalt has successfully passed all tests to date and we believe this new material will be a development of major commercial value.

DAIRY PACKAGING

Certainly glasphalt, glass bricks, and glass wool made from waste glass are part of our new technology. Our economy is changing too, and with it our foods and our life styles. And, I might add, generally for the better.

But the dairy industry itself presents an excellent example of the trend toward convenience containers —the milk bottle. It represents an ideal form of reusable packaging. Yet, the returnable glass milk bottle seems well on the way to becoming extinct. Fewer and fewer dairies today use the returnable bottle because of increased resistance on the part of both retailers and consumers toward returning and handling the empties. The glass container industry did not develop a non-returnable milk bottle and subsequently lost almost the entire market to other packaging materials, principally polyetheylene impregnated milk cartons and more recently plastic bottles.

Each of these containers, however, has its own particular problems when it comes to recycling. Concerning paper products, Wayne Carr of the Forest Products Laboratory, Madison, Wisconsin, says: "Because of consumer demand, the paper and board industry has placed increasing quantities of additives in their products, which lead to greater difficulties in the recycling of these products. Additives are considered as 'contaminants' by the secondary fiber industry" *(3)*.

The paper used in the polyetheylene impregnated milk carton, incidentally, is made from the highest quality wood fiber. It is a potentially valuable resource going to waste because of the high cost of separating the fiber from the plastic coating.

Plastics have made great inroads in the packaging industry in recent years and the dairy industry is no exception. One example is the disposable plastic bottle called "poly-trip" which, as the name implies, is returned to the dairy, cleaned, filled, and distributed again *(19)*; and the relatively new plastic pouch which reportedly occupies about 40% less space in showcases. Unfortunately, it has been found that most of these plastics are not suitable for secondary refabrication.

In England there is now a trend toward a rectangular milk carton laminated on the outside and lined with plastic on the inside. This carton is said to be the latest development in aseptic packaging and reportedly keeps milk fresh for up to 6 months without refrigeration. The recycling or disposal aspects of this package are not known, but the concept of aseptic packaging could lead to a new system of centralized transportation centers *(15)*.

PROPOSED SOLUTIONS TO THE PROBLEM

One proposal that is frequently advanced by those calling for discriminatory legislation against one-trip containers is that packages should be made of materials that readily decompose when discarded. This is not a viable solution since the process of decomposition only threatens to shift the problem to one of pollution of the air, land, or water. Discarded packages cluttering our roadsides and while gradually decomposing may be more difficult and costly to pick up than present packaging. Moreover, the decomposing material may present a health hazard.

Another point not generally considered by proponents of "ban-the-bottle" type legislation is that most glass containers are not soft drink or beer bottles. They are baby food jars, peanut butter jars, jam and jelly glasses, ketchup and salad dressing bottles, pickle jars, and so on almost endlessly. These containers are now and have always been one-way, no-return convenience items.

Another proposal put forth as a possible countermeasure is to impose a so-called "deterrent tax" on

non-returnable containers to limit their sales appeal. The basic problem, says the Midwest Research Institute *(6)*, is that such a tax "would of necessity be discriminatory since it would be imposed selectively." If glass and metals are taxed, says the report, the levy would "almost always be passed on to the consumer and would not act as a deterrent."

Concerning a use tax, the report states that it would be impossible to determine the level of the tax levied; it would not reduce waste quantities, nor eliminate waste of natural resources; may be a license to pollute, and would need elaborate machinery to administer.

With respect to the overall waste situation, there are more than a score of new refuse management systems presently in various stages of development by the private sector. These include volume reduction by high temperature incineration with a potentially reusable by-product of slag; composting methods which incorporate all refuse into a useful soil conditioner, and separation techniques recovering some of all usable materials in refuse *(1)*.

The basic technology of mechanical separation is available today. What's lacking is a market and, here, federal and state governments must assist. Perhaps a partnership between industry and government is called for in this respect. Markets, however, are difficult to develop without a dependable and uncontaminated supply of these materials if they are to be used as raw materials for industry. Conversely, municipalities should not be put in a position of developing markets for the utilization of wastes, but should be developing the right atmosphere to make market development feasible.

In summary, there are no simple solutions to the solid waste disposal problem. Nor can any one industry or government agency be singled out as the villain. Rather, we are all in it together. As Walt Kelly's famous cartoon character, "Pogo," says: "We have met the enemy, and they is us."

I feel that the most promising long-range answer may lie in adopting a comprehensive systems and regional approach towards the reuse of discarded resources. But this will require a great deal of study, planning, and cooperation on the part of individual citizens, industry, and municipal and federal governments.

Such an approach is based on the idea that consumable material converges on the city from all directions, near and far, is used beneficially and subsequently becomes waste. Today, we destroy that material by burning or burying it, and using up suburban land. Our more reuseable waste materials such as glass, metals, and paper, should be reclaimed and recycled by industry. The remaining organic and mineral wastes might be shipped back to the rural areas in some beneficial form, such as compost or fertilizer for land reclamation. Additional costs incurred by processing could be offset by sale of usable materials, decreased cost of disposal, and better use of land which would result for such a program. In this way, we would achieve near total conservation of our natural resources and render pollution from solid wastes virtually extinct.

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WHAT CAN WE LEARN ABOUT SANITATION FROM OTHER COUNTRIES?[1]

C. K. JOHNS

Lazarus Laboratories, Inc., Long Island City, N.Y. and Lazarus Laboratories (Canada) Ltd., Toronto, Ontario

ABSTRACT

The value of regulatory standards for foods in improving sanitation and protecting the consumer is illustrated with reference to various products. The importance of educating and training plant personnel is stressed. Simplified procedures for cleaning and sanitizingequipment are described.

In determining the sanitary quality of milk, the need for a lower incubation temperature is indicated, and reference is made to a number of new tests recently described. In mastitis control, the encouraging results obtained from teat dipping, combined with dry-cow treatment, are mentioned, together with the value of marker dyes in intramammary antibiotic preparations and of a simple test for inhibitory substances in milk.

My knowledge of sanitation is largely confined to the dairy industry, and especially the farm end. Consequently, this paper devotes only limited attention to the non-dairy aspects of sanitation. However, since the dairy industry has been the leader in this field, perhaps some of my remarks will have application in other areas.

STANDARDS FOR FOODS

One thing we can learn from other countries—if we don't already appreciate it—is the value of regulatory standards for foods. A striking illustration of this is with tomato paste, considerable quantities of which are imported into North America from Italy. Some plants there have two lines to handle incoming tomatoes. On one, tomatoes are carefully inspected and any showing mold or rot are culled. The product from this line goes to Canada and the United States, which have standards limiting the number of mold hyphae permitted. On the other line, little or no attempt is made to cull substandard tomatoes; the product goes to countries without regulatory standards. So the North American consumer benefits from this regulatory testing and control.

Regulatory standards for dairy products also have brought about significant improvements in plant sanitation. In New Zealand 91% of the milk is used for manufacturing and the export of dairy products is vitally important. Until recently most of these went to Britain, but of late New Zealand has been working hard to develop markets in other countries such as Japan, Israel, and the U. S. Some of these countries have very stringent requirements, such as coliform-free unsalted butter, Cheddar cheese free from coliforms and coagulase-positive staphylococci, dry milks free from salmonella, etc. Meeting these requirements has put considerable pressure on some factory managers, who were previously rather indifferent, to improve plant sanitation. This also has been true in Australia, which is seeking new markets to replace Britain.

Another example of the value of regulatory standards is found in Canadian Cheddar cheese. Complaints about extraneous matter in 1942 stimulated Ontario and Quebec to start a program of testing. In 1951 the Canada Department of Agriculture assumed responsibility for testing all cheese made in Canada. At first emphasis was upon education of producers and cheesemakers. This brought a very limited return. So in 1955 premiums paid for First Grade Cheddar were limited to those with No. 1 or No. 2 sediment discs. Even this was less effective than had been hoped. Finally, in 1957 regulations were amended requiring a No. 1 or No. 2 disc in order for cheese to be classed as First Grade. This really "hit the pocketbook nerve" and by 1958 "unsatisfactory" sediment discs had declined from 54.51% in 1954 to 2.28% *(11)*. (It may be of interest that all official grading of dairy products has been done by the Canada Department of Agriculture for nearly 50 years. This has promoted uniformity across the country)

EDUCATION OF PLANT PERSONNEL

While regulations are valuable, if high standards of sanitation are to be expected it is highly important that personnel in the food industry be properly trained and supervised. An excellent illustration is found in South Korea, where food processing plants have reached a level of sanitation comparing favorably with the best in North America *(3)*. This is attributed largely to the training received by native food technologists at the training school in Mysore, India, operated by Canada as part of her program for helping under-developed countries.

The importance of thorough training of plant personnel is fully realized in Denmark, too. Here a young man planning to enter the dairy industry must

[1]Presented at the 57th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Cedar Rapids, Iowa, August 17-20, 1970.

[2]In 1967 the average price paid for manufacturing milk was around $2.35 per cwt.

serve an apprenticeship for 3 years in at least two plants. So that each apprentice may receive adequate instruction and supervision, the number of apprentices per plant is limited. During this period apprentices also attend night school. Finally, they must take a 6-month course at a dairy school. During the course of their training they receive adequate instruction on the need for good sanitation, and a visit to a Danish dairy plant, with its gleaming stainless steel equipment, tiled walls, etc., is a heartening experience.

The need for training on the farm, as well as in the plant, is well recognized in the Netherlands. Here, in addition to instruction in plant operations, schools are held to teach proper milking procedures. Such instruction could be valuable here in North America, too.

FLUID AND MANUFACTURING—GRADE MILK

On this continent there is often a great contrast between conditions under which Grade A and manufacturing milk supplies are produced. If the consumer saw some of the farms producing manufacturing milk she might well turn away from dairy products for life! In Australia and New Zealand, however, I could never tell whether a farm was shipping milk for bottling or for manufacturing. Except that milk for bottling had to be cooled to a lower temperature, there appeared to be no difference in requirements for cow and equipment cleanliness, concrete holding areas, milking parlors, milkhouses, etc. Without exception they made a good impression on the visitor. This also was true in the European countries I have visited. Perhaps we could learn something here.

BULK TANKS

Unlike those in other countries, the New Zealand dairy farmer gets no help in the form of a support price or subsidy for his milk.[2] Since he is both producer and processer he is acutely conscious of the need to keep down costs of production, processing, and marketing. Their farm bulk tanks, built to a standard design in their own factory, are much cheaper than ours, and are fitted with 2.5 inch outlets. The tanker driver is able to pump 5,000 lb of milk out and be on his way in 4 to 5 min! And with their moderate temperature range, intensive dairying and short hauls, farm tankers need not be insulated. One feature I did not like was the use of a gauge tube in place of a dip stick for measuring the contents of the tank. I would much prefer seeing milk metered out of the bulk tank as in Sweden and Scotland.

In New Zealand in 1967 all farm bulk tanks I saw were cleaned manually. With larger tanks a man climbed inside to wash them. To find a less laborious, more efficient way, Alan Twomey at Ruakura Animal Research Centre developed a "one shot" procedure. When the tank has been drained, the driver, who is prohibited by union rules from rinsing out the tank, presses a button. This starts an electric pump which proceeds to spray 5 gal of cold iodine complex (25 ppm available iodine) onto the milky surface of the tank interior. When all the solution has been used the pump shuts itself off. At his convenience the farmer opens the outlet valve, drains out the cleaning and sanitizing solution and is ready for the next milking. It seemed incredible that this procedure would clean a vat which had been filled with Jersey milk, but several I inspected were in very satisfactory condition. Since then Twomey has successfully applied the same procedure to milk and cream storage vats. Swab tests have shown the interior surfaces to be practically sterile.

PIPELINE MILKERS

For many years the officially recommended procedure for washing pipeline milkers in New Zealand called for the use of near-boiling water containing 0.05% caustic soda. (For this purpose water heaters had to be set at 196 F or higher!) Despite the soft water in most areas this procedure naturally led to the formation of heavy deposits of milkstone. In 1952 Whittlestone developed the Ruakura Dairy Cleaner, a balanced alkaline detergent. This, when combined with weekly use of an acid-type cleaner, did a much better job. However, in certain areas some milkstone still developed. When the "Tamed Iodine" products became available, Whittlestone substituted a sanitizing rinse with 25 ppm iodine for the hypochlorite previously used. This gave superior results bacteriologically, prevented milkstone formation and eliminated the need for the weekly treatment with an acid-type cleaner. Results were so good that this procedure was soon in use all over Australia and New Zealand. An additional step found to be most valuable is the incorporation of 0.03% of a *suitable* non-ionic wetting agent in the initial cold water rinse *(5)*. (A similar practice was advocated by Levowitz *(8)* back in 1950.) This too is now officially recommended all over Australia and New Zealand.

More recently an even simpler procedure has been developed at Ruakura for cleaning and sanitizing pipeline milkers. Immediately after the last cow is milked, cold water containing wetting agent is drawn through the line via the clusters until it runs clear. Then the line and clusters are filled with warm iodine complex (25 ppm iodine) and left filled until

just before the next milking, when the solution is drained out and the equipment used without any further treatment. This simple procedure produces very satisfactory results with a considerable saving in time, labor, and materials.

Another recommendation "Down Under" is that milker rubberware should not be brushed; all brushing does is to roughen the surface of the rubber and make it harder to keep in sanitary condition. I was greatly interested in this, for in 1929 we published results of studies at Ottawa which showed consistently lower total and coliform counts with "flush" washing than with dismantling completely and brushing *(7)*. French researchers have reported similar findings *(14)*. Yet in North America some regulatory officials still insist on clusters being disassembled and rubberware brushed after each milking!

EFFECTIVENESS OF DETERGENTS AND SANITIZERS

Nowdays consumer protection is getting a lot of attention. In most countries the dairyman has to rely largely upon the reputation of the sanitation chemical manufacturer when deciding which product to buy. Not so "Down Under!" While he was in Australia, Whittlestone developed an ingenious "Milking Simulator" *(20)*. This apparatus enables the investigator to measure the effectiveness of various types of detergents and sanitizers, furnishing more information, with complete control of concentration, temperature, time, etc., in less than two days that could be obtained during a month's milking and cleaning on a farm. This "Milking Simulator," in use in Australia and New Zealand, enables advisory officers to warn producers against substandard products. In New Zealand, too, the Standards Association was considering establishing specifications for iodine complexes on the basis of iodine and acid contents, also vapor pressure, the latter being a valuable indication of the stability of the product. Such standards would be welcomed by reputable manufacturers who face increasing competition, price-wise, from "backyard operators" planning to cash in on the growing popularity of iodine products for dairy and food sanitation.

BACTERIOLOGICAL TESTS

The choice of tests for determining the bacteriological quality of milk is a matter of concern in many countries where farm bulk tanks are in use. Outside of North America and Scotland dye reduction tests, principally the methylene blue test, are still widely used, although their inadequacy is generally recognized. Preliminary incubation (PI) is being employed officially in New South Wales and in New Zealand to improve the correlation between reduction times and plate counts. Of great significance is the discovery by workers at Ruakura *(19)* that this correlation is greatly improved when reduction tests are run at 30 C instead of 37 C. (The lower temperature is obviously better suited to the growth of psychrotrophs, the most important group of saprophytes in milk today.). They also found a modified nitrate reduction test superior to the methylene blue test *(19)* and have developed a new test for thermoduric bacteria *(18)*. After laboratory pasteurization the samples containing nitrate-formate are subjected to PI at 22 C for 16 hr, then incubated at 30 C for 6 hr. This test detected 92% of samples with LPCs in excess of 5,000/ml much faster and more cheaply than by the plating method.

The limited value of counts on freshly pasteurized samples is now generally recognized. Here we have lagged behind our European brothers. Back in 1956 I found plants in the Netherlands and Denmark holding samples at 18 C for 24 to 48 hr before running tests. Plant sanitation was so good that they considered it a waste of time to conduct tests on fresh products. But we still have plants and regulatory laboratories who conduct coliform counts in the vain hope that they will detect post-pasteurization contaminations at levels meaningful today. It should also be noted that in Britain the need of some form of PI for raw milks was recognized nearly 40 years ago, and officially adopted in 1937.

MASTITIS

Mastitis control has been a matter of concern to sanitarians for many years. At last there appears to be good reason to feel that progress has been made. Workers at the National Institute for Research in Dairying in England have clearly shown by extensive field trials the value of *(a)* teat dipping and *(b)* dry cow treatment *(12)*. Teat dipping is being adopted by progressive producers, but the proven effectiveness of dry cow treatment with long-lasting antibiotic preparations cannot be taken advantage of until the Food and Drug Administration overcome their reluctance to allow the use of such products.

The value of incorporating a marker dye in antibiotic preparations for mastitis has been clearly shown in Victoria, Australia, where regulations requiring this in all penicillin-containing preparations were passed in 1960 *(2)*. Similar regulations covering all antibiotic preparations have gone into effect in New South Wales more recently. There too there has been a gratifying decrease in the percentage of samples showing antibiotic residues. The possible dangers attending the use of suitable marker dyes appear to be much less important than the haz-

ard of allergic reactions to penicillin residues by some consumers.

In New Zealand, as a result of difficulties encountered in the manufacture of cheese, casein, yogurt and starter butter where milk contained antibiotic residues, all plants are required to test for their presence every 10 days. (Some test 5 days a week!) As few factories had trained personnel and facilities for conducting more sophisticated tests, a very simple procedure was developed at the Dairy Research Institute *(10)*. In this a cotton pellet impregnated with brom-cresol purple and *Streptococcus thermophilus* is shaken with 10 ml of milk which is incubated at 45 C. Tubes are examined after 6 and 22 hr. Where more than 0.05 I.U./ml of penicillin is found the producer suffers a price cut of from 25 to 50% for the 10-day period. This program has been extremely effective in reducing the levels of residual antibiotics, with concomitant reduction in the incidence of difficulties associated with slow and irregular rates of acid production. Incidentally, the test will detect concentrations of penicillin as low as 0.003 I.U./ml.

One more word on mastitis. A recent report from Phillips et al. *(13)* in New Zealand could revolutionize our approach to mastitis control. This suggests that the foremilk contained in the teat sinus at the time of pre-milking preparation may play an important part in the spread of mastitis organisms in the udder. By careful removal of the foremilk they reduced the incidence of new infections in 540 cows by over two-thirds during a 6-month period.

MEASURING INSANITARY MILK PRODUCTION

In North America we have generally relied upon the measurement of the bacterial content of the milk itself to indicate insanitary production conditions. Because of the huge dilution factor, the insensitivity of such tests applied to fresh milk has long been recognized in Britain. There greater emphasis has been placed upon PI and on swab and rinse tests of milk-handling equipment. Richard and Auclair *(15)* in France also have shown that because of the enormous dilution there is little correlation between pulsating rinse counts on bucket-type milkers and those on the milk until the former exceed 100,000,000/unit!

Here in North America there is a growing dissatisfaction with the Standard Plate Count (SPC) for reflecting production conditions. One reason for this may be our reluctance to adopt an incubation temperature more favorable to the growth of psychrotrophic bacteria. There is increasing evidence that 32 C is too high for some of these important spoilage organisms; in some instances the SPC is less than one-tenth of the psychrotroph count *(6)*. In 1958 a committee of the International Dairy Federation (IDF) recommended that 30 C for 72 hr be employed for plate counts on fluid products *(4)*. More recently this temperature and incubation period also have been recommended for dry milks, while we in the 12th edition of *Standard Methods for the Examination of Dairy Products* reduced the incubation period at 32 C from 72 to 48 hr! The IDF-recommended temperature and incubation period appears to have been adopted quite generally in other countries; it would appear that we in North America have been dragging our feet here.

NEW TESTS

While the need for simpler, cheaper, and more effective methods of testing raw milk is gradually being recognized in North America, other countries seem to be doing more in developing such tests. The Water Agar Test of Taylor in Scotland appears to have real possibilities *(16)*. Loane in Australia has developed a useful test based upon catalase production *(9)*. The nitrate and nitrate-formate reduction tests developed in New Zealand have already been mentioned. And finally we have the use of the Coulter counter for rapid, accurate determination of the colony count of milk as suggested by Tolle et al. in West Germany *(17)*. With this procedure two technicians can run from 500 to 1,000 samples per day, and have the counts made after 20 hr incubation at 20-22 C. With a lower incubation temperature this procedure also can be used to make a count of psychrotrophs. This may very well make the tests currently in use as obsolete as the ox-cart.

One promising procedure developed at the University of Saskatchewan by Blankenagel and Okella-Umo *(1)* should not be overlooked. Since organisms tolerant of 0.5% sodium desoxycholate are rarely found in the udder, they propose using the number of these organisms as an index of production conditions. Preliminary studies suggest that this test, with incubation at 25 C, may be a very useful supplement to the SPC.

SOME OTHER ITEMS

There are two other items of interest. The first concerns sanitary piping which according to 3A standards must be polished to a smooth finish. This leaves a multitude of tiny scratches on the surfaces. Whittlestone suspected these would encourage milkstone formation. When compared with unpolished piping, tests proved that he was right. Would we not have cleaner equipment—and cheaper—if the polishing were eliminated?

The second item concerns clean milk production. A top quality milk should be essentially free from

visible dirt or sediment. In Switzerland straining of milk on the farm is prohibited. They want the dirt *kept out*, not strained out. Yet many milk ordinances, including the U. S. Public Health Service's Grade A Pasteurized Milk Ordinance, don't even mention sediment testing, which at least shows up the worst offenders.

And, to show the other side of the coin, I believe it is appropriate to mention that other countries would be much better off if they had something very valuable for which this Association can take a great deal of credit—our 3A standards for dairy and food equipment.

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3-A SANITARY STANDARDS FOR FLOW METERS FOR MILK AND LIQUID MILK PRODUCTS

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

A.

SCOPE

A.1

These standards cover the sanitary aspects of flow meters for milk and liquid milk products, and include that portion of any device integral with the meter such as strainers, temperature sensors and density sensors, which is in contact with the flowing product. It does not pertain to meters designed to measure the milk from an individual milking animal.

A.2

In order to conform with these 3-A Sanitary Standards, flow meters shall comply with the following design, material and fabrication criteria.

B.

DEFINITIONS

B.1

Flow Meter: A device to measure the flow of milk and liquid milk products.

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

Engineering Plating: Shall mean plated to specific dimensions or processed to specified dimensions after plating.[1]

B.4

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

C.

MATERIALS

C.1

All product contact surfaces shall be of stainless steel of the AISI 300 series[2] or corresponding ACI[3] types (See Appendix, Section E.), or equally corrosion-resistant metal that is non-toxic and non-absorbent, except that:

C.1.1

Rotors of turbine-type meters may also be made of non-toxic hardenable, corrosion-resistant stainless metal (400 series stainless steel, or equivalent) or these materials covered with an engineering plating of nickel, chromium or an equally corrosion-resistant, non-toxic metal.

C.1.2

Shafts and sleeve bearings may also be made of non-toxic, corrosion-resistant tungsten carbide.

C.1.3

Rubber and rubber-like materials may be used for gaskets, seals, meter bodies, meter body liners, magnet carriers, meter valve members, coating, ro-

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[1]QQ-C-320—Federal Specification for Chromium Plating (Electrodeposited), July 26, 1954. (For sale by the Superintendent of Documents, U. S. Government Printing, Washington, D. C. 20402.)

[2]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 & Steel Institute, 633 3rd Ave., New York, N.Y. 10017.

[3]Alloy Casting Institute, 300 Madison Avenue, New York, N. Y. 10017.

tors, pistons, bearings, shafts and parts used in similar applications. These materials shall comply with 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, Serial #1800."

C.1.4

Plastic materials may be used for gaskets, seals, meter bodies, meter body liners, magnet carriers, meter valve members, coatings, rotors, pistons, bearings, shafts, and parts used in similar applications. These materials shall comply with the applicable provisions of the "3-A Sanitary Standards for Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment, Serial #2000", as amended.

C.1.5

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

C.1.6

Pistons and rotors may also be made of hard rubber (a vulcanized rubber having a ratio of combined sulfur to rubber hydrocarbon in excess of 15% and a Shore A Durometer value in excess of 90) that is non-toxic and relatively resistant to abrasion, will maintain its original characteristics such as form, shape and dimensions and will not affect the product and shall when subjected to the test regimen set forth in the "3-A Sanitary Standards for Multiple-Use Plastic Materials Used as Product Contact Surfaces for Dairy Equipment, Serial #2000", as amended, (a) comply with the criteria in Section I (1) and Section I (3), (b) have maximum weight gains as set forth in Section I (2) of 0.30 in the Cleanability Response, and 0.30 in Product Treatment with Solution I and 0.30 in Product Treatment with Solution J.

C.1.7

Where materials having certain inherent functional properties are required for specific applications, such as pistons, shafts, bearings, and rotary seals, carbon[4], and/or ceramic materials may be used. Ceramic materials shall be inert, non-porous, non-toxic, non-absorbent, insoluble, resistant to scratching, scoring, and distortion when exposed to the conditions encountered in the environment of intended use and in cleaning and bactericidal treatment.

C.1.8

Silver soldered or brazed areas and silver solder or braze material shall be non-toxic and corrosion-resistant.

C.2

All non-product contact surfaces shall be of corrosion-resistant material or material that is rendered corrosion-resistant. If coated, the coating used shall adhere. All 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 mill finish on stainless steel sheets. (See Appendix, Section F.)

D.2

All permanent joints in product contact surfaces shall be welded or may be silver soldered or brazed if welding is not feasible. All welded or silver soldered areas of product contact surfaces shall be at least as smooth as the adjoining surface.

D.3

The minimum thickness of engineering plating shall be 0.0002 inch for all product contact parts except that when the parts that are to be plated are other than stainless steel, the minimum thickness of the engineering plating shall be 0.002 inch.

D.4

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

D.5

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

D.6

Meters that are to be mechanically cleaned shall

[4]Carbon which is specifically in compliance with the Food, Drug and Cosmetic Act, as amended, is that which is included in "V Fillers" in the food additive regulation for rubber articles intended for repeated use, 121.2562 of Subpart F, Code of Federal Regulations, Title 21—Food and Drugs.

be designed so that all product contact surfaces of the meter and all non-removable appurtenances thereto can be mechanically cleaned.

D.7
All product contact surfaces shall be self-draining except for normal clingage.

D.8
Connections in product contact surfaces shall conform to "3-A Sanitary Standards for Fittings Used on Milk and Milk Products Equipment and Used on Sanitary Lines Conducting Milk and Milk Products, Serial #0809," and/or to the applicable provisions for welded sanitary product pipelines found in the "3-A Accepted Practices for Permanently Installed Sanitary Product-Pipelines and Cleaning Systems," effective June 9, 1966, as amended.

D.9
All internal angles of 135° or less on product contact surfaces shall have minimum radii of 1/4 inch, except those in the main case of a meter and those at the base of teeth in gear type meters. When the radius is less than 1/32 inch the product contact surface of this internal angle must be readily accessible for cleaning and inspection.

D.10
Gaskets shall be removable. Gasket retaining grooves shall be no deeper than their width. The minimum radius of any internal angle in a gasket retaining groove shall be not less than 1/8 inch, except that the radius may be 3/32 inch where a standard 1/4 inch O-Ring is to be used and the radius may be 1/32 inch where a standard 1/8 inch O-Ring is to be used.

D.11
There shall be no threads on product contact surfaces.

D.12
Any coil spring having product contact surfaces shall have at least 3/32 inch openings between coils, including the ends.

D.13
If legs are used, they shall be smooth with rounded ends and no exposed threads. Legs made of hollow stock shall be sealed. On meters with legs designed to be fixed to the floor the minimum clearance between the lowest part of the base and the floor shall be four inches.

D.13.1
The minimum clearance between the lowest part of the base and the floor shall be:

D.13.1.1
four inches on meters with legs designed to be fixed to the floor or meters having a horizontal area of more than one square foot.

D.13.1.2
two inches on meters having a horizontal area of not more than one square foot and not designed to be fixed to the floor.

D.13.2
Bases when used shall be constructed without ribs or flanges and shall have a smooth top and bottom surface.

D.14
Non-product contact surfaces shall be readily cleanable and shall be free of pockets and crevices except those created on the face of a register at the window, ticket slots, pick-off coils, auto stop buttons, reset handles, totalizer holes and similar places.

D.15
Non-product contact surfaces to be coated shall be effectively prepared for coating.

Appendix

E.
STAINLESS STEEL MATERIALS
Stainless steel conforming to the applicable composition ranges established by AISI for wrought products, or by ACI for cast products, should be considered in compliance with the requirements of Section C.1 herein.
Where welding is involved the carbon content of the stainless steel should not exceed 0.08%. The first reference cited in C.1 sets forth the chemical ranges and limits of acceptable stainless steels of the 300 series.
Cast grades of stainless steel corresponding to types 303, 304, and 316 are designated CF-16F, CF-8, and CF8M, respectively. These cast grades are covered by ASTM[5] specifications A296-67 and A351-65.

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

These Standards shall become effective April 23, 1971.

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

ASSOCIATION AFFAIRS

REPORT OF THE COMMITTEE ON DAIRY FARM METHODS, 1969-1970

The 1969-1970 Farm Methods Committee of the International Milk Food and Environmental Sanitarians is made up of 47 individual members and 13 state affiliate members. During these two years we have had nine task committees, each with an individual chairman. The sixty individual members or state affiliates are, as a whole, only on one task committee. One or two members only are serving on two task committees.

The nine task committees have compiled interesting as well as useful information for the members of the International Milk, Food, and Environmental Sanitarians.

Antibiotics, Pesticides, and Other Adulterants
M. W. Jefferson, *Chairman*

Progress has been made by the dairy industry and regulatory agencies to eliminate antibiotics from the nation's milk supply. Certain variations exist between regulatory programs on control of use of antibiotics and control of adulteration of milk supplies by antibiotics. With the increased emphasis on the control of abnormal and mastitic milk, use of antibiotics and the possibility of adulterated milk supplies by antibiotics could become a greater problem. The Committee recommends:

(a) That sanitarians, veterinarians, and educational groups, through state mastitis or abnormal milk control committees, emphasize that label directions of all antibiotics be followed.

(b) That agricultural extension programs supply information to dairymen on problems relating to the indiscriminate use of antibiotics.

(c) That surveillance testing of all medicated feeds should be carried out.

(d) That control should be established on a nationwide basis to limit the dose rate of antibiotics, and in particular to control the different type antibiotics and their use by the dairy farmer. Certain types of antibiotics should be dispensed only by veterinarians.

Pesticides continue to be a problem in some areas of the country. Several states report a high degree of contamination of soils, water, and feed from extended use of pesticides. Evidence indicates that many cases of adulteration of milk supplies by pesticides have resulted from ignorance and failure to follow directions in the use of pesticides. The Committee makes the following recommendations:

(a) That the directions on the label of all pesticides be as plain, simple, and distinct as possible in order to be understood.

(b) That educational programs be continued and reemphasized for following directions.

(c) That commercial applicators be licensed and controlled by each state.

(d) That investigation of the use of chlorinated hydrocarbon pesticides should be made in depth, and their use prohibited if residues cannot be controlled.

It is possible for milk to be adulterated by sanitizers and detergents through pipeline milking systems and automatic cleaning and sanitizing systems now used on dairy farms. This also applies to dairy processing plants where modern sophisticated equipment, pipeline systems, and cleaning and sanitizing procedures are used. The Committee recommends establishment of research directed toward development of suitable and rapid test procedures to detect the presence of cleaning and sanitizing chemicals in milk.

Cleaning and Sanitizing of Farm Milk Equipment
James R. Welch, *Chairman*

Milk quality can be directly related to properly cleaned and sanitized equipment. There are some specific cleaning procedures and equipment which are of importance and require further clarification. Following are the recommendations of this Committee:

A. *Draining of component parts in pipeline systems*
   1. Automatic drain valves should be installed on all weigh jars incorporated in a system which is cleaned either manually or automatically.
   2. All milk pumps should be provided with automatic drains. (Draining of these component parts is important from the standpoint of adulterants and bacterial contamination. The valves should be self-cleaning and self-closing when not in use.)

B. *Rinsing procedures on pipelines*
   1. Diversion of both the pre-rinse and post-rinse should be practiced.
   2. Recirculation of the sanitizing rinse will insure proper exposure time.

C. *Circulation temperature of cleaning solutions in CIP cleaning of pipelines.* Controlled field tests should be set up which consider geographic factors; types of installations (pipeline or transfer system, around-the-barn or milking parlor); and stainless steel, glass or plastic material. The goals of these tests should be to establish starting temperature and end temperature guidelines for each type of equipment and whether additional equipment is necessary for temperature maintenance (booster heaters, in-line thermometers, or temperature recording devices).

D. *Pipe size requirements in pipeline installations.* Producers should be encouraged to install pipelines of the same diameter throughout the entire system. However, the installation of smaller lines (1.5 inches) on the intake or discharge section of a 2-3 inch pipeline may not be a problem if discharge pumps of ample size are used.

E. *Inflation cleaning in CIP systems.* Producers should be encouraged to pulsate inflations during cleaning cycles. However, further study is needed to complete data on benefits of this practice.

F. *Water heating facilities.* Attached to this report is a chart on recommended heating capacity requirements. These guidelines should be followed on all new installations. Increased emphasis should also be placed on the upgrading of water heating facilities in present installations.

G. *Vacuum system maintenance.* Because of bacteriological and operational factors, all systems should be cleaned once a month-minimum. When foregin matter enters the system it should be cleaned immediately (broken inflation during milking, etc.).

H. *Wash vats.* Many cleaning problems can be traced back to lack of knowledge regarding the quantity of water to be used for washing equipment. Inaccurate and fluctuating quantities of water result in improper deter-

gent concentration. It is recommended that wash vat manufacturers be encouraged to calibrate all wash vats and identify measurement. Wash vats should be constructed of stainless steel. More emphasis should be placed on wash vat cleanliness. Complete cleaning and sanitizing cannot be obtained unless wash vats are clean.

I. *Sanitizing*
   1. Use of quaternary ammonium compounds and household bleach should be discouraged for sanitizing equipment on the dairy farm. All equipment should be sanitized with an approved sanitizer after equipment is assembled and filter media inserted.
   2. Manual sanitizing of equipment such as the bulk tank is neglected. Therefore, the installation of proportioning devices which will accurately meter sanitizing solutions and offer ease in application should be encouraged.

TABLE 1. ESTIMATED WATER REQUIREMENTS FOR MILKHOUSE OPERATIONS

Type	Gallons per day	Recommended hot water heater[b] size (electric) @ 160 F[c] (Gallons)
Can operation—up to 30 cows	20-30	30
Can operation—up to 60 cows	30-40	50
Bulk tank—manual washing	35-45[a]	50
Bulk tank—automatic washing	50-60[a]	80

Water and heating capabilities to be added to *one* of the above conditions for various types of equipment:

Type of equipment	Additional gallons per day	Additional water heating capacity (Gallons)
Dumping station[d]-vac./	20-50	30
gravity wash	60-100	40
pressure wash		
Pipeline milker[d]-parlor,	40-60	30
vac./gravity wash	60-100	40
pressure wash		
Pipeline milker [d]-around-	60-90	40
the-barn	60-150+	80
pressure wash		
Allowance for parlor wash-down	40-60	—
Allowance for spray-type udder wash	0.5 gal/ cow/day	30 gal per 100 cows

[a]Every-other day pickup.
[b]For fast recovery heating units, 3/4 of the listed heater capacity may be used.
[c]Adequate water heating capacity is included to allow the use of hot water for mixing milk replacers for the number of calves in a typical herd.
[d]Capacities are based upon 1 or 1.50 diameter lines.

Note: 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.

EDUCATION

VERNON D. NICKEL, *Chairman*

The Task Committee on Education had the assignment of gathering new material for publication in the *Journal of Milk and Food Technology.*

A new lot of publications on dairy farm science has been collected. Abstracts of these publications will be forwarded to Dr. Elmer H. Marth for publication in the Journal.

The membership of the International Association of Milk, Food and Environmental Sanitarians, Incorporated should be interested in the material that the Committee has collected.

PLASTICS

BERNARD M. SAFFIAN, *Chairman*

The Task Committee on Plastics has attempted to determine the types of cleaners which may be used successfully for cleaning plastics at a maximum starting temperature of 140 F.

Many types of plastics are used in contact with milk on the dairy farm, but the most common plastic is flexible, clear polyvinyl chloride (PVC) used in milk hoses. As temperature is increased, the useful life and clarity of this material is gradually decreased. At temperatures over 140 F, these effects accelerate. The use of free caustic soda in cleaners also shortens the life of flexible PVC and causes stress cracking of some other plastics. High temperature can cause distortion of shape and size of some plastic components. It is believed that if proper cleaning conditions are used (type of cleaner, concentration of cleaner, use of acid rinse to control hard water salts) efficient cleaning may be obtained at starting temperatures of not over 140 F.

Results of the investigation by the Committee are as follows:

(a) It is generally agreed that the following chemicals are effective in cleaning solutions at temperatures not over 140 F: chlorinated polyphosphates, sodium metasilicate (with chloroisocyanuric acid added), and sodium sesquicarbonate. There is a difference of opinion on the need for caustic soda in such cleaning solutions. At temperatures lower than 140 F, the recommended use concentration is increased.

(b) Hard water reduces the efficiency of alkaline cleaners, but many cleaners are formulated to handle a wide range of water hardness. Several methods are used to control the problem of hard water residues. One of these is use of an acid rinse.

(c) Plastics do not require as high a cleaning solution temperature or concentration as normally recommended for stainless steel and glass. Advances have been made in the efficiency of cleaners so that lower temperatures and/or concentrations can be used. Since visual cleanliness of equipment and low bacteria count of the milk are the important criteria for determining the effectiveness of a cleaning system, it is recommended that regulations consider these factors rather than temperature as a yardstick for cleanliness.

SEDIMENT

M. H. ROMAN, *Chairman*

Milk is clean as it leaves the cow's teats. However, from this point on it is subject to contamination with extraneous matter, commonly referred to as sediment, unless proper milking procedures and care are exercised in production and handling of the milk.

One of the primary sources of contamination of milk with sediment is at cowside because of lack of cleaning of teats and udders prior to milking. Other sources of contamination are faulty handling of milking machine inflations, dusty air, and unclean water used for cleaning purposes.

Contaminants such as manure, barnyard soil, and silt may be fragmented into tiny particles in the milk and may have a

high moisture content. The liquid portion and the fragmented particles cannot be effectively strained out by farm filtration.

Clean milk production can be made easier by *(a)* keeping cows clean and properly clipped, *(b)* use of clean sanitizing solution of proper temperature for udder and teat preparation, with NO REUSE of the solution, *(c)* use of individual paper towels for washing and drying of udders and teats, and *(d)* protection of the milk by use of covered pails and strainers in stables.

A mixed sample sediment test of milk from the bulk tank will effectively reveal faulty milking practices which may not be observed by sanitarians when making dairy farm inspections at non-milking times.

Clean production is a prerequisite for high quality milk. APHA *Standard Methods* recognizes the sediment test as one of the milk quality tests. The USPHS *Pasteurized Milk Ordinance* spells out procedures for clean milk production, and unclean milk is encompassed by the definition of adulterated milk. USDA, FDA, and APHA have cooperated in the preparation of sediment grading charts. USDA has proposed maximum sediment levels for State adoption as standards for cleanliness of milk used for manufacturing. Some State and local regulatory agencies require routine sediment testing of farm milk supplies and rejection of unclean milk, but many regulatory agencies do not require sediment testing and thus may be assuming that cleanliness of milk is not a problem. However, the degree of cleanliness of milk supplies has been found to be a major milk quality problem and one in need of constant attention.

This Committee recommends:

(a) That a mixed milk sample of at least 4 oz taken in a sterile container be procured at each farm bulk milk collection to serve for all quality and chemical tests.

(b) That industry and regulatory agencies recognize the sediment test as a test of cleanliness of milk production. And, they should recognize that an acceptable dairy farm score and unclean milk in the farm tank are not compatible.

(c) That all receivers of milk institute a routine mixed sample sediment testing program to determine the degree of cleanliness of individual supplies, using procedures outlined in APHA *Standard Methods.*

(d) That as a rapid screening test, a 4 oz mixed milk sample be procured by the hauler of each producer's milk and be brought to a central point for testing through a 0.2 inch diameter area of a sediment test disc. Thus it can be ascertained which producers should be notified to effect improvement in cleanliness of milk production.

(e) That milking time inspections be made in those instances where producers do not effect improvement after notification. Sediment tests made on milk prior to farm straining will reveal the degree of cleanliness of production as well as sources of contamination.

(f) That an abnormal milk test be conducted on milk samples which foul the sediment test disc and thus resist passage or which show the presence of yellow color on the back side of the test disc.

(g) That in order to be better versed in clean milk production, each sanitarian should conduct at least two milking time inspections with sediment testing of each cow's production prior to straining of the milk. One inspection should be made at a farm where sediment tests have been consistently clean and the other at a farm where sediment tests have been found to be unclean.

(h) That milk producers be encouraged to conduct their own sediment tests at frequent intervals in order to assure that clean milk is being produced.

PROPER MILKING PRACTICES

KENNETH HARRINGTON, *Chairman*

Preparation

Proper preparation of the teats and udders before milking serves a three-fold purpose: *(a)* sediment control, *(b)* mastitis control, and *(c)* stimulates milk let down. Clipping of udders and flanks will greatly improve proper sanitary preparation of the cow. Observe teats and udders for cuts, cracks, bruises, and swelling while preparing the udder.

Thoroughly wash and massage teats and lower udder for approximately 30 sec with a single service towel that has been soaked in an approved germicidal solution. Tepid water (110 F-120 F) is recommended. This solution should be changed as frequently as necessary to maintain germicidal strength and proper temperature.

Whenever possible, a metering device should be installed in the water line to feed the proper amount of clean water and sanitizers to the hose being used. This will eliminate the problem of contaminated solutions. A single service towel should be used.

Drying of the teats and lower udder with *another* single service towel will further stimulate let down and remove excess water that could get into the milk.

Use strip cup, strip plate or paddle (CMT, WMT, etc.) to check all cows for all abnormalities. Discard all abnormal milk showing flakes; clots; discoloration; or unusually thick, thin, or watery consistency. When abnormal milk is suspected, the cow should be milked last, the milk discarded, and affected equipment sterilized. Remove 3 to 4 streams of milk from each teat into the strip cup. This fore-milk is low in fat and high in bacteria. Use of the strip cup also helps stimulate milk let down.

Milking procedures

Approximately 1 min after stimulation and preparation, gently apply milker unit.

Use only the number of units per man that *will not* cause over milking. The number of units per operator will vary considerably because of the agility of operator, type of installation, milk flow per cow, and adequacy of stimulation. The recommended number of units that can be properly used per typical operator:

Bucket type units	- 2
Stanchion pipeline units	- 3
Milking parlor (Tandem)	- 3
Herringbone parlor	- 4

Cows should be trained to milk out completely in 3-5 min.

Operator should follow manufacturer's recommendations as to inches of vacuum and rate of pulsation.

Operator should observe all milker units closely. When milk flow is reduced to a minimum or ceases, machine stripping should be started. Practice machine stripping rather than hand stripping. Machine stripping is accomplished by gently pulling down on teat cups and massaging each quarter in downward motion. Machine stripping should not exceed 0.5 min. Prolonged machine stripping induces bad milking habits and may result in injury to the delicate tissue lining the teat, the udder cistern, and the teat end. Do not allow teat cups to creep up on udder to shut off flow of milk.

Remove teat cups gently by shutting off the vacuum. Break the vacuum by pressing the thumb between the inflation and the top of the teat. This breaks the vacuum seal so that inflation can be easily and gently removed.

It is recommended that inflations be sanitized between cows. Rinse teat cups in clear fresh potable water. Disinfect teat cups in an approved germicidal solution. Change germicidal solution as frequently as necessary. Be sure solution reaches all milk contact areas of the inflation.

Post milking procedure

Teat dipping with an approved non-irritating germicidal preparation is recommended. This germicidal solution will eliminate milk film on the teat end which has proven to be an excellent medium for bacterial growth. Since the muscle surrounding the teat canal opening is relaxed after milking, bacteria may gain entrance through the teat canal if teat dipping is not accomplished.

CLEANING AND SANITIZING OF FARM MILK PICK-UP TANKERS

STEPHEN B. SPENCER, *Chairman*

The backbone of the milk collection system in the United States is the bulk farm pick-up tanker. In any collection system, sanitation must be of high standard and apply to all components of that system in order to supply quality products to the consumer.

The farm pick-up tanker can be a weak link in a sanitation program. Tankers load and unload at all times of the day and night, hence, there is sometimes little opportunity for supervision. In addition, drivers are more interested in the mechanical aspects of their "rigs" than in being sanitarians. Finally, some of the facilities that are provided for cleaning and sanitizing the tanker are less than ideal.

The Task Committee attempted to determine the preferred procedures and methods of pick-up tanker sanitation. It is agreed that the driver is responsible for cleanliness and sanitization of his tanker. Facilities for washing tankers should be provided where they are unloaded. This includes reloading operations. Tankers should be washed immediately after unloading.

The tanker should be sanitized before being used. Chlorine sanitizers should be applied just before use. Acid or iodophor sanitizers may be applied immediately following the cleaning operation.

Drop-in sprays can be used to wash small tankers satisfactorily, however, the preference is for permanently mounted CIP sprays, especially for large tankers and transports.

With reference to accessories:

(a) Compartment lights for night pick-up and meters to replace dip-sticks are needed.

(b) A blower to air-dry plastic hoses is important.

(c) Emergency power sources and self-contained cleaning systems are less important.

The importance of hot water to wash the tanker cannot be overemphasized. The minimum end-point temperature is considered to be in the 110-120 F range. Ideally the system should have the capability of heating and maintaining a temperature by steam injection or heating coils. A constant temperature of 135 F is considered ideal. Proper cleaning can be accomplished in a 5-7 min wash cycle if the end-point temperature does not drop below 110-120 F. Wide variations in temperature may cause buckling from pressure and vacuum development.

The volume of cleaning solution varies with the type of system. A sound guideline is that the solution must be adequate to prevent pump starvation. A tank's slope of 0.5 inch per foot facilitates drainage and the reduction of solution volume.

Bulk farm pick-up tankers need not be the weak link in a sanitation program. They can be cleaned and sanitized properly when the necessary resources are provided and used.

SAMPLING OF BULK TANK MILK

WILLIAM L. ARLEDGE, *Chairman*

Considerable concern has been expressed throughout the country relative to sampling of bulk tank milk including the procedures and responsibilities involved.

The *bulk milk hauler* should be trained, examined, and licensed to collect official samples. Educational haulers' meetings should be held twice yearly to review techniques, procedures, and new developments.

An *official sample* should be collected from each bulk tank at every pickup. All samples so collected should be available on a random basis for all tests, such as butterfat, bacteria, cryoscope, somatic cells, sediment, solids, etc. This will eliminate the danger of collusion and non-representative samples. When official samples are collected at specified times, particularly with special bottles, it is impossible to insure against collusion or non-representative samples.

The requirements for *agitation of milk* vary from 3-10 min. It is recommended that 5 min minimum agitation be required on all tanks. On some bulk tanks necessary agitation time should be determined for sampling. All route drivers should be instructed in this important problem area. Timing devices are not generally required to periodically agitate the bulk tank milk prior to pickup. This area has merit for study. The advantages of such devices would probably outweigh the disadvantages of possible mechanical malfunctions.

For *sample collection,* the Committee recommends the use of: *(a)* sample dipper and dipper-well carried on the route truck and maintained by the driver; *(b)* individual sample dippers kept and maintained at each farm; *(c)* single service plastic straws for official use by fieldmen and sanitarians.

When bulk tank milk is agitated for the proper time, there is no reason to require that samples be collected from specific spots of the tank. Single service plastic sample bags are recommended. Sterile glass bottles with approved closures are a second choice.

Sample care after collection is an area of minimum uniformity. The samples should be placed in an approved ice chest, in ice or ice water at 33-40 F until delivery to its destination. The ice chest should be so constructed as to be durable and with sufficient insulation on all sides for minimum melting of ice through a 12 hr period during 90-100 F weather and to prevent freezing of samples when weather is 0-20 F.

It is recommended that this Committee develop guidelines on the following: *(a)* detailed procedure for the collection and care of bulk milk samples, *(b)* design and construction of sample cases, and *(c)* guidelines for agitation and sampling of milk in transportation tankers at their destination. These guidelines should be made available to the USPHS and the IMS laboratory committee.

WATER PROTECTION

HENRY ATHERTON, *Chairman*

The Task Committee on Water Protection is the outgrowth of an earlier task committee which was interested primarily in the relationship of farm water quality to milk quality. At the annual meeting in 1969, this task committee was asked to seek information to keep the membership aware of pollution problems resulting from uncontrolled drainage of dairy farm wastes into the water supply.

The need for information on water protection has been

apparent for some years. Problem areas in water protection and treatment have been discussed in numerous conferences in the past. However, the new awareness of population pressures and concern for the environment have created an urgency which must be recognized by all of us.

Public concern for the aesthetics of human existance has resulted in serious questioning of some of the normal practices in American agriculture. Knowledge is now available to solve many existing pollution problems in a manner which, though expensive by current concepts, will have little effect on the operation of the enterprise. Other problems are not so easily resolved if we hope to retain the present identity of the operation. Solutions to these problems must be found or some farms will be forced out of business. Reports indicate this is occurring already in some areas.

Activity of the Task Committee has been exploratory in nature this year. To determine the extent of the pollution problem (or the awareness of it) as it related to dairy operations in the country, a letter was sent to each of the Directors of Dairy Divisions (Agriculture or Health Departments) in each of the states. Dairy Extension Specialists in each state also were contacted. Each was asked for any information he could give on: *(a)* whether milk quality was being affected by lack of a suitable farm water supply; and *(b)* whether liquid wastes from farm operations were contributing to significant pollution problems. Some replies indicated other agencies had more specific information on the questions. These also were contacted.

To date, 74 responses have been received from 37 states and the U. S. Department of Interior. Respondents reported little concern that milk quality was being affected detrimentally by lack of enough good water. On the other hand, letters from approximately two-thirds of the reporting states indicated there was some concern about pollution from dairy farm wastes. Farm operations in several states have been restricted or forced to move as the result of opposition to their methods of disposing dairy wastes. California, in particular, seems to be well advanced in the study of this problem.

It would seem from the comments received that the IAMFES acted wisely and timely in establishing a Task Committee on Water Protection. While there is little definitive information available at this time, these replies indicate many states are now studying the problems of water pollution. This Task Committee will try to keep the members informed as programs develop in this area of interest.

Information has been received about several conferences on animal waste management which have been held recently or are planned for the near future. Several of these—such as the Proceedings of the Cornell Conference on Agricultural Waste Management in 1969 and 1970 or the Wisconsin Farm Animal Waste and By-Product Management Conference of 1969, the California State Water Quality Control Board's or the U. S. Department of Interior's comprehensive reports on *Water Quality Criteria,* California Water Resources Center's Proceedings of their 1966 Symposium on Agricultural Waste Waters, USDA's two reports on *Control of Agriculture–Related Pollution* and *Wastes in Relation to Agriculture and Forestry,* or The Department of Interior (FWPCA) Review of the *Pollution Implications of Animal Wastes*—give basic information which would be most valuable for any individual or group interested in background data now available. In addition, attention has been drawn to a number of valuable papers which have been presented during the past year or two as a part of more general conferences. Information on many of these references will be available through the Task Committee on Education.

Your task committee looks forward in the years ahead to a challenging role in obtaining information to keep the membership informed of developments in this field of Water Protection.

Three possible areas of interest have been suggested for future study. These are: *(a)* a review of the various recommendations by Federal and State agencies as they relate to construction of farm water supplies; *(b)* new developments in the area of liquid waste disposal from milk houses, parlors, etc.; and *(c)* animal waste disposal as it relates to general problems of water contamination.

A. K. Saunders, *Chairman,* The De Laval Separator Company, 5724 North Pulaski Road, Chicago, Illinois 60646.

A. E. Parker, *Western Assistant Chairman,* Milk Sanitation Section, Multnomah County Oregon, 104 S. W. Fifth Avenue, Portland, Oregon 97204.

James B. Smathers, *Eastern Assistant Chairman,* Maryland and Virginia Milk Producers Assn., Inc., 1530 Wilson Boulevard, Arlington, Virginia 22209.

Dr. J. C. Flake, *Farm Methods Report Editor,* Evaporated Milk Association, 910 Seventeenth Street, N.W., Washington, D. C. 20006.

William L. Arledge, Dairymen, Inc., P. O. Box 18118, Louisville, Kentucky 40218.

Henry V. Atherton, Department of Animal Sciences, University of Vermont, Burlington, Vermont 05401.

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

Phillip Bergner, Alameda County Health Department, Eden District, 15001 Foothill Boulevard, San Leandro, California 94577.

Frank Blumenschein, Multnomah County Health Division, 104 S. W. Fifth Avenue, Portland, Oregon 97204.

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

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

Floyd M. Copenhaver, Dairy Section, Kansas City Health Dept., 21st Floor—City Hall, Kansas City, Missouri 64106.

Clifford J. Cosgrove, Animal Science Department, Woodward Hall 212—University of Rhode Island, Kingston, Rhode Island 02661.

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

C. W. Dromgold, St. Louis Department of Public Health, 403 Melrose Place, Centralia, Illinois 62801.

Clarence C. Gehrman, Dairy Inspection Section, Dairy and Food Division, Department of Agriculture, P. O. Box 1122, Olympia, Washington 98501.

D. F. Goyer, Agway, Inc., Box 1333, Syracuse, New York 13201.

W. J. Harper, Department Dairy Technology, Ohio State University, Columbus, Ohio 43200.

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

Keith A. Harvey, Engineering and Sanitation Division, Statehouse, Boise, Idaho 83707.

M. W. Jefferson, Department of Agriculture & Commerce, Division of Animal Health & Dairies, 1444 East Main Street, Richmond, Virginia 23219.

C. Bronson Lane, Department of Dairy Science, University of Florida, Gainesville, Florida.

R. E. Lock, De Laval Separator Company, 350 Dutchess Turnpike, Poughkeepsie, New York 12602.

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

James McDowell, Dairymen, Inc., Kyanna Division, P. O. Box 18118, Louisville, Kentucky 40218.

C. M. Mecham, Maryland and Virginia Milk Producers Ass., Inc., 1530 Wilson Boulevard, Arlington, Virginia 22209

A. N. Myhr, Department of Food Science, University of Guelph, Guelph, Ontario, Canada.

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

Roy R. Perkins, Memphis and Shelby County Health Department, 814 Jefferson Avenue, Memphis, Tennessee 38105.

Wm. T. Pickavance, Universal Milking Machine Division, National Cooperatives, Inc., First Avenue at College, Albert Lea, Minnesota 56007.

Loren E. Pine, Sr. Milk and Dairy Sanitarian, 1020 West Sixth Street, Ontario, California 91761.

D. G. Raffel, Department of Agriculture, State of Wisconsin, 4702 University Avenue, Madison, Wisconsin 53702.

R. G. Raup, The De Laval Separator Company, 5724 North Pulaski Road, Chicago, Illinois 60646.

John W. Ring, Technical Products Division, Corning Glass Works, Forest Hill Drive, Corning, New York 14830.

Richard Rintelmann, Klenzade Products, Division of Economics Laboratory, Inc., Osborne Building, St. Paul, Minnesota 55102.

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

Bernard Saffian, Chamberlain Laboratories, P. O. Box 1624, Stow, Ohio 44224.

Paul W. Scherschel, Associated Milk Producers, Inc., Tri-State Region, 343 South Dearborn Street, Chicago, Illinois 60604.

Robert Simon, Borden Milk Company, Baton Rouge, Louisiana 70801.

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

Donald K. Summers, Food and Drug Administration, Region VIII Office, 9017 Federal Building, 19th & Stout Streets, Denver, Colorado 80202.

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

Mrs. Helene Uhlmann, Calumet Region Milk Sanitation Department, 1429 Virginia Street, Gary, Indiana 46407.

R. J. Weaver, Associated Suburban Boards of Health, 75 East Lancaster Avenue, Ardmore, Pennsylvania 19003.

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 3051, Fresno, California 93721.

Harvey J. Wilhelm, Mountain Empire Dairyman's Association, Inc., 945—11th Street, Denver, Colorado 80204.

CONTACT MEN IN STATE AFFILIATES WITH PARTICIPATING FARM PRACTICE COMMITTEES

Connecticut: Russell Weinholt, H. P. Hood & Son, Hartford, Connecticut 06101.

Florida: Melvin Ness, Northeast Florida Milk Producers Assn., 5654 Dunn Avenue, Jacksonville, Florida 32211.

Idaho: Jess Sproul, City-County Health Department, 1455 North Orchard, Boise, Idaho 83704.

Indiana. Verne Cavanaugh, Indiana State Board of Health, 623 Dewey Street, Michigan City, Indiana 46361.

Iowa: James Burkett, 3340 Stone Park Boulevard, Sioux City, Iowa 51104.

Kansas: David Monk, Wichita Sedgwick County Public Health Dept., 1900 East Ninth Street, Wichita, Kansas 67214.

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

New York: Lee Page.

Oregon: James W. Green, Carnation Company, 3342 S. E. Morrison Street, Portland, Oregon 97214.

Pennsylvania: Clarance Nagle, Johnston Sanitary Dairy Company, 400-422 Franklin Street, Johnstown, Pennsylvania 15905.

Virginia: M. K. Cook, R. R. 1—Box 437, Roanoke, Virginia 24003.

Washington: Harry Gleason, Box 708, Chehalis, Washington 98532.

Wisconsin: Emmett Fincher, 2614 Waunona Way, Madison, Wisconsin 53713.

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NEWS & EVENTS

MISSION 5000

U.S. Department of Health Education and Welfare
Public Health Service
Environmental Health Service
Environmental Control Administration
Bureau of Solid Waste Management

Mission 5000 is an important part of the effort to protect and improve the quality of our environment. Specifically, Mission 5000 is aimed at closing 5,000 open dumps by June 30, 1972. Attainment of this objective—converting dumps to sanitary landfills or providing some other acceptable disposal means—will be a significant step toward achieving a cleaner and healthier environment for all Americans.

Why mission 5000?

Open and burning dumps are a disgraceful—and unnecessary—part of our Nation's environmental crisis. These sites contribute to air and water pollution; provide food and harborage for rats, flies, and other vectors; are potential sources of disease and accidents; and are aesthetic insults. Unfortunately, open dumps are also the most common means of solid waste disposal in the United States. A survey by the Environmental Health Service, Bureau of Solid Waste Management, indicates that only 6% of all authorized land disposal sites (those patronized by regular collection services) are acceptable. Nearly half of these sites contribute to water pollution, and approximately three-fourths are contributing to local air pollution.

Who participates in mission 5000?

The success of mission 5000 depends upon dedicated action by officials at Federal, State and local levels; the encouragement of civic, trade, and professional organizations; and the understanding and support of every citizen. The role of the Federal government, though important, is limited. The Bureau of Solid Waste Management will render technical assistance, including furnishing recommended standards and model legislation. Special training courses in solid waste management will be offered for operators, supervisors, and public officials. In cooperation with State and local personnel, data relevant to dump elimination will be collected and evaluated, and progress made in achieving the Mission will be measured.

Regulatory authority to insure proper solid waste management and operational responsibility for disposal sites are typically State and local matters. Accordingly, full cooperation by State and local officials is essential.

Civic, trade, and professional organizations are assisting by supporting this program through their membership. These individuals and their organizations often represent the professionals in communities who are influential in making community decisions; thus, their support and cooperation is essential.

Finally, citizens can contribute to the success of Mission 5000 by urging its support upon local officials by writing letters to editors, or otherwise using their personal powers of persuasion and influence in behalf of the project.

When do we begin mission 5000?

Now! There is no reason, with present technology, why open dumps cannot be eliminated in favor of some pollution-free and aesthetically acceptable method. While research promises many future improvements in the field of solid waste management, the environmental crisis is immediate. Fortunately, it is not necessary to await the results of research to achieve immediate and dramatic improvement in solid waste disposal practices. In solid waste management, or in any field, change is the only constant. As technology improves, disposal methods must change and improve also. But to do less than present

know-how and technology will permit is unworthy of a Nation that takes pride in its progressive spirit and technological excellence. The success of Mission 5000 will take work, persuasion, and money. But the rewards are great—a cleaner, healthier and more beautiful land.

NATIONAL CONFERENCE ON INTERSTATE MILK SHIPMENTS

May 16-20, 1971

The time has again come to notify Conference members that they should begin thinking about the next meeting of the Conference, which is scheduled to be held at the Chase-Park Plaza Hotel, St. Louis, Missouri, May 16-20, 1971.

The hotel management has guaranteed a flat room rate of $13.00 for a single, and $20.00 for a twin ($10.00 per person). The Chase-Park Plaza is one of the finest hotels in the country with air-conditioned guest rooms and public function rooms. Free inside parking is also available for guests registered in the hotel.

John Schilling, Local Arrangements Chairman, promises that the social side of the Conference will not be neglected. Both John and his lovely wife, Dot, are working on the preparation of a Ladies program that should surpass anything done in the past. Make your plans to attend—and bring your wife along.

J. C. McCAFFREY, *Editor Newsletter*

TEXAS A&M DAIRY INDUSTRY CONFERENCE

The Fourth Annual Dairy Industries Conference sponsored by the Department of Animal Science, Texas A&M University has been scheduled for April 21-22, 1971. All activities will be held at the Holiday Inn, Bryan, Texas. Additional information may be obtained from Dr. H. E. Randolph, Dairy Section, Department of Animal Science, Texas A&M University, College Station, Texas 77843.

PREP-STALLS ARE NOT COW WASHERS

Babson Bros. Co. has recently introduced the first mass produced automated prep-stall. The Surge Prep-Stall is designed to automatically prepare the cow for milking before it enters the milking stall.

"There is a big difference between just washing a cow and properly preparing a cow for milking," points out Robert Dawson, Product Manager for Surge Dairy Equipment. "The benefits are twofold. First, the operator saves considerable time previously spent washing udders and waiting for stimulation to trigger the natural let-down process. Secondly, the cow is ready for milking at her prime-let down period, so that the operator can take advantage of peak milk flow for safer, faster, more productive milking. The chance of irritation from attachment before full milk flow, is greatly reduced."

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One prep-stall is recommended for each row of two or three individual type milking stalls. They may also be installed in groups for use in herringbone parlors.

"Our experiences from actual installations in both new and old parlors indicate not only an increase in production per cow, but also in pounds per man hour," states Dawson. For more information about Surge Prep-Stalls contact your local Surge Dealer or write to Babson Bros. Co., 2100 S. York Road, Oak Brook, Ill. 60521.

NEW SCHOLARSHIPS AT UNIVERSITY OF WISCONSIN

The trustees of the General Foods Fund have approved a grant of $1600 for the College of Agricultural and Life Sciences, University of Wisconsin, to establish four $400 scholarships for freshmen entering the college for the 1971-1972 academic year. All of the scholarships will be available on a competitive basis. Two of the scholarships are to be awarded to students who intend to major in Food Science and the other two are available to students who choose one of the following areas for study: Agronomy, Bacteriology, Biochemistry, and Dairy Science. Selection of recipients is to be made by the College Committee on Scholarships and Loans and is to be based on intellectual competency, leadership ability, high moral character, and financial need. Further information may be obtained from Dr. G. W. Sledge, Office of Resident Instruction, 116 Agriculture Hall, University of Wisconsin, Madison, Wis. 53706.

THE FREELOADERS

A new color filmstrip program on pest control, "The Freeloaders," has been released by the National Restaurant Association.

In announcing the new 10 minute filmstrip program, NRA President Martin L. Horn, Jr. said: "The Freeloaders emphasizes the factors which cause pests to enter, stay and multiply in your establishment—food, moisture, warmth and shelter, and stresses the good practices which must be observed in order to deny them these attractants. Good housekeeping and prompt removal of trash are particularly underscored."

President Horn stated further that: "Insects, rodents and other pests can be very harmful to the success of your foodservice operation. They can bring disease and infection to your customers and employees. They can cause costly loss of food which has been contaminated or destroyed. Their presence, when observed by patrons, can impel customers not to return to your establishment. Claims and suits are both embarrassing and expensive. The end result can range from a damaged reputation to the loss of your business."

The filmstrip/record program is available for purchase from the NRA Educational Materials Center, 1530 North Lake Shore Drive, Chicago, Illinois 60610, for $14.95.

LANNIE NORRIS, JR. SUCCEEDS FATHER AS PRESIDENT—NORRIS DISPENSERS, INC.

Officials of Norris Dispensers, Inc., of Hot Springs, Arkansas, manufacturers of refrigerated milk dispensers, package milk vending machines, milk coolers and walk-in freezers and coolers, recently announced the appointment of Lannie Norris, Jr. as President of the company. Lannie F. Norris, Sr. founder of the firm over 25 years ago, was elevated from President to Chairman of the Board of the company.

Mr. Norris, Jr. has been with the company since 1967 and recently served as Vice President and supervised engineering, production and technical sales administration. He is a graduate of the University of Minnesota where he studied Mechanical Engineering. He is currently a member of the American Institute of Industrial Engineers, ASHRAE and APICS.

Mr. Norris, Jr. announced that his company's major objectives during the next five years will be a product diversification program coupled with the strengthening of the firm's field marketing force.

Included in the announcement was the appointment of Gary Bloomquist as Manager of Marketing and Legal for the company. Bloomquist joined the company in 1969. He holds a B.A. degree in History and Journalism from the University of Minnesota and the J.D. degree from the University of Minnesota Law School. Bloomquist presently holds memberships in the Minnesota Bar Assn., American Bar Assn., and American Judiciative Society.

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*International Association of Milk, Food and Environmental Sanitarians; U.S. Public Health Service; The Dairy Industry Committee.

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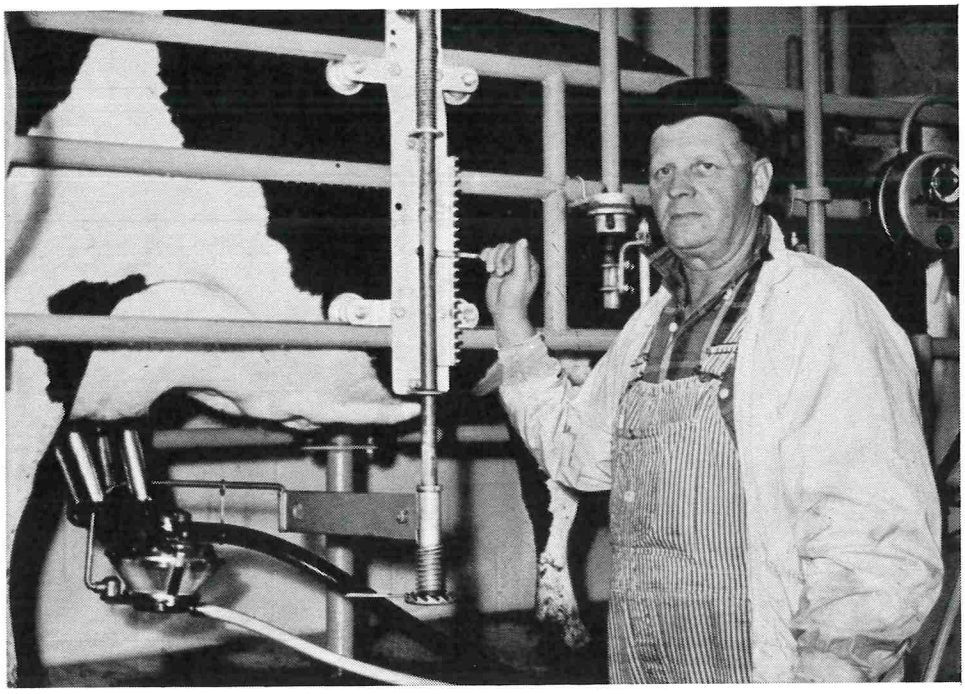

Gerrit Van Beek of Everson, Washington, built his Diagonal Stall Surge Parlor three years ago. It was an addition the whole family appreciated.

"It is in just as good condition today as it was when it was installed," states Van Beek. "We keep the equipment up-to-date and regular service by our Surge dealer makes certain everything is performing properly. We milk 60-head morning and night. At least one of these milkings is done by our twin daughters Sharon and Shirley, so it is important that everything works when they flip the switch," Van Beek continues.

"When we bought our equipment, we went for the Surge quality. We also knew that with more cows and a more complete milking system, we would need regular, dependable service. The way I see it, today's dairyman has to have both."

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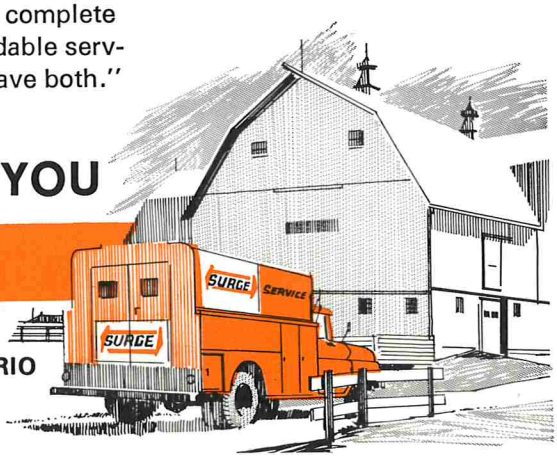

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