

*Journal of*

# MILK and FOOD TECHNOLOGY

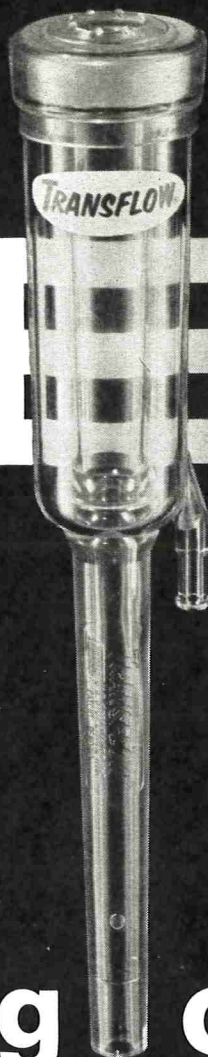
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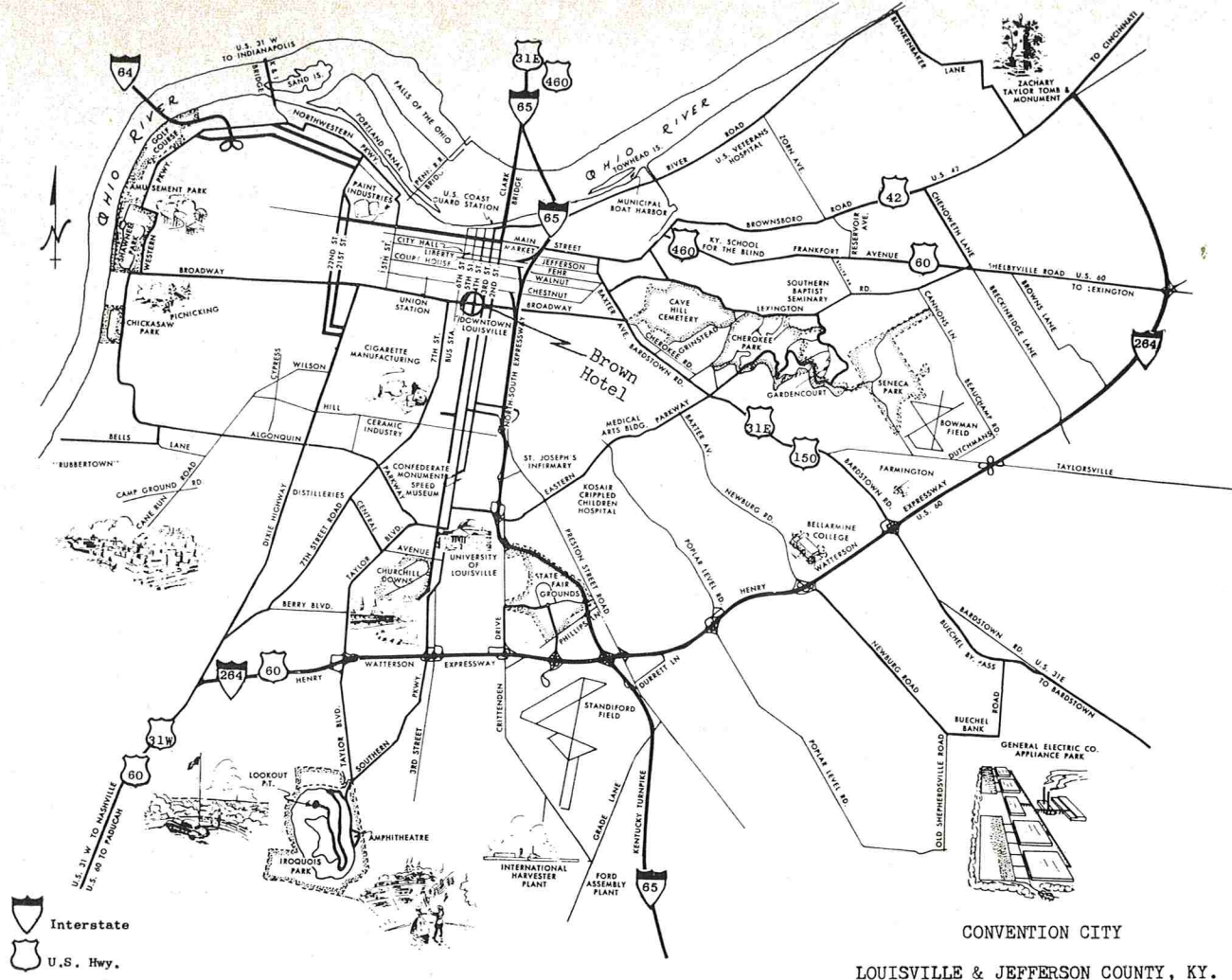
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Journal of

# MILK and FOOD TECHNOLOGY

INCLUDING MILK AND FOOD SANITATION

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International Association of Milk, Food and Environmental Sanitarians, Inc.

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Vol. 32

April, 1969

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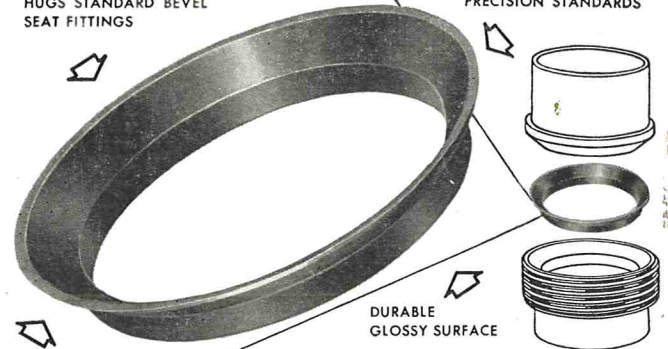
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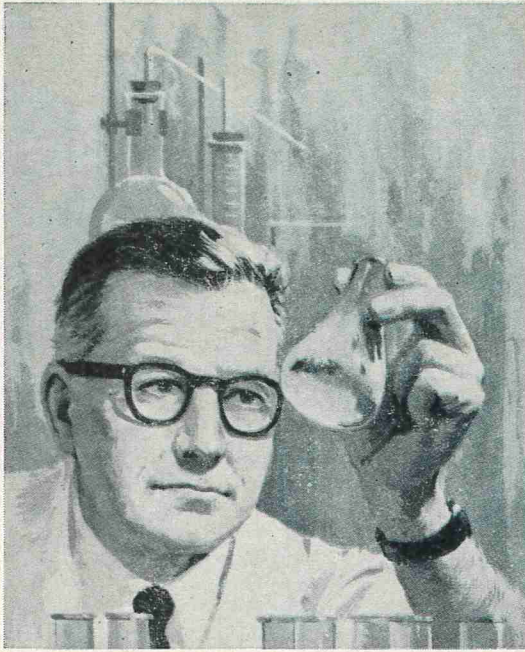
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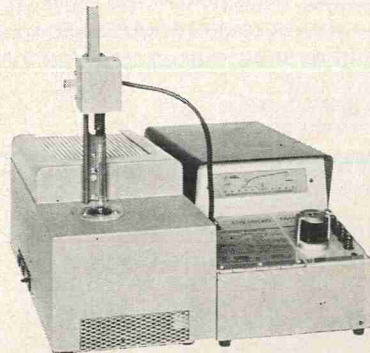
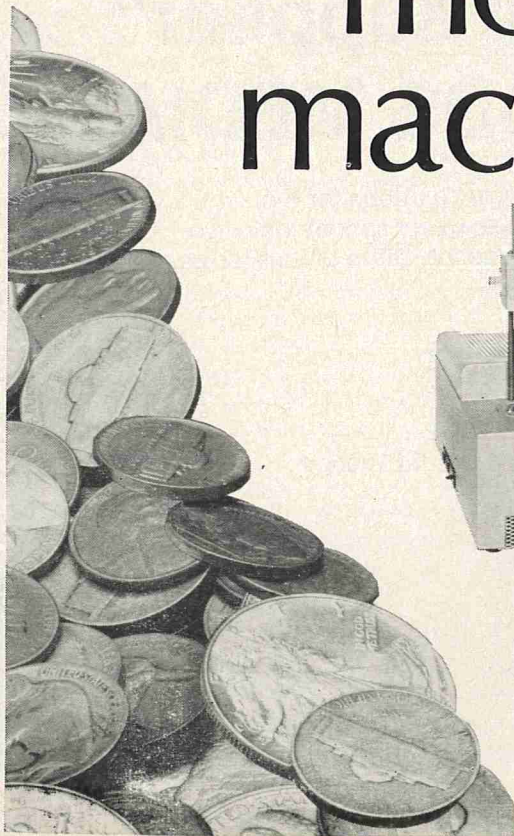
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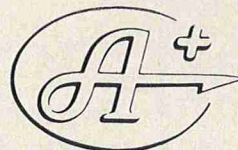
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# EVALUATION OF PERFORMANCE OF A FOOD SANITATION PROGRAM<sup>1</sup>

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(Received for publication October 31, 1968)

## ABSTRACT

An attempt has been made to apply a model for evaluating program effectiveness and efficiency to an actual program on a retrospective basis. It was not possible to apply the model fully since there was a lack of specification and measurement of program sub-objectives.

In the absence of a predetermined "extent of intended attainment," program effectiveness was computed using a Utopian, perhaps unrealistic standard of total elimination of violations. Two different measures of program objectives were constructed from available data. The first is a rating scale similar to the conventional rating scales recommended by the Public Health Service for surveying food and milk control programs. It differs primarily in that a given category may have variable debits assigned, based on judged severity of the conditions as compared to the minimum acceptable standard. The second measure used was correction rate, that is, the proportion of violations recorded at a given inspection that were corrected (not in violation) at the time of the subsequent inspection.

Both measures indicate the program was operating in a maintenance fashion during the period studied. The difference in the average ratings of establishments studied were not significantly different before and after the period. Although a considerable number of violations were corrected during the period, a slightly greater number of new violations occurred. Observations of a district that was not inspected for a period of time suggests that ratings would decline in the absence of the program.

Program activities were performed in considerably less quantity than planned but at near planned quality. Correlation of activity with objectives indicates that the number of activities performed has a small positive correlation with attainment of objective but that quality of activity as measured has a negative correlation with attainment. It was impossible in the present study to determine whether the assumptions about the quality of work that is thought to be effective are in error or whether the measure of quality was invalid. The analysis leads one to believe that had all activity been performed as planned, effectiveness would have been greater but still considerably short of complete attainment.

Program resources were expended at very nearly the planned level. Thus, failure to perform the number of activities planned resulted from error in planning assumptions linking these variables, not from failure to use resources as planned.

Efficiency was considerably less than anticipated for all efficiency measures.

It would seem four general directions are available to the program director in terms of future operations.

1. Since there is considerable room for improvement, both in terms of rating and correction rates, he may plan to increase program effectiveness in the future. The implications from this study are that some improvement would be possible by performing more activity of the same sort as in the past. It would seem advisable, however, to think more in terms of modifying the qualitative aspects of activity. Unless some basis could be found for justifying a particular modification, it might be preferable to experiment with several kinds of qualitative modifications in different areas to learn the relative effectiveness (and efficiency) of different kinds of activity. Current efficiency findings would be of little value in planning for the future should different kinds of activity be planned.

2. The program director might decide that current levels of effectiveness and efficiency are about as high as possible, and are satisfactory. In this instance, he would be likely to decide to maintain current levels of operation.

3. A third kind of decision would be to maintain similar levels of objectives while trying to improve current efficiency levels.

4. Finally, based on knowledge of current levels of operations and estimates of potential alternatives, the decision could be made to discontinue the program in favor of some equally beneficial alternative program where efficiency is estimated to be greater. Since the program is established on a legislative rather than administrative basis, such a decision may be unrealistic in the present case.

It does seem clear, however, that considerations of desired and actual effectiveness should logically precede considerations of efficiency. The planner would consider first the levels of effectiveness that are desirable and only then consider the expected costs of each level of achievement. His final decision concerning future operations will depend on the relationship of costs to predicted benefits, except in the rare case where an objective is deemed so desirable that costs are of no concern.

Program evaluation is frequently described as an inexpensive, operational tool to aid in the planning and conduct of ongoing program activities. Evaluation is also frequently said to be most useful if it is "built in" to program planning and if it is "continuous." However well-sounding these concepts may be, they must frequently leave the program operator in a state of vagueness or ambiguity because little information is available on how inexpensive, built-in, continuous evaluation may actually be accomplished in the context of a real program.

To provide answers to these questions a program evaluation is here reported which produced information of rather considerable usefulness in program planning. Moreover, the evaluation was conducted without gathering any original data, by using exist-

<sup>1</sup>This investigation was supported by the Public Health Service, Research Grant No. CH 00044 from the Division of Community Health Services.

ing program records. Thus, the marginal costs of obtaining the evaluative data were zero. The amount of professional and clerical time necessary to analyze was, as will be seen, low; in fact, the largest item of expense may well be the time consumed in the preparation of the present paper.

This report is oriented toward demonstrating the following conclusions: (a) program evaluation produces data that can materially improve program planning and operation, (b) program evaluation can sometimes be done inexpensively, (c) for at least some programs, inexpensive reporting schemes can be developed which produce evaluative data on a continuing basis and (d) the analytic skills frequently involved in making objective evaluations are either already contained in many health agencies or are easily within reach.

#### EVALUATION DESIGN

The logic behind the evaluative approach employed has been described elsewhere (1, 2). It entails specifying information about three program variables:

1. Objective: A situation or condition of people or the environment which is considered by responsible program personnel to be desirable to attain. To permit subsequent evaluation, the statement of an objective must include a specification of:

- a. *What*—the nature of the situation or condition to be attained.
- b. *Extent*—the quantity or amount of the situation or condition to be attained.
- c. *Who*—the particular group of people or portion of the environment in which attainment is desired.
- d. *Where*—the geographic area to be included in the program.
- e. *When*—the time at or by which the desired situation or condition is intended to exist.

2. Activity: Work undertaken in the service of an objective. Activity as used here is intended to convey what others may term method or effort. The term "activity" does not imply any fixed amount, or scope, of work; the size of a unit of activity may vary from program to program.

3. Resource: Personnel time, funds, materials, and facilities allocated to permit the performance or support of activity.

Ideally, each of the three variables is specified in the program plan; in some instances they are only implicit in the minds of program personnel. Nevertheless, for evaluative purposes, information is needed about (a) the planned level of attainment of each program variable and (b) the actual attainment at some point in time after the program has been in operation. Comparisons between the planned and actual status of each program variable give indices of program effectiveness while comparisons between each combination of two variables give indices of program efficiency.

By gathering data on objectives, activities, and resources, four evaluative questions may be answered: To what extent were pre-determined objectives accomplished by the program? To what extent were activities performed as planned? To what extent were program resources expended as planned? To what extent was the program conducted as efficiently as planned?

#### The program

The evaluated program was a food sanitation program in a mid-western county whose 1964 estimated population was 735,300. The program involves regulation of some 3,250 food establishments. Program personnel include a program chief, two field supervisors, 14 district sanitarians, one of whom is a vending specialist, and one health educator. A local advisory committee has been formed which meets regularly and advises on operation of the program. Classes for food industry employees are conducted routinely. (Food sanitation programs, highly traditional in public health, were deemed most worthy of evaluation since it has been shown that they consume a large proportion of environmental health budgets on the local level.)

#### Source of data

A program record system had been in operation for some years prior to the evaluation. These records contained much of the data needed in answering questions about program effectiveness and efficiency although there is no indication that the program operators made maximum use of it for those purposes. Where the record system did not include needed data, certain inferences had to be made which may be more or less acceptable to the reader. It should be pointed out, however, that had one known in advance what specific information would be needed for subsequent evaluation it would have been possible to build into the reporting system provisions for collecting it.

#### Program objectives

The objectives of this program had not originally been stated in precise enough terms to permit satisfactory measures. It was necessary, therefore, to reconstruct a measure of the objectives. Discussion with the program chief indicated that this program has two objectives: one relates to risk of food-borne disease; the other relates to esthetic acceptability of conditions in food establishments. These two objectives are not entirely independent since a given condition may be both esthetically unacceptable and also increase the risk of food-borne disease. The available data did not permit construction of separate measures for these two objectives.

The program uses a rating or scoring system in which the conditions of concern are grouped into 23 categories, such as storage of food, display and serving of food, lighting, ventilation, temperature control, etc. Each of the categories is then assigned a number intended to reflect the relative importance of the category; for example, lighting is given 3 points, wholesomeness of food is given 10 points. The total number of points distributed among the 23 categories is 100. This rating system is unusually flexible in that variable numbers of points may be debited, depending on the seriousness of the sub-standard condition observed. For example, sub-standard lighting may be debited 3, 2, or 1 point.

Although the program chief does not consider the rating system to be a completely adequate measure of the program objective as he views it, a more adequate measure is not available. Nevertheless, when a food service operation is rated less than 85, operating procedures require that additional program activity be carried out. This implies that the rating is used as an index of program effectiveness and that 85 is considered a minimum acceptable rating.

Since the rating is based on violations, another way of measuring attainment would be the violation correction rate. One major short-coming of a correction rate as a measure is that it is indifferent to the magnitude of the numbers involved. Thus, the rate is the same if 50 of 100 violations are

corrected as it would be for 5 of 10, despite the fact that in a given group of establishments, 10 violations are preferable to 100. Thus, one cannot look at correction rates completely independently of absolute ratings.

Two additional problems occur in the use of correction rate as a measure of effectiveness. First, a violation was considered uncorrected if any violation in the same category was reported on the subsequent inspection. Thus, a restaurant would not receive credit for correction of a previously noted violation, if, for example, it corrected inadequate lighting in the restrooms but, in the meantime, developed inadequate illumination in kitchen, because a lighting violation would still be observed at a second inspection.

Finally, it will be recalled that a "partial debit" system is used in this program. For example, cleanliness of equipment has a maximum value of 6 points, and may be debited any number of points between 1-6. Thus an establishment may have been debited 5 points on one inspection, and actually improved to only a 2-point debit on the next inspection; nevertheless, this was also counted as a non-correction because the problem still existed in some degree.

#### Program activities

Activities have both quantitative and qualitative components. Personnel are expected to make so many inspections and each inspection is intended to be of high quality. The development of a single measure of activity which includes both amount and quality is no simple task. This is especially true because program activities are varied as indicated in the following list provided by the program chief:

| Type of Activity                          | Estimated Amount of Program Time Consumed |
|-------------------------------------------|-------------------------------------------|
| Inspections                               | 75%                                       |
| Inservice Education                       | 12%                                       |
| Operation of Food Service Employee School | 5%                                        |
| Work with County Food advisory committee  | 5%                                        |
| Investigation of food-borne disease       | 1-2%                                      |
| Follow up of TB cases and contacts        | 1-2%                                      |
| Approval of plans and equipment           | 5%                                        |

The present evaluation is restricted to consideration of the inspectional component of the program since it consumes most of the program resources and also because adequate data were not available for measuring other activities.

The plan for frequency of inspection is stated in the following policy:

"The ordinances governing the licensing and control of food establishments require that each establishment be inspected at least once every three months. However, more frequent inspections are required of those establishments having low sanitation ratings and/or an excessive number of serious, repeated violations. The following chart is a guide used by district sanitarians in determining the frequency of inspections."

| Sanitation Rating Score | Frequency of Inspection |
|-------------------------|-------------------------|
| 85 or more              | 90-day intervals        |
| 75 to 84                | 60-day intervals        |
| 70 to 74                | 30-day intervals        |
| 65 to 69                | 15-day intervals        |
| 64 or less              | 2 to 10 days            |

It may thus be seen that there are different recommended intervals between inspections of different restaurants depending on the sanitation status at each inspection. Moreover, sanitarians may fail to make needed inspections precisely when planned; rather, they may inspect somewhat before or

after the planned date. These facts preclude any simple determination of the planned number of inspections.

The following scoring procedure was used in the present evaluation to measure the amount of activity: (a) The due date for the first inspection in the year 1966 was computed from the date and score of the last inspection in 1965—the year prior to evaluation. (b) Then the score on the first inspection during the 1966 evaluation period was used to determine the due date of the second inspection, and so on for all subsequent 1966 inspections. [On the basis of the sample of establishment records reviewed (to be described later), the average planned inspection frequency under the system is about 5.5 inspections per establishment per year.] (c) Based on 1 and 2 above, a formula was developed to provide a measure of the actual number of activities performed: Number of inspections =

$$1 + \frac{\text{No. of days in advance of due date}}{\text{No. of days in inspection interval}}$$

or

$$1 - \frac{\text{No. of days following due date}}{\text{No. of days in inspection interval}}$$

For example, if an establishment received a score of 72 on March 15, the next inspection would be due on April 15. If the inspection was actually made on April 15, it would be counted one inspection (i.e.,  $1 \pm 0/30$ ). However, if the inspection was made on April 1, it would be counted as 1.5 inspections (i.e.,  $1 + 15/30$ ). If made on May 1, it would be counted as 0.5 inspections (i.e.,  $1 - 15/30$ ).

The planned quality of inspections was defined as the average quality of work expected by the program chief. Two separate monthly ratings of the work of each district sanitarian were made by supervisors on a three point scale: *average, above average, below average*. One rating was based on the supervisor's direct observation of sanitarians' work in the field. It included impressions about accuracy of his observation in establishments, his manner of discussing findings and also the extent to which the proper number of inspections were being made. The other rating was based on a review of written inspections reports. Criteria for this rating included the clarity of the description of the violations and appropriateness of recommendations.

In order to quantify these ratings, arbitrary scores were assigned to each rating so that a rating of below average received a score of 1; average, a score of 2; and above average, a score of 3. The overall quality score was the average of the two quality ratings.

To arrive at a single measure of activity combining quantity and quality, the activity quantity score,  $\frac{\text{inspections performed}}{\text{inspections planned}}$  was multiplied by the quality score.

#### Resources

Program resources were measured in dollars. The program budget was used as the measure of planned or allocated resources while the expenditure report provided the measure of actual resources expended. Since the agency utilized program budgeting, there was a separate budget for the food program. Since some other programs contributed to the food program, e.g., the laboratory, the data processing unit and the agency's administrative unit, the food program was charged a proportion of each of these unit's budget, based on service to the food program.

## EVALUATION FINDINGS

The findings will be presented in the order in which they could ordinarily be obtained in program evaluation and not necessarily in the order of their importance. Thus, while an operator may be most concerned with the extent to which his program objectives have been attained, that question can ordinarily not be answered until relatively late in the evaluation. Long before that point is reached it is possible to check on the extent to which resources are expended as planned and activities are performed as planned. Similarly, program efficiency, dependent as it is upon knowledge both of outcomes (objectives attained) and inputs (resources expended) must follow data on program effectiveness.

*Effectiveness*1. *Resources*

The planned and expended program resources were as follows:

|                                                | Planned   | Actual    |
|------------------------------------------------|-----------|-----------|
| Food Program Budget                            | \$118,466 | \$114,084 |
| Vital Statistics (4% of V. S. budget)          | 3,607     | 3,480     |
| Laboratory (25% of Lab. budget)                | 5,348     | 4,945     |
| Administration (7.5% of Administration budget) | 8,885     | 8,556     |
| Program Resources                              | \$136,306 | \$131,065 |

The ratio of actual resources expended to planned resources equals .96; therefore, the program expended nearly all resources planned to be expended.

2. *Activities*

a) *Quantitative.* The activity data are based on a sample of 128 establishments. A stratified sample of all non-vending food establishments was selected by drawing 10 establishments at random from the case load of each of the 13 field sanitarians who had approximately the same case loads. One establishment was rejected since it had only been in operation a few weeks; the record of a second was lost prior to analysis. When the quantitative measures of data for activity were computed according to the procedures described earlier, the following results were obtained: (a) A total of 352 inspections should have been performed, according to the plan. (b) There were 215 actual inspections performed. (c) The 215 reduced to 209 inspections when the earlier described correction for interval was applied. (d) The ratio of actual to planned activity quantity is thus .59 (209/352); about three-fifths of the number of planned activities were actually performed.

b) *Qualitative.* The average quality of the inspections was .95 of planned quality. The average on the first quality rating was 1.9; on the second, 1.8. Since average rating was defined as 2, the average

of the ratings was divided by 2 to convert to a base of unity.

c) *Composite activity.* Multiplying average activity quality by average activity quantity yields a total activity score of .56 (.59 x .95); the ratio, actual activity to planned activity, is slightly more than half of the planned activity.

The validity of these measures is certainly open to question. Both the formula for computing activity frequency and the measurement of activity quality require further consideration.

One validity check on the measure of activity quantity was available. Since, as indicated, amount of work was one consideration in one of the "quality" ratings, it should be correlated with the activity frequency index. However, the correlation between these two scores was only .285 as calculated by Pearson's Product-Moment. This indicates that two different variables are being measured; at least one (and possibly both) of these scores does not accurately measure activity quantity.

*Objectives*

Initial analysis of the data on average ratings shows:

1. The average rating of establishments in the sample at the last inspections preceding the evaluation period was 87.0, the average rating at last inspection prior to the end of the evaluated period was 85.7, for a net reduction in compliance of 1.3.

2. The proportion rated 85 or higher at the beginning of the period was 66.4; at the end of the period, 60.5.

3. Of 84 operations rating 85 or above at the beginning of the evaluation period, 43 fell below 85 during the period and 19 were still below 85 at the last inspection.

4. Of 43 operations rated below 85 at the beginning of the period, 13 scored above 85 during the period and 5 were still above 85 at last inspection.

Before one concludes that the program had little or no positive effect, it is necessary to deal with the critical problem of what the ratings would have been had there been no program. An accurate answer would require a control or comparison group consisting of a randomly assigned sample of establishments which received no service. Lacking such a control group, it is only possible to estimate the program impact. Some evidence was obtained that ratings would decline over time in the absence of a program. One district had not received inspectional service over a 14-month period other than responding to complaints because a sanitarian vacancy could not be filled. During that time, as measured by a supervisor's survey, the average rating fell 12.5 points, from 75 to 62.5, compared to an average survey score for all districts of 72.6. It is, of course, dangerous to gen-

eralize the experience of this one district to the program as a whole.

The notion that ratings would decline in the absence of activity is supported to some extent by an analysis of violation correction rates. Of the 128 establishments in the sample, 100 had 2 or more inspections which permits computation of correction rates. These 100 operations had 615 violations at the first inspection during the period and 635 at the last inspection during the period. However, many of these operations had more than 2 inspections. In addition to the 615 violations at first inspection for which correction status could be determined, an additional 350 violations occurred for which there was a subsequent inspection, allowing their inclusion in computation of correction rates. Of the 965 violations, 330 or 34% were corrected during the evaluation period. Thus, although many violations were corrected, there was a net increase over the evaluation period of 20 violations, accounting for the lower average rating at the end of the period than at the beginning.

In a retrospective study, there is no way to determine how many, if any, of the 330 violations would have been corrected in the absence of the inspectional program. For technical practices such as use of a sanitizer, proper detergent concentration, temperature of operation of refrigerators and steamtables, one would expect an operator to continue current practice unless he saw an operational reason for changing. The same situation would be predicted for presence of physical facilities such as hot water in restrooms, sneezeguards over displayed food, hoods and exhaust fans, etc. In the case of violations of cleanliness or maintenance, however, a different situation exists. An initially clean or adequately constructed surface or utensil will, over time, become increasingly dirty or worn. On the other hand, some very dirty or worn surfaces and utensils will normally be cleaned, repaired, or replaced. The point in this time interval at which a sanitarian inspects probably greatly influences both the violation rates and the correction rates for cleaning and maintenance conditions.

Many sanitarians have heard operators say, "I was going to clean it tonight;" "I have a new one ordered which will be in next week." For such statements which are true, violations are recorded which would not have been violations had the inspection taken place a day or week later. In addition, the next inspection will show a correction that would have occurred even had there been no inspection. However, it is not easy to determine what proportion of these statements are in fact true. Therefore, we will make the assumption that all 330 corrections noted above can be attributed to the program.

If we use correction rate as the measure of program objective, the effectiveness ratio would be  $330/965$  or 0.34. This measure seems preferable to use of rating scores although a quite similar ratio can be obtained in the following manner.

The average rating at the beginning of the evaluation period was 87.0. If we could generalize the experience of the non-inspected district to the total program, we would expect the rating to decline at the rate of about one point per month, or 6 points over the period and would predict a rating of 81 at the end of the period in absence of program activity. The difference between actual rating at end of period (85.7) and predicted (81.0) is 4.7. Possible effectiveness would be 19, that is total effectiveness (100), minus predicted status (81). Thus, in terms of rating we would say the program was 4.7/19 or 0.26 effective.

It is the tenuousness of the assumptions involved in this calculation rather than the lower effectiveness which led us to select correction rate as the preferred index of effectiveness.

### *Efficiency*

Let us now look at the findings in terms of efficiency, which is defined as the relationship between program resources and attainment of program objectives.

It will be recalled that resource expenditures were \$131,065. Although inspectional work was estimated to comprise only 75% of program activity, we will assume for the evaluation that all of the resources were expended on inspectional activity—which is reasonable since inspections were given credit for the attainment of objectives.

Since only one-half year was studied, resources applicable to the evaluation period are \$65,532.50. Further, since we calculated activity and objective measures on a sample of 128 of the 3,250 establishments served by the program, the resources applicable to inspectional work in these operations are \$2,562.

Program efficiency, i.e., the relationship between objectives (calculated as corrections obtained) and resources is  $330/2562$ . The inverse ratio,  $2562/330$ , yields an average cost of \$7.76 per correction.

The subordinate efficiency measures, the ratios between (a) resources and activities and (b) activities and objectives are respectively:

1.  $209/2562 = 0.08$ , or an average cost ( $2562/209$ ) of \$12.26 per inspection.
2.  $330/209 = 1.6$  corrections per inspection.

These efficiency measures would have been quite different had the program operated as planned, i.e., all resources expended, \$2678; all activities perform-

ed, 352 inspections; and all of the objectives attained, 965 corrections.

The comparison of planned and actual efficiency is as follows:

|                             | Planned | Actual  |
|-----------------------------|---------|---------|
| Average cost per correction | \$2.78  | \$ 7.76 |
| Average cost per inspection | 7.61    | 12.26   |
| Corrections per inspection  | 2.74    | 1.60    |

#### INTERPRETATION OF FINDINGS

The overall measures of effectiveness show (a) the ratio of actual to planned resource expenditure is 0.96, (b) the ratio of actual to planned activity performance is 0.56, and (c) the ratio of actual to planned objective attainment is 0.34. It is clear that the program plan substantially overestimated attainment on two of the three variables; although the program did expend nearly all of the planned resources, it performed only a little more than half the planned activity and accomplished about one-third of the planned objective.

If we could assume these relationships would remain constant if applied in the future and at different levels, we could predict the result of various proposals.

Suppose, for example, we asked, what would it require in resources and activities to correct all existing violations? Since there were 635 existing violations at the end of the period, we would estimate it would require 397 inspections ( $635/1.6$ ) at a cost of \$4867.22 ( $635 \times \$12.26$ ) to correct the existing violations in the 128 operations in the sample. We would estimate for the program, there would be 16,120 violations requiring 10,075 inspections at a cost of \$123,519.50. This, of course, ignores new violations that would occur during the time period.

We could similarly set various levels of resources and predict what the food sanitation situation would be under the alternatives considered. Keep in mind, however, that these projections assume constant returns to scale, which only rarely occur. It is possible to look for places where efficiency might be improved. Since data for individual sanitarians were collected, we can examine the evaluations results separately for each sanitarian in an effort to produce analyses that are more useful for future planning.

Computation of the resource variable for individual sanitarians is unproductive since we find the salaries and expenses actually paid were in fact as planned. The total program ratio of 0.96 is explained by the existence of a staff vacancy during the period.

There is considerable variation among the sanitarians on the activity variable (Table 1). It can be seen that none of the sanitarians performed as many inspections as the schedule requires. Applica-

tion of the formula for adjusting the number of actual visits according to the planned timeliness of the visit resulted in increasing the number of inspections for three sanitarians, virtually no change for four and reducing the number for six. There was much more consistency among sanitarians in the number of inspections that should have been performed than in either actual or calculated performance.

There was much less variation in quality of work as it was measured. However, it is clear that one sanitarian performed considerably above average, two considerably below, five were slightly below, and five performed as planned.

There was also considerable variation among districts in terms of attainment of program objectives. These findings are reported in Table 2.

It can be seen in Table 2 that the highest correction rates were generally associated with highest initial ratings ( $r = +.378$ ). This suggests that there are differences among the districts and that corrections are somewhat easier to obtain in the initially better districts (or that correction would be more apt to be made even if there were no program). This observation, however, appears to be of little use for future planning except perhaps to suggest that in general, the more violations observed initially, the more effort may be required to get a given correction rate.

If the assumptions linking the performance of activity to attainment of objectives (in terms of correction rates) were true, one would expect to find a positive correlation between activity scores and correction rates.

We observe (a) there is a slight positive correlation between the quantity of activity and correction rate, (b) a consistent negative correlation between the three indices of activity quality and correction rate, and (c) little or no correlation at all between the composite activity measure and correction rate.

Before deciding whether program changes should be made on the basis of these findings, we must consider the question of the validity of the measures. (a) Do these indices actually measure the qualitative and quantitative components of activity?, and (b) Is correction rate a valid measure of the program objective?

If these measures were valid, the major implication would be that serious consideration be given to the concept of quality of work since that which has been defined as high quality of work does not produce a high correction rate and to some extent, may produce poorer correction rate.

If, however, the measures are not valid indicators of activity and objective, efforts need to be made to develop more appropriate measures.

TABLE 1. ACTIVITY MEASURES—BY SANITARIAN

| San. No. | No. Real Insp. Done | No. Insp. Due (By Formula) | No. Completed (By Formula) | Activity Quantity Score | Average Quality Score | Overall Activity Measure |
|----------|---------------------|----------------------------|----------------------------|-------------------------|-----------------------|--------------------------|
| 1        | 12                  | 30                         | 9.7                        | .32                     | .65                   | .21                      |
| 2        | 21                  | 30                         | 21.2                       | .68                     | 1.0                   | .68                      |
| 3        | 23                  | 35                         | 30.9                       | .88                     | .95                   | .84                      |
| 4        | 19                  | 28                         | 17.3                       | .62                     | .90                   | .57                      |
| 5        | 16                  | 27                         | 15.3                       | .57                     | 1.0                   | .57                      |
| 6        | 12                  | 20                         | 8.9                        | .44                     | .90                   | .39                      |
| 7        | 15                  | 23                         | 15.3                       | .67                     | 1.0                   | .67                      |
| 8        | 9                   | 23                         | 7.4                        | .32                     | 1.0                   | .32                      |
| 9        | 21                  | 25                         | 20.6                       | .82                     | .90                   | .76                      |
| 10       | 17                  | 27                         | 18.4                       | .68                     | .80                   | .52                      |
| 11       | 15                  | 21                         | 12.3                       | .59                     | .90                   | .54                      |
| 12       | 18                  | 25                         | 17.3                       | .69                     | 1.2                   | .83                      |
| 13       | 17                  | 38                         | 14.4                       | .38                     | 1.0                   | .38                      |
| Program  | 215                 | 352                        | 209.0                      | .59                     | .95                   | .56                      |

TABLE 2. OBJECTIVE MEASURE—BY SANITARIAN DISTRICT

| Sanitarian District | Ave. Rating Beginning of Period | Ave. Rating End of Period | Violations Subject to Correction Over Total Period | Violations Corrected By End of Period | Percent Violations Corrected |
|---------------------|---------------------------------|---------------------------|----------------------------------------------------|---------------------------------------|------------------------------|
| 1                   | 91.9                            | 89.4                      | 19                                                 | 9                                     | 47                           |
| 2                   | 89.4                            | 85.4                      | 72                                                 | 26                                    | 36                           |
| 3                   | 85.4                            | 89.6                      | 171                                                | 66                                    | 39                           |
| 4                   | 81.6                            | 83.4                      | 108                                                | 43                                    | 40                           |
| 5                   | 87.3                            | 85.2                      | 46                                                 | 9                                     | 20                           |
| 6                   | 86.1                            | 84.4                      | 53                                                 | 16                                    | 30                           |
| 7                   | 87.7                            | 87.8                      | 74                                                 | 22                                    | 30                           |
| 8                   | 89.0                            | 85.5                      | 41                                                 | 10                                    | 24                           |
| 9                   | 82.6                            | 85.1                      | 56                                                 | 20                                    | 36                           |
| 10                  | 84.1                            | 85.6                      | 80                                                 | 23                                    | 29                           |
| 11                  | 91.3                            | 93.1                      | 71                                                 | 45                                    | 63                           |
| 12                  | 85.0                            | 83.6                      | 89                                                 | 23                                    | 26                           |
| 13                  | 86.3                            | 82.2                      | 85                                                 | 18                                    | 21                           |
| Program             | 87.0                            | 85.7                      | 965                                                | 330                                   | 34                           |

The rank order correlations of the various activity measures with correction rate are reported in Table 3.

TABLE 3. CORRELATION OF MEASURES OF ACTIVITY AND OBJECTIVES

| Activity Measure         | Correlation of Activity Measures With Correction Rate |
|--------------------------|-------------------------------------------------------|
| Quantity                 | +.19                                                  |
| Quality rating No. 1     | -.23                                                  |
| Quality rating No. 2     | -.62                                                  |
| Combined Quality ratings | -.55                                                  |
| Overall activity score   | +.12                                                  |

It is unfortunate that sub-objectives were not specified for this program. Specification and measurement of such sub-objectives would have contributed to identification of reasons for the low correction rate and would thus have provided a firmer basis for program improvement.

Interpretation of the efficiency findings depends in part on future plans for the program. If it should be decided that little improvement in effectiveness is possible or required, one might seek ways of reducing costs while maintaining current levels of effectiveness. If, however, greater accomplishment is desired, the focus would be on ways of obtaining a higher rate of activities or different kinds of activities.

If rather drastic changes in the amounts or quality of activity are made, data on current levels of efficiency based on past operation may have little applicability to future planning.

#### COSTS OF EVALUATION

There were no out-of-pocket costs required for this study. Several hours of the program director's time were required for describing the program to the authors, discussion of the program objectives, and discussion of measurement of objectives and activities. A few hours were required for selecting the sample and abstracting data from summary record cards and personnel records. About one week of a statistical clerk's time was required for coding and tabulation of the data. The only additional costs were the authors' time spent in interpretation and the preparation of this paper.

In retrospect, it may have been worth the additional time that would have been required to abstract data on compliance from the narrative inspection reports. This would have allowed (a) separation of new violations from continuing violations when there were consecutive violations within a category and (b) taking account of changes in the severity of violations.

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## APPLICATION OF THE OXIDASE TEST TO REFRIGERATED DELICATESSEN FOODS

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### ABSTRACT

A total bacterial count, oxidase count, coliform, and yeast and mold count was made on each of 135 samples of delicatessen foods collected at retail outlets and food processing plants. Analysis of the data obtained, primarily through correlation of the total count, oxidase and coliform counts, allowed for an assessment of possible sources of bacterial contamination. The importance of the oxidase test is stressed since delicatessen foods may be contaminated by psychrophilic pseudomonads and this test offers a rapid measure of such contamination. Interpretation of results obtained on any one sample are explained.

Bacterial examination of food products is usually conducted for one of three reasons: detection of pathogens, as an index of gross contamination, or as an estimate of probable shelf life. It is this last category which we discuss in this report including an evaluation of sanitary practices in the processing plant or food market as determined by the interpretation of bacteriological analyses.

The organism or group of organisms chosen as an indicator of perishability must reflect the condition under which the food is stored. Since delicatessen foods (salads, stuffed clams, coleslaw, chopped liver, potato salad, etc.), which are the subject of this report, are kept under refrigeration, a psychrophilic count could have meaning. Unfortunately, a standard test for psychrophiles takes at least 7 days to complete and after this time interval the data may be of only historical significance. However, the rapid test for potential psychrophiles proposed by Hankin and Dillman (4) allows for the almost simultaneous determination of the total bacterial count and potential psychrophiles. This test measures the number of oxidase-positive organisms and can be completed within 48 hr. A correlation between the oxidase test and potential psychrophiles in pasteurized milk has been shown (4). Pseudomonads comprise the largest group of psychrophiles in foods (9) and are particularly obnoxious in that many produce off-flavors and odors in a relatively short period of time. The oxidase test when applied to milk has been shown to give an indication of sanitary practices on the farm (5) and the number of oxidase-positive organisms in pasteurized milk has been correlated with certain off-flavors by Hankin and Anderson (3).

This study was conducted to determine if the oxidase test, and its relationship to other bacteriological analyses, could be applied to refrigerated foods, particularly the delicatessen foods. A study of this type of food within this State would also provide guidelines for the interpretation of results obtained in the subsequent analysis of individual samples and help processors in providing a better quality of product to the consumer.

### METHODS

Commercial food samples were aseptically collected on the open market, refrigerated (38-40 F), and delivered to the laboratory on the same day. Total numbers of bacteria were determined according to recommended methods (1). The yeast and mold counts were made on potato dextrose agar (Difco, Detroit, Michigan), and the number of coliform organisms was determined with both violet red bile agar (Difco) plates and a standard Most Probable Number procedure (1). The oxidase test was conducted on the same plates as were used for the total bacterial count with the method as described by Hankin and Dillman (4).

### RESULTS AND DISCUSSION

The 135 samples examined were arbitrarily divided into categories, because of similarity of product, to facilitate discussion. These categories are: coleslaw, including garden salad; stuffed clams; other types of salads (including ham, chicken, macaroni and herring); potato salad; fish products other than stuffed clams; and miscellaneous items such as corn, beet and cucumber salads, puddings, and refrigerated bakery products.

A summary of the test results is shown in Table 1. The following general statement can be made concerning all samples. With a few exceptions, stuffed clams and coleslaw contained more oxidase-positive organisms (as per cent of the total count) than any other category. Fish products ranked next in total number of oxidase-positive organisms. A discussion of the significance of these results is presented under each category. The number of oxidase-positive organisms is stressed in this report since they are potentially psychrophilic (4) and in this respect extremely detrimental in delicatessen type foods. This is not to suggest that the presence of pathogens or



TABLE 1. VIABLE COUNTS OF DELICATESSEN FOODS—135 SAMPLES EXAMINED

| Type of Product            | Number of Samples Examined | Total bacterial count (per g) |                    | Oxidase count (per g) |                   | Coliform count (per g) |                  | Yeast and mold count (per g) |  |
|----------------------------|----------------------------|-------------------------------|--------------------|-----------------------|-------------------|------------------------|------------------|------------------------------|--|
|                            |                            | Average <sup>1</sup>          | Range              | Average <sup>1</sup>  | Range             | Range                  | Range            |                              |  |
| Stuffed clams              | 15                         | 102,000                       | 3,500—<br>>300,000 | 28,000                | <300—<br>>300,000 | <10—<br>>2,400         | <10—<br>8,100    |                              |  |
| Coleslaw <sup>2</sup>      | 22                         | 68,000                        | <300—<br>>300,000  | 30,000                | <300—<br>>300,000 | <10—<br>1,600          | <10—<br>13,000   |                              |  |
| Potato <sup>3</sup> salad  | 24                         | 46,000                        | 310—<br>250,000    | 2,000                 | <300—<br>34,000   | <10—<br>680            | <10—<br>5,400    |                              |  |
| Salads <sup>4</sup>        | 35                         | 105,000                       | <300—<br>>300,000  | 9,000                 | <300—<br>94,000   | <10—<br>>3,000         | <10—<br>>300,000 |                              |  |
| Fish products              | 11                         | 42,000                        | <300—<br>>300,000  | 6,000                 | <10—<br>44,000    | <10—<br>1,300          | <10—<br>5,700    |                              |  |
| Miscellaneous <sup>5</sup> | 28                         | 108,000                       | 320—<br>>300,000   | 2,000                 | <300—<br>48,000   | <10—<br>>3,000         | <10—<br>>300,000 |                              |  |

<sup>1</sup>A few samples were reported as <3,000 or >300,000. In these few instances the count was arbitrarily set at 3,000 or 300,000 for computation of the average, only for use in this table.

<sup>2</sup>Eight samples were labeled as containing a preservative.

<sup>3</sup>Seven samples were labeled as containing a preservative.

<sup>4</sup>Five samples were labeled as containing a preservative.

<sup>5</sup>One sample was labeled as containing a preservative.

TABLE 2. EXAMPLES OF POSSIBLE SOURCES OF CONTAMINATION IN VARIOUS PRODUCTS AS DETERMINED BY RELATIONSHIP BETWEEN TOTAL COUNT, OXIDASE COUNT, AND COLIFORM COUNT (MPN).

| Sample              | Total Count (per g) | Oxidase Count (per g) | Coliform (MPN per g) | Probable interpretation                                  |
|---------------------|---------------------|-----------------------|----------------------|----------------------------------------------------------|
| Coleslaw            | 110,000             | 33,000                | >2,400 <sup>1</sup>  | Organisms from unwashed and loose outside cabbage leaves |
| Coleslaw            | > 300,000           | >300,000              | 460                  | Dirty equipment                                          |
| Coleslaw            | 140,000             | 160                   | <3                   | Ingredient contamination other than cabbage              |
| Stuffed clams       | 300,000             | 20,000                | >2,400               | Dirty shells and/or dirty equipment                      |
| Stuffed clams       | 18,000              | 10,000                | 23                   | Dirty equipment                                          |
| Stuffed clams       | 260,000             | 1,200                 | >2,400               | Dirty equipment or contaminated ingredients              |
| Potato salad (9291) | 200,000             | <10                   | 3.6                  | Contaminated ingredients                                 |
| Potato salad (9272) | 4,800               | 3,800                 | <3                   | Dirty utensils                                           |
| Potato salad        | 210,000             | 34,000                | >2,400               | Dirty utensils, poor handling                            |
| Potato salad        | 9,400               | 1,300                 | >2,400               | Poor handling                                            |
| Ham spread          | >300,000            | 10                    | 1,100                | Contaminated ingredients                                 |
| Chicken rolls       | 5,100               | 160                   | <3                   | O.K.                                                     |
| Bean salad          | 230,000             | 210                   | —                    | Contaminated ingredients                                 |
| Eclairs, custard    | 260,000             | 0                     | 93                   | Poor refrigeration                                       |

<sup>1</sup>*E. coli* in this sample <3 per g.

organisms of the coliform group are any less important. The oxidase test provides additional information about the source of contamination in the sample. Although many samples showed a high yeast and mold count we did not find a correlation between this test and the other tests made.

The data shown in Table 2 indicate the type of interpretation that can be reached from information obtained from the tests carried out. For example, coleslaw might be expected to contain high numbers of oxidase-positive organisms since pseudomonads

abound in soil and water (8) and can become lodged between the leaves of the cabbage, especially the outer ones. The type of treatment that the cabbage receives prior to shredding varies considerably. In some instances neither the outer leaves are removed nor is the cabbage washed prior to shredding. Our information, from knowledge of individual plant practices, indicates that high oxidase counts are associated with the non-washers and non-leaf removers. If the outer leaves are used they should be removed and washed prior to use. If the outer leaves are re-

moved and washed, and a high oxidase count is found then dirty equipment would be indicated as the source of contamination.

In fish, especially shellfish, emphasis is placed upon determining whether or not the sample was harvested from contaminated waters. The coliform test serves as the indicator. Pseudomonads, however, may also be prevalent on fish (2, 6) and can also serve as an indicator group of organisms. Most processors of stuffed clams use canned clams which have been heat treated. Therefore, the presence of oxidase-positive organisms (and coliforms) presumably indicates either poorly sanitized shells, dirty utensils or contamination from ingredients other than clams. If the oxidase count is high and the coliform count is also high then contaminated shells is probably the source of contamination. If the oxidase-positive count is high but the coliform count is low, then dirty equipment is the source. The results of the oxidase test coupled with that of the coliform test is a useful combination for determination of the source of bacterial contamination. A few examples are shown in Table 2.

As an illustration, a test was made in one plant to determine if undersanitized shells were contributing to the bacterial count of stuffed clams. Stuffed clams were taken from a production line. Unstuffed shells were taken from the line, sanitized with a 200 ppm chlorine mist, replaced on the line, and subsequently filled. Bacterial examination revealed the following. Production line stuffed clams: total count, 60,000/g; and oxidase count, 3,400/g. Clams on sanitized shells: total count, 11,000/g; and oxidase count 2,000/g. It was clear in this instance that poorly sanitized shells contributed materially to the bacterial count. Sanitizing the shells reduced the total count by about 82% and the oxidase count by about 41%.

Fish products other than stuffed clams include shrimp rolls, clam cakes, clamburgers, and fish spread. Generally, higher total count and oxidase counts were found in shrimp products. It would appear that interpretation of data obtained is the same as for stuffed clams since shrimp are also given some heat treatment prior to use.

Most of the ingredients in potato salad are either thoroughly cooked prior to use (potatoes, eggs) or heat treated (mayonnaise) with the possible exception of optional ingredients such as raw celery. Therefore, high coliform counts indicate poor handling and high oxidase counts dirty equipment. Examples are shown in Table 2. In sample labeled 9291 neither the oxidase nor the coliform count was high. The source of contamination therefore was probably not hands or dirty equipment. In 9727 the total count was low but since most of the total was oxidase-

positive, contamination from dirty equipment was indicated. In raw milk it has been shown that when the percentage of oxidase-positive organisms in the total count is high, the source of the sample merits attention since it can indicate a build-up of these organisms on equipment and subsequent recontamination of fresh samples (5).

In the category of miscellaneous foods, chopped liver is of sufficient interest to warrant some discussion. Although 6 of the 9 samples had a total count of 100,000/g (most over 300,000) the oxidase counts were low, both percentagewise and in actual numbers. The coliform counts tended to be high on these samples. However, since liver is par-boiled before it is processed the high coliform numbers indicate extremely poor processing techniques. The lack of high oxidase counts shows no general utensil contamination.

Other miscellaneous products were quite variable. Many had been cooked or baked and showed a low total count. A few examples are shown in Table 2. In salads, both the total count and oxidase counts were quite variable. High counts reflect both the degree of contamination of ingredients as well as post-processing contamination. The oxidase count on eclairs was relatively low. In one instance the total count was 160,000/g; the oxidase count 48,000/g or about 33%. Such information indicates post-processing contamination. The same interpretation can be made when products are processed by high heat such as baked goods. A high total count with low oxidase count can indicate faulty refrigeration. Obviously in any one product some assessment must be made as to the "normal" oxidase-positive flora of the product.

Many studies have been made to show that either total viable or direct microscopic counts indicate the sanitation level that occurred during processing. It is our contention, however, that while a total count may reflect the sanitation level it does not provide adequate information as to the source of contamination nor does it adequately portray the bacterial flora of the product. The use of the oxidase test in conjunction with a total bacterial count quickly provides further insight into possible groups of organisms and does this without excessive laboratory time. In general, bacterial counts at the level of  $10^6$  or  $10^7$  per g of material are required before decomposition can be detected organoleptically (2). However, Peterson and Gunderson (7) found only  $10^4$  psychrophilic organisms were needed per g of chicken pot pie to give an off-flavor. Such levels of oxidase-positive organisms were found on some of the samples examined in our study. While some work has been done on the relationship between oxidase-positive organisms and flavor in foods, it is clear that further investiga-

tion in this area is needed in order to help in the promulgation of meaningful standards for this type of organism in food products.

What we have shown in this report is that routine bacteriological tests on delicatessen foods can be made more meaningful when the oxidase test is applied to the total count. It not only provides a measure of potential psychrophiles in the food but it also provides a ready insight into sanitary practices at the processing plant. It must be stressed that some knowledge of the "normal" flora of the basic ingredients of a food product and processing procedures is essential. Information, especially as regards psychrophiles, is not available quickly and at the same time as the total count when standard tests are applied to this group of organisms. Our data have pointed out specific instances in the use of the combination of bacteriological tests to both pin-point possible sources of contamination and also to detect potential psychrophiles. Thus, more efficient use is made of the data already being obtained when the results of the total count are coupled with the results of the oxidase test and the coliform count.

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## HARMLESS MICROBES NOW CUT GREASE TRAP MAINTENANCE COSTS

A new microbial concentrate that cuts maintenance costs by eliminating grease build-up, sewer line clogging and hand cleaning of grease traps has just been announced by Circle Research Laboratories, Inc., Glen Ridge, New Jersey.

The new formulation, Grees-Out Formula No. 150 Bacteria-Enzyme Grease Trap Cleaner and Deodorizer, is a wettable powder with a high concentrate of specialized fat-digesting bacteria and enzymes, plus protease, amylase and cellulase producing microorganisms that digest other organic waste which may be combined with the fats and oils in a grease trap. The effectiveness is long-lasting. The bacteria in it penetrate grease and other organic waste, establish reproducing colonies in them, and continue digesting them for prolonged periods of time after each treatment. The microorganisms use waste as food—literally eating away clogging substances.

An important feature is odor control. Hot water in grease traps and other plumbing tends to upset the symbiotic balance

of bacteria in them. It kills certain types of bacteria that cannot stand high temperatures, but permits other bacteria, which can stand heat, to multiply. These give off offensive odors. The bacteria in Grees-Out are specially bred to consume organic-waste over a wide temperature range, thereby controlling odors.

Grees-Out is certified salmonella-free and may be used in food preparation and food service areas; it contains no poisonous, caustic or acid chemicals. A grease trap or other plumbing fixture may be examined after treatment without danger of skin burns or eye damage. Simple to use, Grees-Out No. 150 is mixed with warm water and flushed into grease traps through sink or other drains nearest traps. Circle Research has prepared a Product Bulletin which contains complete information on the product as well as directions for use in all types of traps and plumbing lines. A free copy is available from Circle Research Laboratories, Inc., Glen Ridge, N. J. 07028.

# PRACTICAL CONTROL OF SALMONELLAE<sup>1, 2</sup>

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## ABSTRACT

Salmonellae occur in practically all raw feeds and foods of animal origin; consequently the key word to their control is sanitation. The twentieth century has brought with it profound changes in animal husbandry practices, large-scale production of foods, packaging innovations, mass storage, transportation, and retailing patterns. As a consequence of these developments, substantial segments of the consuming public can be placed at risk within a short period of time.

Surveillance of animals, their feeds, and other raw materials to assure that *Salmonella* contamination is minimized is of paramount importance. Pest control, ingredient specifications, handling requirements, improved personal hygiene practices, proper clothing, and prevention of foods to access by workmen who are ill or have cuts, sores, or boils are of equal importance to the maintenance of quality. Other requisites for holding salmonellae in check are the elimination of dust, debris, and refuse from the plant; proper cleaning of equipment and utensils in contact with foods; inactivation of microorganisms by the application of cold or heat; rigid control of ingredients; and segregation of finished products so that cross-contamination is not possible. The role of the producer, processor, warehouse man, trucker, regulatory and public health officials; doctor, retailer, and consumer in contributing to this chain of infection must be properly assessed.

## BACKGROUND

Among the major foodborne illnesses to which man is susceptible, salmonellosis recently has received the most attention. During the past 5 years, isolations of salmonellae reported have been in the neighborhood of 20,000 per annum (Fig. 1) and the number of reported cases varies from 300 to 500 each week. Most infections take place during the months of July, August, September, and October and might be attributed to the widespread popularity of outings and picnics during that period which provides peak opportunity for the ingestion of these organisms. Many public health officials consider the true incidence of salmonellae to be far higher. Several investigators intimate that the true number may be 5-20 times this figure (2, 3, 9).

Each year during this same interval there has been an increase in non-human *Salmonella* isolations (Fig. 2). Until 1966 turkeys and chickens accounted for over one-half of the isolates (Fig. 3). In 1966, how-

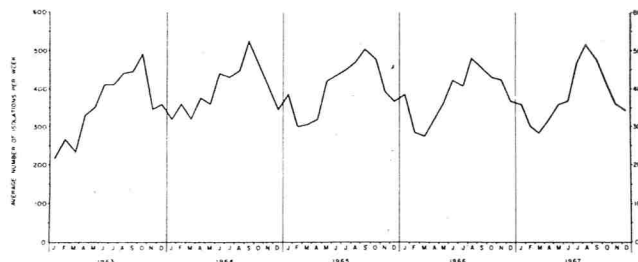


Figure 1. Reported human isolations of salmonellae in the United States. (Courtesy: NCDC, HSMHA, PHS, USDHEW).

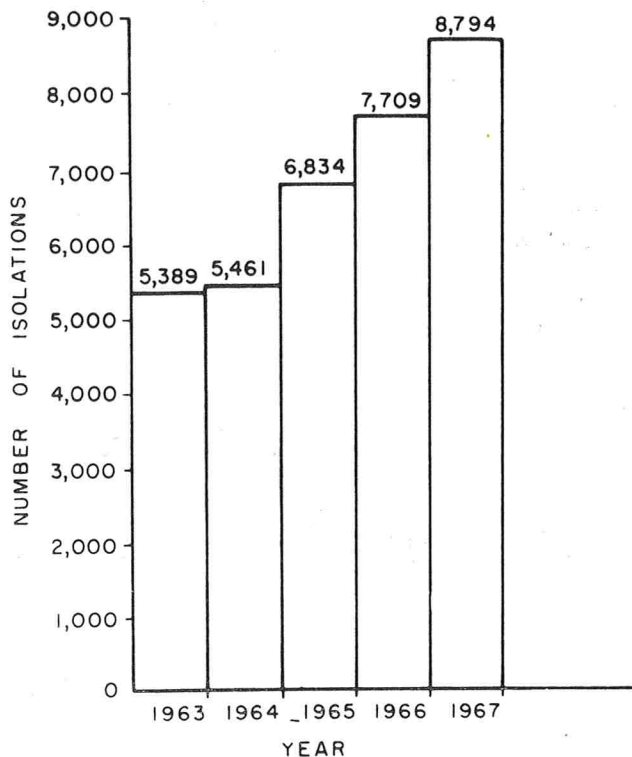


Figure 2. Reported nonhuman isolations of salmonellae, United States, 1963-1967. (Courtesy: NCDC, HSMHA, PHS, USDHEW).

ever, they represented 42.3% and in 1967 only 27.5% of all isolations while 16.5% and 17.5%, respectively, came from animal feeds, 12% and 16.2% from cattle and swine, 5.3% and 6.3% from eggs and egg products and the remainder from other fowl and animals, water, dried foods, other foods, dyes, animal glandular products, and a miscellany of other sources (Fig. 4 and 5).

<sup>1</sup>Presented at the 55th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Inc., St. Louis, Mo., August 18-22, 1968.

<sup>2</sup>Journal Series Paper No. 343, University of Georgia, College of Agriculture Experiment Stations, College Station, Athens.

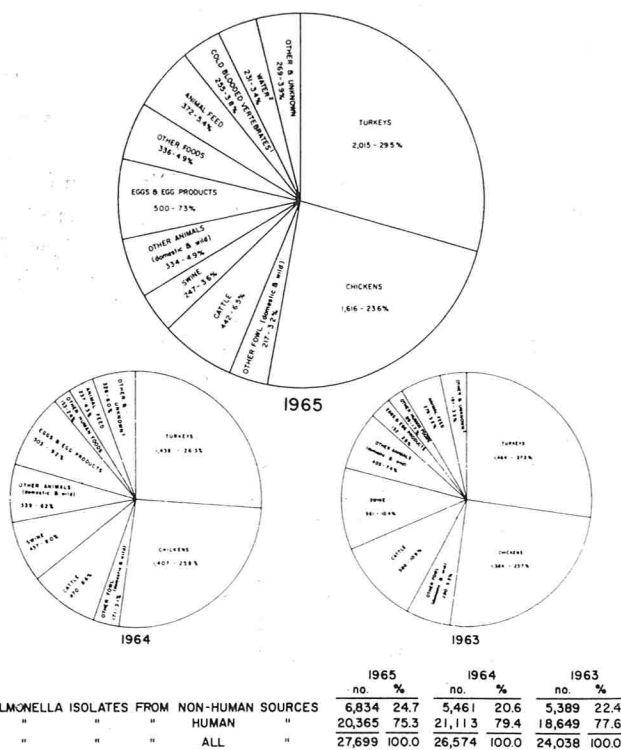


Figure 3. Number and per cent of non-human *Salmonella* isolations from the indicated sources in the United States. (Courtesy: NCDC, HSMHA, PHS, USDHEW).

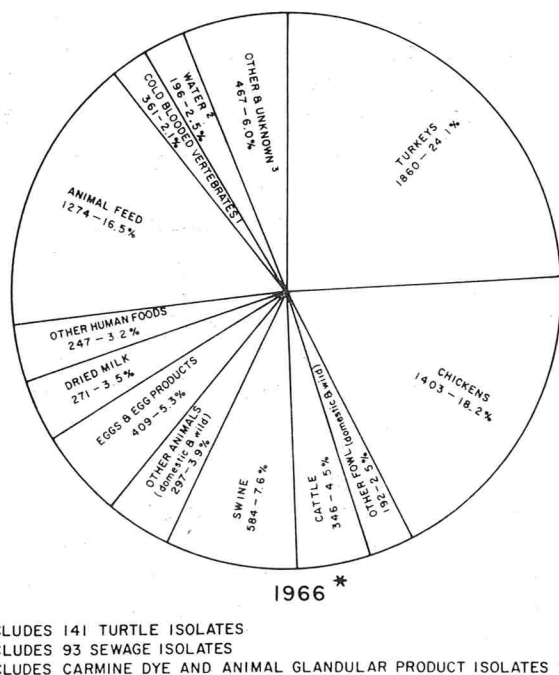


Figure 4. Number and per cent of non-human *Salmonella* isolations from the indicated sources in the United States. (Courtesy: NCDC, HSMHA, PHS, USDHEW).

These organisms are so widespread in nature that it is readily possible to recover them from flies, cockroaches, shellfish, carp and other scavenger fish, reptiles, free flying birds, rodents, monkeys, and man (Table 1). Common household pets including goldfish, turtles, canaries, parakeets, parrots, guinea pigs, rabbits, cats, and dogs (Table 1) are other important sources of these pathogens. During the years 1965 and 1966, the Communicable Disease Center recovered some 215 and 141 isolates, respectively from turtles as a result of an intensive investigation of these pets. Since pet turtles are kept in aquaria or terrariums where they ordinarily receive grossly contaminated feed and from time to time the container and contents are emptied into the same sink where

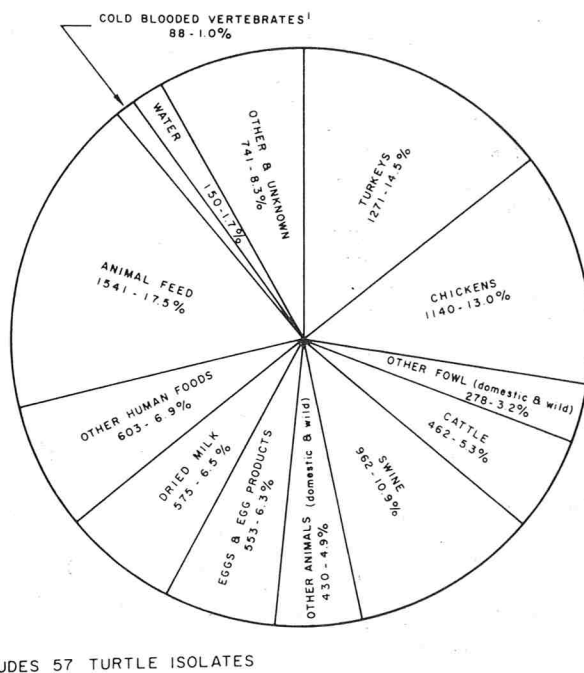


Figure 5. Number and per cent of non-human *Salmonella* isolations from the indicated sources in the United States-1967. (Courtesy: NCDC, HSMHA, PHS, USDHEW).

dishes may be washed later, this source of infection has more relevance than one might expect.

Apparently nearly every domestic bird or mammal is a potential source of salmonellae (Table 1). Of even more direct concern are foods derived from dried eggs, dried milk, cheese, poultry and meat products, coconut, and bakery products (Table 1). Every one of these foods have been implicated in outbreaks of salmonellosis. A few years ago eggs and egg products were considered the prime offenders but now the Federal Government requires that egg products be pasteurized and during the past 2-3 years, more attention has been given to much more exotic sources of salmonellae such as carmine (a dye made from the cochineal bug), candy, instant non-fat dried milk,

and glandular products such as desiccated thyroid.

The ecology or relation of *Salmonella* to its environment provides valuable clues to the epidemiologist, and for this reason the establishment of the antigenic pattern of the recovered organism is important. The unusual occurrence of several isolations of *Salmonella new brunswick* prompted the Communicable Disease Center (CDC) of the Public Health Service in 1966 to issue an alert to all laboratories that were regularly serotyping *Salmonella* to be on the lookout for this organism and, if found, to report such find-

source of eggs and meat. During the past quarter century this picture has changed in Georgia and many other states so that now the rearing of broilers is an integrated agri-business. The poultry processor has control over the feed, eggs used for hatching, growth of the broilers, use of pesticides, and merchandising of the meat—perhaps even as far as at the retail level. Present day production practices for turkey broilers are similar, in many respects, to those applied to chickens. While the rearing of other livestock is not as rigidly intergrated, feed lots used for swine, sheep, and cattle receive intensive use.

TABLE 1. SOURCES OF SALMONELLAE

|                                                                                                                                                                                                                                                          |                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| A. <i>Natural sources:</i>                                                                                                                                                                                                                               |                                                                                                                                                       |
| mollusks                                                                                                                                                                                                                                                 | — oysters, clams, snails, slugs                                                                                                                       |
| arthropods                                                                                                                                                                                                                                               | — (insects) flies, fleas, cockroaches, ticks, and mites; crayfish, lobster, crabs, other crustacea                                                    |
| fish                                                                                                                                                                                                                                                     | — carp and other scavenger fish                                                                                                                       |
| reptiles                                                                                                                                                                                                                                                 | — snakes, lizards, tortoises                                                                                                                          |
| birds                                                                                                                                                                                                                                                    | — sparrows, starlings, doves, ducks, geese, swan, pheasant, turkey, peafowl                                                                           |
| mammals                                                                                                                                                                                                                                                  | — (rodents) mice, squirrels, gophers, hedge hogs; (carnivores) especially foxes, skunks, bears; (ungulates) deer, elk, moose; (primates) monkeys, man |
| B. <i>Pets:</i>                                                                                                                                                                                                                                          |                                                                                                                                                       |
| sunfish, snakes, alligators, turtles, canaries, parakeets, parrots, chicks, ducklings, pigeons, guinea pigs, hamsters, rabbits, squirrels, cats, dogs                                                                                                    |                                                                                                                                                       |
| C. <i>Domestic animals:</i>                                                                                                                                                                                                                              |                                                                                                                                                       |
| chickens, pheasants, turkeys, guinea fowl, ducks, geese, pigeons, rabbits, swine, cattle, sheep, goats                                                                                                                                                   |                                                                                                                                                       |
| D. <i>Food products:</i>                                                                                                                                                                                                                                 |                                                                                                                                                       |
| water and ice, milk and milk products (especially cheese), poultry and poultry products, eggs and egg products, fish and shell fish, meats and meat products, candy, confections, bakery products (especially cakes and pastries), fruits and vegetables |                                                                                                                                                       |

ing to the CDC. This chain of events led to the discovery that several commercially produced instant non-fat dried milk products were contaminated. As a result of this information, the Food and Drug Administration required that these products be recalled and shortly after these seizures the source of *S. new brunswick* was located and was associated with faulty sanitation in a milk drying plant. The outbreak was terminated after equipment and procedures in this plant were modified.

#### SALMONELLAE ASSOCIATED WITH THE LIVE ANIMAL

Profound changes have taken place in animal husbandry practices during the twentieth century. In earlier years, poultry was raised on individual farms in small numbers and primarily considered by most of the people raising these birds as an immediate

Present poultry and meat animal producing and marketing procedures are conducive to *Salmonella* build-up. As a consequence of restricting movement of animals and of reusing facilities, exposure to microbial contamination is much greater than was formerly true. Further, when birds or red meat animals are moved from the producer to the processing plant, there is much greater likelihood that large numbers from diverse sources are brought together and held for a time before slaughter.

To determine sources of salmonellae in turkey products, Bryan et al. (1) investigated a number of farms supplying birds to a processing plant. Their studies included investigation not only of the birds and their droppings but also the feed, feeders, storage tanks, trough water, brooder houses, and of the trucks used to transport the birds to the processing plants. They observed that often a particular serotype found on a farm was subsequently traced to the turkey meat and the processing equipment after turkeys from that farm had been processed and that the predominant serotype isolated from the plant environment changed when a new flock was processed.

Several workers have demonstrated that the intestinal contamination of pigs at the time of slaughter was considerably higher than that found at the farm. The organisms were very commonly recovered from swine that were kept for some time in holding pens. Leistner et al. (7), Kampelmacher (6) and Hobbs (5) have decried this practice. These workers have shown rather conclusively that the degree of contamination is directly related to the time that the animals are held in close association. Hobbs reported about 10% recovery of salmonellae from pigs held in pens for 2-5 days but when held for 1-2 weeks or longer, nearly all of the animals yielded the organisms (Table 2). Similarly, trucks transporting pigs to market were generally heavily contaminated and were considered an important means of dissemination. In most instances these salmonellae are considered to be commensal rather than parasitic, but in a few isolated instances, lymphatic invasion was involved (5, 7).

TABLE 2. SALMONELLAE FROM PIG MESENTERIC GLANDS (FROM HOBBS, 1965)

| No. of pigs examined | No. positive for salmonellae | Serotypes isolated                               | Holding pen                              |              |
|----------------------|------------------------------|--------------------------------------------------|------------------------------------------|--------------|
|                      |                              |                                                  | Contamination                            | Days in pens |
| 19                   | 2                            | <i>brandenburg</i><br><i>typhimurium</i>         | —                                        | 2-5          |
| 19                   | 1                            | <i>brandenburg</i>                               | —                                        | 2-5          |
| 19                   | 6                            | <i>brandenburg</i>                               | +                                        | 7-14+        |
| 11                   | 10                           | <i>brandenburg</i> (5)<br><i>typhimurium</i> (5) | +                                        | 7-14+        |
|                      |                              |                                                  | <i>brandenburg</i><br><i>typhimurium</i> |              |

TABLE 3. *Salmonella* SEROTYPES ISOLATED FROM A PROCESSING PLANT RECEIVING TWO CONSIGNMENTS<sup>a</sup> OF TURKEY BROILERS (FROM BRYAN ET AL., 1968)

|                         |                                                                                                                              |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Picker No. 1            | <i>S. chester</i><br><i>S. newington</i>                                                                                     |
| Picker No. 2            | <i>S. anatum</i><br><i>S. chester</i>                                                                                        |
| Picker No. 3            | <i>S. san diego</i>                                                                                                          |
| Spiral picker           | <i>S. infantis</i><br><i>S. anatum</i><br><i>S. bredeney</i>                                                                 |
| Chute                   | <i>S. chester</i>                                                                                                            |
| Picking table           | <i>S. anatum</i>                                                                                                             |
| Gutter                  | <i>S. anatum</i>                                                                                                             |
| Trussing table          | <i>S. typhimurium</i><br><i>S. newington</i>                                                                                 |
| Grade table             | <i>S. typhimurium</i>                                                                                                        |
| Packaging table         | <i>S. newington</i>                                                                                                          |
| Carcasses after picking | <i>S. infantis</i> (A)<br><i>S. anatum</i> (A, B)<br><i>S. chester</i> (A)<br><i>S. san diego</i> (B)<br><i>S. derby</i> (A) |

<sup>a</sup>Where possible to distinguish between birds of the two flocks, the letters A and B are used. *S. newington* had been isolated from fecal droppings at Farm A, and *S. anatum* at Farm B.

#### OTHER SOURCES OF CONTAMINATION

Kampelmacher (6) observed that a fairly large percentage of slaughtering knives were contaminated by salmonellae and so now the Dutch no longer require that the mesenteric lymph glands be incised during the normal inspection of slaughterhouse pigs.

It is well known that rats and other rodents are important carriers of salmonellae. Public health officials need to apprise the farmer or rancher—and not just the processor—of the consequences if vermin have access to feeds or if watering troughs, storage tanks, brooders, farrowing houses, pens, and trucks are not kept free of the excreta from the animals themselves. Feed bags and storage areas must be made rodent-proof and pens where poultry or animals are reared

or held must be disinfected before re-use. Trucks in regular use for transporting livestock should be sanitized after every use.

Feed ingredients are frequently contaminated with salmonellae. Niven (8) indicated that outbreaks of salmonellosis in farm animals have been traced directly to contaminated feed supplies. While animal, poultry, and fish by-products are the most common offenders, cottonseed protein, soybean meal, coconut pulp, and brewer's dried yeast also have been incriminated.

Recently, considerable attention was directed to this problem and the picture has improved over what existed a few years ago. This notwithstanding, a survey by the Food and Drug Administration of the processing of animal feeds disclosed that over 50% of the plants inspected were producing a product contaminated with salmonellae.

One large feed processor has found that contamination by salmonellae can be eliminated from properly extruded feeds (10) and that when these organisms are detected, generally they have gained entrance through recontamination. Storage must provide adequate protection so that these organisms do not have access to feeds. Moisture, dust and pest control, good housekeeping, bacteriological monitoring of feed ingredients, employee training, and segregation of activities involving raw materials and finished products have all contributed to reducing the level of contamination to a very low order.

An interesting aspect of this problem is the role of contaminated feeds that are only partially digested by birds and animals when the latter are eviscerated. While the Federal Government has jurisdiction of products that move interstate, local feed mills, etc. may be sources of *Salmonella* by virtue of livestock receiving such feeds and moving over state boundaries. When the bird or animal is eviscerated, the edible viscera may be sources of the organisms. Washing may reduce the numbers of salmonellae but does not completely eliminate them.

Associated with the dilemma of the presence of pathogens in the living animal or the raw commodity is the even greater danger that some of these organisms will be disseminated during processing or manufacture and will recontaminate the final product. For example, in the study reported by Hobbs (5) in which pigs were held in pens for short and long periods of time, even after the supply of contaminated carcasses to the two packing plants was stopped and the establishments cleaned, 3 of 83 samplings of pork and beef sausage meat yielded positive isolations of *Salmonella brandenburg*. After thorough cleaning of the holding pens and slaughter of the pigs as soon as possible, isolations of this organism were rare. Yet it is a matter of common knowledge that the

eradication of salmonellae from food products has not been successful.

Bryan et al. (1) considered that defeathering machines were important in the initial spread of the salmonellae to the carcasses of turkeys and that the washing treatment (spray) did not remove all of this contamination. As a consequence, other equipment surfaces then became contaminated and contributed to further spread of the organisms. They concluded that the dissemination of *Salmonella* starts on the farm and is brought to the processing plant by incoming turkeys and transferred to the equipment and turkey meat during processing.

#### SALMONELLAE IN FOOD PRODUCTS

Intact eggs have usually been considered to be of minor importance in salmonellae outbreaks. On the other hand, cracked and leaking shell eggs have been reported to be responsible for several outbreaks. One such incident occurred in 1963 (11) and was of such magnitude that 840 cases of salmonellosis were traced to several hospitals in the environs of Philadelphia and has since been referred to as the *Salmonella derby* outbreak. Many other outbreaks have been traced in egg and egg products. Frozen and dried eggs are often contaminated with salmonellae and have repeatedly been implicated in salmonellosis in humans in various countries. The presence of salmonellae in egg products is unacceptable and suitable means for their destruction without seriously deteriorating the functional properties of the food must be sought.

In addition to the commodities already mentioned, a wide variety of other foods have been incriminated. Within the past 2 or 3 years, reports have appeared in the literature detailing recovery of these pathogens from nonfat dry milk, candies, custard and cream-filled bakery products, dressed chicken, chicken gravy, chicken salad sandwiches, barbecued chicken, natural food color (carmine), food supplements, smoked whitefish, headcheese, yeast powders, and enzymes and hormones of animal origin. Coconut has caused food infections in Australia, the United Kingdom, and in Germany.

#### FOOD PLANT SANITATION

Important considerations in the location of food buildings and premises are the control of air and water pollution, odors, insects, and other pests. Aesthetic values, including a neat, clean appearance, are important to potential clients and to the morale of the workers. The filth produced by birds and animals on streets, gutters, eaves, window sills, pipes, equipment, and clothing provides a constant source of contamination that may fall or be blown onto foods, carried in with pieces of machinery, or track-

ed in by workers. Aerosols created by the combined activities of animals, wind, and man on crowded city streets pose a very real threat to health—not only with respect to salmonellosis but to other diseases as well.

Within the plant control of dirt, temperature, and moisture is of prime importance. Windows and doors should be so constructed that they admit only clean, pure air. Dust or other debris from adjacent processes must be eliminated, especially when these involve animals or animal by-products, chemicals, or other toxicants. Many of the newer food plants have no windows to the outside and the air that enters is filtered. Separate areas must be maintained for poultry, fish, and livestock until such time as the raw materials are freed of skins, feathers, scales, hides, viscera, and extraneous debris. In the processing area itself, items such as intestines, etc. should be segregated until they have been adequately cleaned since it is likely that pathogens and spoilage microorganisms will be present in high numbers. Working areas, as well as storage rooms for raw materials, must be kept free of flies and other insects, rodents, birds, pets, and unauthorized personnel. When temperatures can increase to high levels in areas where food is kept, these are apt to become trouble spots. Walls, floors, and equipment should be such that they can readily be cleaned with detergents and water and preferably by steam. Saws, knives, tables, trays, cutting boards, and other surfaces that come into contact with the product should not be allowed to build up debris, fat, or extraneous materials and periodically must be subjected to thorough sanitation. Facilities and equipment in food plants need not be new or expensive. However, machines should be so designed that they can be easily cleaned. Before buying apparatus, the processor needs to ask himself the questions of how it can be cleaned, how costly it will be to maintain in working order, and how easily it can be subjected to microbial contamination and build-up.

In poultry processing plants, salmonellae frequently are isolated from processing equipment, conveyors, scales, tables, saws, cutting tools, pans and meat tanks, and from personnel coming into contact with the meat during processing operations. During 23 of 26 plant visits, multiple recoveries were made and as many as eight different serotypes were isolated during a single visit (Table 3). These organisms represent a public health problem in the food product and to the processing personnel.

It has become a practice during the past decade to package an increasing number of foods in plastic bags, often without refrigeration, and sometimes in a partially moistened state. Since these are not sterile products, careless handling either before or after



processing could create microbiological problems. At the time of packaging, the food product should be entirely free of pathogens. Ready-to-eat foods may present special bacteriological problems. Laboratory studies have demonstrated the potential hazard associated with precooked foods (4). It is important that any sterilizing treatment be a terminal process to eliminate the possibility of recontamination.

#### ELIMINATION OF SALMONELLAE FROM FOOD PRODUCTS

Temperature, moisture, and dust control during transportation of the product to and from the warehouse requires the same rigid surveillance to prevent spoilage or hazard to health. Where some physical or chemical means of preservation is necessary during preparation of the product, a minimum expectation would be the complete elimination of pathogens and the reduction of spoilage organisms to very low levels. After this status has been attained, the packaged product must then be maintained in such a manner to prevent recontamination.

An important aspect of efficient and sanitary plant management includes training of employees. A good policy to follow would be to have the cleaning operation take place on a scheduled basis or after a defined number of units of food have been handled. It is essential that proper attitudes be expected of all employees concerning the perishability of the product and the necessity of providing the best sanitation possible. The individual selected to take charge of clean-up programs should be responsible and his work should be integrated with a well-conceived and executed quality control program. This activity must never be relegated to a "chore" status that is accomplished at the end of a working day or when operations have become so tedious or cumbersome that work is stopped for a short while to "get rid of accumulated product and trash."

Product control must be administratively feasible or attainable under conditions of good commercial practice. Also, it must be workable, i.e., deal with conditions as they actually exist. For adequate product surveillance, a well-trained bacteriologist and/or chemist should be in charge of quality control. It should be his responsibility to work in cooperation with the maintenance crew.

#### DETECTING SALMONELLAE IN FOODS

Testing procedures should be kept simple, uniform, and direct. This is quite a stumbling block at present. At least six well-recognized procedures are advocated for determining the existence of *Salmonella* in feeds and foods. The several organizations need to resolve differences that exist so that a single recom-

mended procedure is all that the control laboratory needs to follow.

Guidelines should be established for the distribution of the product in retail channels and for handling of the food until it is prepared for consumption in the home. Institutional users, as well as the general consuming public, should be provided with this information. This has special pertinence for restaurants, cafes, cafeterias, and mess halls where service men, university students, and hospital patients are fed. Such education of food handlers should extend through the entire food chain—producer, processor, warehouse, trucker, jobber, retailer, and consumer.

The main responsibility for the overall quality of the product remains with the processor. It should be his prerogative to require that the producer supply him with materials free of all pathogens and he must expect to conduct whatever tests are needed to verify this. Likewise, it is his charge that the product placed in the hands of the consumer constitutes no hazard whatever. The public health official should need only to monitor these products from time to time to assure the consumer and himself that satisfactory standards have been provided.

#### IMPROVING *Salmonella* SURVEILLANCE

While regulatory agencies must demand that food processors be ethical and that the level of danger be such that the consumer is adequately protected, more surveillance is needed at the plant level rather than at the federal level. Sampling by federal and state agencies should be adequate to prevent public health hazards without being prohibitively expensive or time consuming. Regulation should be avoided when the danger is merely assumed and not verified. Similarly, it behooves public health officials to improve the methods of investigating food infections and toxemias. The true incidence of this type of poisoning is not known since often incidences are inconsistently reported, if and when they are recorded at all. Part of this difficulty rests with the practicing physician and with the patient himself. It is important that all food infections and toxemias be reported to either city, state or federal public health agencies and an interrogation or follow-up of each case is needed.

Education of the consumer is the most difficult and unpredictable aspect of the problem. Since the present symposium is directed to the processor, attention will not be given to this important area at this time.

#### ACKNOWLEDGEMENT

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### FDA EXTENDS SANCTION FOR OCTYLIN-STABILIZED PVC TO DAIRY FOOD PACKAGING

The Food and Drug Administration has issued an amended regulation that now permits all dairy products except liquid milk to be packaged in polyvinyl chloride (PVC) containers stabilized with octyltins. The newly sanctioned foods include cheese and cheese products, yogurt, cottage cheese, sour cream, whipping cream and other dairy case items. The amendment to the regulation supplements sanctions issued more than a year ago by the FDA for two Thermolite dioctyltin stabilizers produced by M&T Chemicals Inc., a subsidiary of American Can Company. The stabilizers, called Thermolite 813 and Thermolite 831, had previously been approved for use in PVC packaging for a wide variety of foods including cooking oil, salad dressing, instant coffee, peanut butter, mayonnaise, fruit juices and vinegar.

PVC provides several distinct advantages to the food packer. In addition to visibility, inertness and economy that char-

acterize some of the more traditional packaging materials, PVC has unique benefits such as squeezability and shatter-resistance. Also, it can be molded into any shape to give it a wide range of consumer appeal for all types of food products. In addition to bottles, it can be thermoformed into packages, boxes, and films.

Organotins have been used for stabilization of nonfood PVC for more than 20 years. Octyltins, which are one form of organotins, have been used in PVC for food packaging applications in the U.S. and Europe for some time. The function of the stabilizer is to prevent yellowing and brittleness when PVC is molded, thus assuring greater uniformity of bottle color, clarity, and impact resistance. More information about the application of clear PVC to packaging of dairy and other food products is available from M&T Chemicals Inc. or producers of PVC bottles, films, and other thermoformed containers.

## RECENT DEVELOPMENTS IN THE PREVENTION OF FOODBORNE DISEASE<sup>1</sup>

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Preventive measures for the control of microbiological and chemical contaminants are manifest in almost every phase of production, processing, transportation, preparation, serving, and even eating of foods. It is obviously impossible to cover all aspects of the problem, but perhaps some examples selected from areas in which the U. S. Department of Health, Education, and Welfare (DHEW) has been an active participant may serve to illustrate the problem areas in which new developments are essential for consumer protection. A few general remarks about food may be helpful in placing these problems in perspective. Food is more than a necessity of life because it is so intimately associated with the socialization processes of man. Food is a major source of insult from the environment; it accounts for 80 to 90% of man's total intake of many potentially hazardous substances, such as radionuclides, pesticide residues, heavy metals, and microorganisms. For these reasons, no facet of environmental health is more important than food protection.

In 1967, 273 foodborne outbreaks, representing 22,171 cases of disease, were reported (22). During this time, 10 states reported not one single case, thus clearly indicating that the above figures are unrealistically conservative and do not reflect the true incidence. If this level of disease incidence were associated with air or water, it would unquestionably be viewed as a national disaster. Why is it that we as a nation accept foodborne illness as a necessary evil? Perhaps our success in minimizing the more lethal forms of food poisoning has misled the public. At any rate, most consumers regard any food product available from commercial sources as safe, wholesome, and above reproach.

### NEW INTEREST IN FOOD PROTECTION

Renewed interest in food protection now seems evident, at least among the technically trained personnel in industry and government. Public health agencies have long advocated stricter sanitary control; the increased efforts on the part of industry to

minimize food hazards during the past 5 years may be credited mainly to (a) deaths resulting from botulism in 1963 associated with eating smoked fish, (b) enforcement actions taken by the Food and Drug Administration (FDA) against products contaminated with *Salmonella* organisms, and (c) surveillance of agricultural products for mycotoxins by the U. S. Department of Agriculture (USDA), FDA, and other organizations.

Although foodborne diseases are often regarded as being caused by pathogenic microorganisms, the term is equally applicable to food-related diseases of chemical and nutritional origin. In each instance prevention depends on associating an adverse health effect with food, establishing the cause-and-effect relationship between a specific agent and the disease, finding means for prevention or control of the disease, and finally introducing practical corrective measures into the potentially offending food chain.

### PROTECTIVE MEASURES

Early recognition of the relationship between pathogenic microorganisms and disease in man led to the development of a large number of protective measures including commercial sterilization of canned goods, pasteurization of milk, and application of sanitary practices that now encompass an incredible number of control procedures. This effort has been so widespread and so closely related to the specific needs of the many food industries that it has actually interfered with the development of a comprehensive understanding of the problem of foodborne disease of microbiological origin. The control of microorganisms in food is now regarded as so important that industry, agriculture, and health authorities are attempting to define microbiological criteria of quality and safety against which standards can be set. To realize these goals, standardized methods of sampling and microbiological analyses are, of course, essential prerequisites. Increased emphasis is being given to the problem by a number of public and private organizations. Since 1964, both the Food Protection Research staff of the Public Health Service (PHS) and the Division of Microbiology of the FDA have published bacteriological laboratory manuals (4, 12) for the examination of foods. Microbiological

<sup>1</sup>Presented at the 55th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Inc., St. Louis, Missouri, August 18-22, 1968.

methods for the examination of precooked frozen foods have been published by the Association of Food and Drug Officials of the United States (3).

Over the past several years the Association of Official Analytical Chemists (AOAC) has steadily increased its collaborative studies of microbiological methods under the guidance of a general referee and approximately a dozen associate referees, several of whose recommendations have received first-action approval by the Association. The American Public Health Association (APHA) has recently signed a 3-year contract supported by the PHS to establish an interorganizational commission for revision of *Standard Methods for the Examination of Dairy Products*.

So many organizations have become involved that the Subcommittee on Food Microbiology of the National Academy of Science—National Research Council (NAS-NRC) Food Protection Committee is developing "A Proposal for Evolving Acceptable Reference Methods for Microbiological Examination of Foods." In addition, the APHA has appointed an ad hoc Committee on Uniformity in Standard Methods and shares membership with AOAC on a Liaison Committee to promote agreement on microbiological methods between the two organizations. Last year a Committee on Salmonellosis was appointed by the NRC at the request of FDA and USDA to make recommendations for the control of this important foodborne disease. The work of these and other related committees is not yet complete, but the United States is clearly moving in the direction of establishing uniform criteria and standardized methods for evaluating the sanitary quality of commercial food products.

#### THE ORGANISMS

Prevention of foodborne disease may be effected in many ways and may be based on knowledge concerning the organisms themselves, their characteristics and occurrence, their potential hazards, or their susceptibility to measures of control. Sometimes the recognition of a potential problem and the research conducted to prove its significance can be most rewarding. Food poisoning caused by *Clostridium perfringens* is a good example. During the years following World War II, this organism was recognized to be of considerable importance in England. In 1953, Hobbs et al. published their classical paper describing the situation in Great Britain (9). At that time only one isolated report (13) had appeared in the United States related to this organism as a foodborne pathogen. Recognizing the potential problem, the PHS began research in the late 1950's to develop media and methods for the detection of the organism in foods (2) and to determine the incidence (6, 7) and

characteristics (8) of the organism occurring in "outbreak" and other foods in the United States. The results of this research and research carried out by others stimulated by the activity in the PHS have more clearly defined the problem and led to a better understanding of the etiology as well as means of control. For years workers in Great Britain had postulated the existence of food poisoning strains of *C. perfringens* as distinct from the classical type causing gas gangrene. American workers (8) had maintained that any strain of *C. perfringens* present in large numbers in a food would cause illness. Canadian workers (10, 11) substantiated the American viewpoint, and a recent publication in England (18) indicates that a similar situation exists in Great Britain. The increased awareness of the problem resulting from this research led to the reporting, in 1967, of 19 confirmed outbreaks of *C. perfringens* foodborne disease, which was 7.0% of all confirmed foodborne disease outbreaks reported. These outbreaks involved 2,529 cases or 11.4% of the total number of confirmed cases for the year. In many instances the recognition of a potential problem and the carrying out of research to establish its significance, results in improved reporting and increased activity related to the control of foodborne disease. At the present time the PHS and others are actively engaged in similar studies related to the potential hazards of *Vibrio parahaemolyticus*, *Bacillus cereus*, and viruses as foodborne pathogens.

#### MANUFACTURING GRADE MILK

Another active area of interest relates to recent advances in the sanitary control of manufacturing grade milk, which result from an agreement between the Secretaries of DHEW and USDA for uniform standards of quality. Some of the important areas of agreement that will upgrade the quality of manufacturing grade milk and render it a less probable carrier of pathogens include: (a) establishment of a cooling requirement of 50 F or lower for milk in cans; (b) institution of routine testing programs for the presence of antibiotics; (c) lowering of acceptable commingled standard plate count to  $3 \times 10^6$  organisms per ml and bringing the time of reduction tests in line with this level of contamination; and (d) institution of an abnormal-milk control program similar to the one described below.

Similar discussions are being held to develop uniform standards for extra grade dry milk in consumer sized packages.

#### ABNORMAL-MILK PROGRAM

Another new area in milk sanitation is the "Abnormal-Milk Program" sponsored by the PHS with

the assistance of the National Conference on Interstate Milk Shipments (NCIMS). The immediate purpose of this program is to exclude milk of mastitic cows from the Grade "A" supply. The program consists of issuing standards and methods (16) to distinguish between normal and abnormal milk and instituting testing programs in all IMS participating laboratories. The program is being additionally supported by training courses and seminars, by split-sample comparison of results between laboratories, and by providing some laboratories with the equipment and knowledge to carry out a highly precise testing program based on the direct counting of leucocytes by electronic means (17).

#### TOLERANCES

The control measures thus far mentioned have been designed for the complete destruction of pathogens since there are no circumstances where their presence in food is either necessary or desirable. In considering illnesses of chemical and nutritional origin, we must necessarily change our outlook from one of total exclusion of the undesirable entity to a concept of benefits versus risks. This is necessary to accommodate the nature of food itself. Fortunately, however, if we disregard things like polar bear liver, certain poisonous plants, and toxic shellfish, man has a great biological tolerance for almost all substances of plant and animal origin that are used as foods and are toxic only in cases of extreme deprivation or excessive intake. Most problems of chemically-induced foodborne diseases result from errors in judgment concerning either intentional or inadvertent addition of substances to foods, which range from the accidental substitution of salt for sugar in an infant formula to the consumption of flour contaminated with parathion. Control of these diseases is generally brought about by education and by supporting regulations to minimize the possibility of their occurrence. The parathion-poisoning episode occurring in Mexico a few months ago, resulted in new and extended regulations concerning the requirements for simultaneous shipment of foods and economic poisons (20).

#### INTENTIONAL FOOD ADDITIVES

The FDA approval procedures used for controlling the safety of intentional food additives have proven effective. Few, if any, cases of intoxication or illness have arisen from proper use of approved food chemicals. The areas of major concern are: (a) toxicants being unintentionally included in foods such as pesticide residues or radionuclides, (b) the presence of substances such as heavy metals that are a normal constituent of food but together with excessive intake

from other environmental media create a toxic insult to man, and (c) the presence of uncontrolled naturally-toxic substances in foods such as shellfish poison. Although the technique for the control of these hazards is so variable that no useful generalizations can be made, the research and administrative developments that have gone into the control of radionuclides in milk are sufficiently characteristic to warrant a brief resume. Excepting the populations of Hiroshima and Nagasaki at the end of World War II, the first possibilities of significant exposure to radioactive fallout occurred during a period of extensive weapons testing that began in 1956. In recognition of the potentially hazardous effects of fission products on man and the importance of foods, particularly milk as a major vector of exposure, a program was developed within the PHS to investigate these problems. The work has included the development of rapid methods of analysis for specific radionuclides, which were suitable for surveillance of milk and other foods (23); the establishment of a surveillance network to assess the levels of exposure to man from milk and other foods (1, 21); and the development of commercially feasible methods for the selective removal of fission products of biological significance from milk by the use of properly charged ion-exchange resins (14, 15). Using data developed by the DHEW along with a massive amount of information from the medical and atomic energy field concerning the biological effects of radiation, the Federal Radiation Council developed guidelines of acceptable levels of exposure (5) in which the benefits of the use of nuclear energy were weighed against potential hazards to populations of this country and the world. The Council consists of Secretaries of the DHEW, USDA, and the Department of Defense.

The concept of surveillance networks as a means of assessing environmental hazards has been steadily increasing in the past few years and at the present time there are national networks to monitor radionuclides, pesticide residues, the several marine toxins, and a variety of trace elements. Surveillance is certain to become an even more important tool in controlling hazards of foodborn origin in the years to come.

#### NUTRITIONAL DISEASES

Since the discovery of major vitamins and the successful eradication of pellagra and other nutritional diseases in the early part of this century primarily through the vitamin fortification programs, the problem of nutritional disease in the United States has been almost a dead issue until very recently. As part of our national quests to eliminate poverty, evidence is accumulating that there may be a significant prob-

lem of malnutrition among the urban and rural poor (19). The National Center for Chronic Diseases is now beginning a nationwide nutritional survey in poverty areas in the United States, using techniques similar to those employed by the Interdepartmental Committee on Nutrition for National Defense throughout much of Asia and other parts of the world. The objective of the survey will be to determine the prevalence and location of serious hunger and malnutrition and the resulting health problems in low-income populations in eight selected states located in different geographic regions of the United States, and to make recommendation for dealing with such conditions. The results of the survey will no doubt have a major impact of the nature of our future programs in nutrition and may also provide answers to some cogent questions about ourselves as a nation, such as: (a) How prevalent is caloric malnutrition? (b) Are there specific nutritional deficiencies that correlate with urban and/or rural poverty? (c) At what level of nourishment does "working for food" cease to be a major consideration in the socialization process? (d) How effective are the various ongoing food programs?

The realization that fatal outbreaks of botulism occurred in this country less than 3 years ago and that our current problems with salmonella in egg and dry milk are only new manifestations of old problems provide reasons for concern about the effectiveness of our programs for prevention of foodborne disease. These observations suggest that our programs must be sensitive not only to the hazards themselves, but equally sensitive to the influence of an ever-changing food industry and the unforeseen forces of changes in our environment.

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# BAKING INDUSTRY SANITATION STANDARDS COMMITTEE

## STANDARD NO. 2

for

### DOUGH TROUGHS

(Revised April 1, 1967)

**Editors Note:** permission has been granted to International Association of Milk, Food and Environmental Sanitarians, Inc. to publish in the Journal of Milk and Food Technology the Baking Industry Standards as published to-date. This is being done for many of our members who have an interest in bakery and food sanitation. Balance of standards will appear in future issues in accordance with available space.

The requirements of this standard shall apply to the design and construction of dough troughs used within a bakery.

This standard, as revised, shall become effective on and after April 1, 1967.

The General Principles of Design and Construction (pages 7 through 9) shall apply to all equipment covered in this standard and shall be considered as a part of this standard except where specifically exempt. Special or Specific Requirements for equipment covered in this standard follows, and shall also be considered a part of this standard.

#### 4. SPECIAL PRINCIPLES OF DESIGN AND CONSTRUCTION, DEFINITIONS AND INSTALLATION OF EQUIPMENT OR MACHINERY COVERED BY THIS STANDARD

##### 4.1 Definitions

4.1.1 The product zone of a dough trough shall include all inside surfaces, the exterior of the rim, and all other surfaces with which the product may come in contact.

##### 4.2 Specific Design Requirements

4.2.1 All surfaces shall be of corrosion-resistant material or shall be of protectively coated material. (3.1.5 Modified)

4.2.2 Trough rims shall be so constructed that the underside and corners shall be readily accessible for cleaning, or if closed, shall be sealed by welding or by other suitable means.

4.2.3 Division boards are part of the product zone, and provisions of Section 3.1 and 4.2.1 shall apply.

4.2.4 The interiors of top extensions and trough covers are part of the product zone, and the provisions of Section 3.1 and 4.2.1 shall apply.

4.2.5 If hinges are used in the product zone, they shall be designed so that all parts of the hinge are accessible. (3.1.18 Modified)

4.2.6 Bearings shall be outside the product zone and shall be sealed or self-lubricated; and the design and construction shall be such that lubricant cannot leak, drip or be forced into the product zone. (3.1.14 Modified)

4.2.7 Rack and pinion-type ends shall be designed so that the gate is removable.

4.2.8 Chute-type ends shall be designed so that the

hinge, overlapping guides and other parts that come in contact with the dough shall be accessible.

4.2.9 Gate-type ends shall be designed so that all parts in the product zone shall be readily accessible.

4.2.10 Slide-end troughs shall have removable ends.

4.2.11 Guide grooves in slide-end troughs shall be rounded to provide for drainage and shall be readily accessible.

4.2.12 All non-product zone surfaces shall be smooth and may be protectively coated except on metal-to-metal moving contact areas.

4.2.13 Caster shoes shall be totally enclosed. When permanently attached, such attachment shall be a continuous weld.

4.2.14 Casters and wheels shall conform to the requirements of BISSC Standard No. 15 for Caster Assemblies and Wheels.

4.2.15 Hoisting hooks and other outside attachments shall be attached to the trough so that no cracks or crevices are formed.

4.2.16 Hollow shafts or pipes used in locking devices shall be sealed.

4.2.17 The exteriors of top extensions and trough covers are part of the non-product zone, and the provisions of Section 3.2 and 4.2.12 shall apply.

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## ABNORMAL MILK CONTROL—A PROGRESS REPORT

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### ABSTRACT

Two phases of a national program on control of abnormal milk are in effect. The third phase is scheduled to take effect July 1, 1970. The program will be evaluated at the May, 1969 meeting of the National Conference on Interstate Milk Shipments (IMS). A report from the IMS Committee on Abnormal Milk Control will serve as a basis for this evaluation. Many organizations are active in abnormal milk work. These include U. S. Public Health Service, U. S. Department of Agriculture, National Mastitis Council, local and state regulatory agencies, and many segments of the dairy industry. The Public Health Service published "Guidelines for the Control of Abnormal Milk" in May, 1968. These guidelines cover the first two phases of the IMS Abnormal Milk Program. Committees of the National Mastitis Council are making significant contributions to the abnormal milk program. Good progress is being made on control of abnormal milk. If reason prevails, the efforts of many organizations and individuals will bring success.

In April 1967, the National Conference on Interstate Milk Shipments (IMS) adopted a three phase program on control of abnormal milk. The first two phases are in effect. They require a screening test program on a regular basis on raw milk for pasteurization for all interstate milk shippers. The third phase, or the penalty portion of the program, is scheduled to take effect July 1, 1970. This date was established to provide time for experience with the program and to permit evaluation at the May, 1969 meeting of IMS.

To assist in this evaluation, IMS President Shelby Johnson appointed a Committee on Abnormal Milk Control. This Committee has been working diligently to prepare sound recommendations for consideration by the 1969 IMS Conference. The Committee has held two meetings—one in Chicago on February 14, and one in St. Louis on August 19. The Committee expects to have a constructive report to present to the May, 1969 meeting of IMS in Denver.

### ACTIVE ORGANIZATIONS

Many organizations have been active in the abnormal milk work. These include the U. S. Public Health Service, U. S. Department of Agriculture (USDA), the National Mastitis Council, local and state regulatory agencies, and many segments of the dairy industry.

The Public Health Service (PHS) has been busy with its part of the program. Good progress has been made on standardization and approval of state central laboratories and in research on procedures for analysis of bulk milk samples for abnormal milk. PHS has also reported good progress on application of the testing program by the states, and on evaluation of abnormal milk testing procedures in state surveys of local laboratories.

In May, 1968, the PHS published "Guidelines for the Control of Abnormal Milk." These guidelines are designed for uniform interpretation and enforcement of certain items in the *Grade "A" Pasteurized Milk Ordinance*. They cover the first two phases of the IMS Abnormal Milk Program. The third phase was omitted pending experience with the program and reports of the IMS Committee on Abnormal Milk Control and the Subcommittee on Screening Tests of the National Mastitis Council.

The IMS program has focused attention on the need for increased research on procedures for control of abnormal milk and mastitis. This was recognized by the International Association of Milk, Food, and Environmental Sanitarians at the 1967 meeting of this Association. A resolution was passed that the Secretary of Agriculture should be requested to approve research work in this important matter.

The Milk Industry Foundation appeared before appropriate committees of Congress in 1967 and 1968 in support of mastitis research funds for USDA. These efforts were successful in that finances were secured for additional research by USDA.

### USDA RESEARCH

USDA research in this field is based on certain principles. One of these is that success of abnormal milk control programs depends on (a) development of a reliable cell counting procedure and screening test; (b) establishment of realistic control limits; and (c) development of effective means of reducing the incidence of mastitis in the dairy herd. It is also recognized that more information is needed on factors affecting the cell count in milk from healthy cows. The control limits should be designed to prevent the sale of milk from cows with mastitis, without penalizing the dairyman for cell count changes resulting from normal sources of variation in healthy, well-managed cows. The research activities of USDA include the following: (a) screening tests for abnormal

<sup>1</sup>Presented at the 55th Annual Meeting of the International Association of Milk, Food, and Environmental Sanitarians, Inc., St. Louis, Mo., August 18-22, 1968.



milk, (b) relation of mastitis to abnormal milk, (c) utility of bulk milk cell counts as an index of udder infection, and (d) effectiveness of current recommendations in reducing the incidence of abnormal milk.

The special appropriation by Congress is being used by USDA to establish two cooperative field studies on the effect of control recommendations on reducing mastitis and cell counts. In effect, these are a study of the IMS Abnormal Milk Program. One of the field studies is underway at North Carolina State University. The other is to be established with a large dairy cooperative in the upper Midwest.

#### ADSA SYMPOSIUM

A symposium at the June 1968 annual meeting of the American Dairy Science Association is a good illustration of the wide interest in mastitis research and control of abnormal milk. This was a joint symposium of the four sections of ADSA—Production, Extension, Manufacturing, and Industry and Business.

On this program at Ohio State University over 2 hr were devoted to the subject "Mastitis Control: Methods and Progress." The speakers and their subjects were as follows:

Introduction to the problem of mastitis control. F. H. Dodd, National Institute for Research in Dairying, Reading, England.

Role of hygiene and management in mastitis control. F. K. Neave, National Institute for Research in Dairying, Reading, England.

Role of therapy in mastitis control. W. N. Philpot, North Louisiana Hill Farm Experiment Station, Homer, Louisiana.

Role of immunization in mastitis control. N. L. Norcross, Cornell University, Ithaca, New York.

Interstate milk shippers abnormal milk control program. R. B. Read, Jr., U. S. Public Health Service, Cincinnati, Ohio.

#### NATIONAL MASTITIS COUNCIL

The National Mastitis Council has been active on the problems of abnormal milk and mastitis. This includes educational work and research.

In addition to the annual meetings in Chicago, the Council held a regional meeting in Omaha in 1967 and is planning a regional meeting in Raleigh, North Carolina in September, 1968. Over 400 persons attended the February, 1968 annual meeting.

Distribution of the authoritative booklet, *Current Concepts of Bovine Mastitis* continues. This has passed the mark of 25,000 copies.

The Education Committee of NMC prepared a publication on "What Dairymen Should Know About Mastitis." This abstract of material from *Current Concepts of Bovine Mastitis* has been made available for publication to editors of 20 magazines that reach dairymen and others interested in the dairy industry.

A committee of NMC prepared an extensive man-

ual on "Aids for Teaching Prevention of Mastitis." Over 200 copies have been distributed to state directors of high school agriculture, state 4H Club leaders, extension dairymen, extension veterinarians, and Federal personnel concerned with these activities.

It is well recognized that a mastitis control program should be organized to assist dairymen in solving their problems. This program should involve all resources which may be of assistance. The National Mastitis Council has published a guideline for the establishment of such a control program. Copies of the program recommendations are available from the Council office.

NMC has recently established a new committee that has an important role to fill in this field. This is the State Mastitis Council Coordination Committee. As the name implies, this Committee will compile a roster of state councils and will coordinate the work of these councils with that of the National Mastitis Council.

NMC has been active in research through the work of two subcommittees of the Research Committee. The Subcommittee on Screening Tests has standardized the procedure for the Direct Microscopic Somatic Cell Count. Publication of this procedure is expected soon. There will be a series of three papers in the *Journal of Milk and Food Technology*. These will be (a) reticle design, (b) Direct Microscopic Somatic Cell Count method, and (c) statistical evaluation of the method. This Committee is also working on evaluation of screening tests.

Another subcommittee is working on preparation of a manual on "Microbiological Procedures for Diagnosis of Bovine Mastitis." The Research Committee and the Directors of NMC believe that a manual on recommended or standardized procedures for diagnosis of mastitis is urgently needed and should prove highly useful for laboratory workers. The manual will include procedures for collection and handling of milk samples for microbiological examination and tests for detection and identification of the various pathogenic microorganisms that cause mammary gland infection or bovine mastitis. The NMC Directors have authorized the officers of the Council to expend the necessary funds for this project, including publication of the manual.

This discussion of diagnostic tests should serve to remind us of the complex nature of mastitis and its control. It involves a great deal more than making a screening test for abnormal milk and keeping the cell count of the dairyman's milk below a certain level.

In conclusion, the abnormal milk control program is moving well. If reason continues to prevail, the efforts of the many organizations and individuals will bring success.

# RESIDUAL MICROORGANISMS IN CLEANED-IN-PLACE SYSTEMS FOR HANDLING MILK<sup>1</sup>

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## ABSTRACT

A model system was used to simulate commercial cleaned-in-place (CIP) conditions. Alterations in the system were made to determine the effect on the microflora, as potential food product contaminants. By the use of *Serratia marcescens* as a tag, contamination was shown to be more complex than a simple residue from the daily operation. Also, the use of *S. marcescens* revealed that contamination did not move from outside surfaces of the equipment into the liquid food even with severely corroded equipment. Increasing corrosion provided greater harborage for microorganisms. The harborage could be limited somewhat by drying the surfaces, but a much greater reduction in harborage was obtained by storing the system filled with a solution at pH 11. With manipulations that reduced the total contaminants, there was an increase in the relative frequency of Gram-positive asporogenous rods, certain genera of which show promise as indicators of unsatisfactory equipment condition.

Systems of lines for conveying milk and similar liquid food products are commonly cleaned by CIP (cleaned-in-place) methods. Improvements in design have been directed toward CIP which allows permanent installations. The microflora of permanent installations of CIP equipment is somewhat different from that of traditional hand cleaned dairy utensils (4). The reliability of CIP cleaning, however, is greater than of traditional methods involving disassembly and hand washing (2, 3, 6, 7). In addition, with CIP methods there is less human contact with surfaces of equipment that contact food thereby reducing chances for contamination. Economic advantages to the food processor encourage automation and CIP installations.

CIP systems provide a new approach to sanitation and protection of public health. A new environment, however, is created for potentially objectionable microorganisms. Even after use of effective, acceptable cleaning processes, enough soil remains for the survival and growth of microorganisms (4, 5, 7). Control of these microorganisms is based on techniques established for hand-cleaning methods.

Deterioration of equipment increases the potential harborage of objectionable microorganisms and the avenues for contamination. The effect of deteriora-

tion of equipment on the microflora was therefore studied to provide a better understanding of the public health significance of this phenomenon.

## EQUIPMENT AND EXPERIMENTAL METHODS

### CIP systems

Model systems were constructed to simulate commercial conditions. Each system consisted of approximately 8 m (27 ft) of 3.8 cm (1.5 inches) stainless steel tubing, a 38 liter (10 gal) tank with a liquid height of 1.0 m (40 inches), and a pump to provide a flow rate of 1.2 m (4 ft) per sec in the tubing. Model systems were constructed with welded joints. A comparable system was constructed with conventional CIP joints. A more complete description has been given in a previous publication (6).

The original model simulated commercial conditions. Other model systems were corroded until pinholes occurred at the seams to simulate changes due to deterioration. Typical substances, such as chlorine, salt, and acid, proved excessively slow requiring several months for adequate corrosion. An etching solution, consisting of 100 ml HCl (concentrated reagent), 25 ml HNO<sub>3</sub> (concentrated reagent), 200 gm FeCl<sub>3</sub>, and made to 1,000 ml, was later found to be effective and provided a system for controlled deterioration of the equipment.

### Operational systems

A system was soiled by circulating 38 liters (10 gal) of mixed raw milk for 4 hr at room temperature. For cleaning, the circuit was rinsed with tap water then washed with commercial 0.5% phosphated caustic for 20 min at 60-65 C (140-149 F). After washing, the equipment was rinsed and approximately 16 hr were allowed for incubation at approximately 25 C (77 F) to simulate environmental conditions in commercial equipment after cleaning and before sanitizing.

The earliest observations were to assure the comparability of the model system to commercial systems. Thereafter, observations on the microflora associated with progressive stages of deterioration were made. The third phase involved the following operational changes to alter the environment and to study the effect on the microflora: (a) commercial acid cleaning solutions were substituted for the alkaline cleaners; (b) the equipment was air dried and stored dry after forcing warm air through the lines; (c) an inoculum of *Serratia marcescens* was used to determine the persistence of contamination; and (d) the equipment was filled and stored with an alkaline solution at pH 11.

### Observations on the microflora

After the treatments of soiling, cleaning, and incubation the equipment was rinsed with tap water to which sodium thiosulfate had been added to neutralize the chlorine in tap water. Bacterial counts were made on Standard Plate Count

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TABLE 1. CHARACTERISTICS OF MICROORGANISMS ISOLATED FROM RINSINGS FROM SOILED, CLEANED, AND INCUBATED MODEL CIP EQUIPMENT

| Category                        | Number of isolates | Per cent of isolates |
|---------------------------------|--------------------|----------------------|
| Gram-positive asporogenous rods | 30                 | 51                   |
| Micrococci                      | 21                 | 36                   |
| Gram-negative proteolytic rods  | 7                  | 12                   |
| Other                           | 1                  | 2                    |
| Total                           | 59                 | 101                  |

Agar (Difco) with duplicate plates of these solutions following *Standard Methods* (1). Isolates from the plates were studied to determine the nature of the microflora. Three isolates were taken at random from each plate used for counting. While this technique limited the number of isolates from each sample, it avoided the common error of over-weighting samples involving unusual growth situations. Groupings were related to physiological activity of organisms of particular interest to the dairy industry, e.g., micrococci, streptococci, bacilli, other Gram-positive rods, Gram-negative rods such as coliform indicators, and Gram-negative proteolytic rods. A more complete description of the methods has been given in a previous publication (4).

#### Controlled contamination

A pure culture of *S. marcescens*, which produced a deep red pigment on Standard Plate Count Agar, was used. The inoculum was prepared by growing the *S. marcescens* culture in nutrient broth and applying as explained in the specific experiments described later.

## RESULTS

### Microflora of the model equipment

The model equipment was soiled, cleaned, and incubated to simulate commercial conditions. With 10 trials representing both welded joint systems and a system with CIP joints, the recovery evaluations gave counts ranging from 10,000 to 140,000 bacteria per ml with a mean count of 62,000 per ml. The results were similar for the model systems constructed with welded joints and the comparable model with commercial CIP joints. These observations were in agreement with previous reports (6, 7) comparing commercial systems with welded joints and similar systems with CIP joints.

Results from tests to characterize the microflora of the model equipment are given in Table 1. It was apparent that no single group predominated. These results are in general agreement with previously reported data for a commercial operation (4). There was no apparent difference between the microflora from the systems with welded joints and the system with CIP joints.

Therefore, the remaining experiments utilized only systems with welded joints. This decision was in

harmony with the trend toward welded pipelines in industry.

### The microflora of pasteurized, packaged milk

The ultimate concern in milk processing operations is the microflora of the pasteurized, packaged product. Throughout the course of the work, observations were made on the nature of the microflora of the pasteurized, packaged milk. This product was taken from the same raw milk supply that was used for the soiling operations of the model system. These observations extended for a period of more than a year. A summary of the results is given in Table 2.

The microflora of the soiled, cleaned and incubated model equipment was similar to the microflora of pasteurized, packaged milk. The two major groups of contaminants were the same. The relatively frequent occurrence of bacilli in the pasteurized, packaged milk seemed to be the primary difference. A secondary difference was the more frequent occurrence of Gram-negative proteolytic rods on the equipment. The frequent occurrence of Gram-positive asporogenous rods had not been expected in light of common knowledge of milk fermentation.

Note should be made at this point that the soiling procedure for the model equipment utilized raw milk to include the gamut of microorganisms associated with milk. The microflora of this equipment was found to be generally similar to that of equipment in commercial plants and of pasteurized milk. Further substance to this generalization is added by results of subsequent experiments. Thus, it is apparent that the selective effect of pasteurization is not an overriding influence in the resulting microflora of dairy equipment, except perhaps the elimination of Gram-negative rods.

### Corrosion of model systems and the resulting effect on harborage of contaminants.

In order to determine the effect of corrosion of equipment on harborage of microorganisms, a representative set of the model equipment was deliberately corroded stepwise according to the techniques described under Methods. A specific corrosion treat-

TABLE 2. CHARACTERISTICS OF MICROORGANISMS ISOLATED FROM SAMPLES OF FRESHLY PASTEURIZED, PACKAGED MILK

| Category                        | Number of isolates | Per cent of total |
|---------------------------------|--------------------|-------------------|
| Gram-positive asporogenous rods | 99                 | 40                |
| Micrococci                      | 80                 | 32                |
| Bacilli                         | 53                 | 22                |
| Streptococci                    | 12                 | 5                 |
| Coliform                        | 2                  | 1                 |
| Total                           | 246                | 100               |

ment was given and then the equipment was soiled, cleaned, and incubated after which observations were made on the residual contaminants. This process was considered "complete" when holes occurred at some of the welded seams, and a generally rough surface was apparent.

When the model equipment was completely corroded, comparative trials were made with good equipment and with the corroded equipment observing both total contamination and types of microorganisms. A gradual but erratic increase in the total contamination accompanied the increase in corrosion. An average of 10 trials on the corroded equipment showed a mean count of 630,000 bacteria per ml. With a comparable non-corroded system, the mean count on eight trials was 55,000 bacteria per ml. It should be recalled that in the original assessment of contamination the mean count of bacteria in 10 trials with new equipment was 62,000 per ml. The 10-fold increase in contamination with increased corrosion of the equipment was expected in light of the general belief by regulatory and industry sanitarians that rough surfaces harbor microorganisms. Yet, no quantitative data had been available to substantiate this belief.

Observations on the nature of the microflora are given in Table 3, which shows the similarity between the new and the corroded equipment. The lack of bacilli again was apparent. There was, however, one seemingly unique group associated with the corroded equipment. Morphological characteristics and the Gram-variable nature in older cultures indicated these to be *Arthrobacter* spp.

#### Sequence of cleaning system and residual effects

While common operations in commercial cleaning consist of a final alkaline treatment, the procedure may be reversed. The question is raised as to the effect of acid or alkaline cleaners in establishing the residual microflora.

A common commercial acid cleaner ("Flash-Klenz," Klenzade Products, Beloit, Wisconsin), at the manufacturer's recommended concentration, was substituted for the alkaline treatment. In all other aspects the usual soiling, cleaning, and incubation procedures were followed. Observations were made on the total contamination and the nature of the microflora.

The results indicated little, if any, difference between the acid and alkaline treatments on the total recoverable contamination. Neither was there an apparent difference between the new and the corroded equipment relative to the total contamination. The mean bacterial count on four trials was 52,000 with a range of 22,000 to 81,000 per ml. The microflora consisted primarily of Gram-positive asporogenous

TABLE 3. FREQUENCY OF OCCURRENCE WITHIN CATEGORIES OF MICROORGANISMS ISOLATED FROM MODEL CIP EQUIPMENT

| Category                                                          | Percentage of isolates |                    |
|-------------------------------------------------------------------|------------------------|--------------------|
|                                                                   | New equipment          | Corroded equipment |
| Gram-positive asporogenous rods                                   | 65                     | 50                 |
| Micrococci                                                        | 15                     | 10                 |
| Gram-negative non-proteolytic rods, excluding coliform indicators | 12                     | 25                 |
| <i>Arthrobacter</i> spp.                                          | 0                      | 13                 |
| Gram-negative proteolytic rods                                    | 8                      | 2                  |

ous rods. The isolates showed no special capacity for high acid production in litmus milk such as is typical of certain species of *Lactobacillus*.

#### Persistence of contamination

In seeking the source and nature of the contamination, an attempt was made to see if there was a carry-over from day to day. The usual procedure for soiling, cleaning, and recovery of contamination was followed except that *S. marcescens* was added to give 120 to 3,000 cells per ml in the milk used for soiling a corroded model system.

The contamination recovered during the following days was examined to see if *S. marcescens* persisted as evidenced by red colonies on the plating medium. The results for 4 trials indicated a complete absence of *S. marcescens* in the recovery solution. Isolates from this recovery solution were studied in the usual way and found to be predominately Gram-positive asporogenous rods. Thus, it appeared that the contaminants did not arise from a simple contamination, residue, and recovery process each day. A more complex harborage was therefore indicated.

#### Outside surfaces as a source of contaminants

Since the previous data indicated a complex or remote harborage as the source of contaminants, the outside surfaces were considered as a potential source. Possible pathways via pinholes or pump and gasket seals for movement of bacteria from outside the equipment into the soiling medium were sought. *S. marcescens* was used as the indicator organism.

During normal contamination trials with corroded model systems, the surface of the equipment was thoroughly wetted with a 24 hr nutrient broth culture of *S. marcescens*. In addition, the equipment was stopped periodically to encourage syphonage. The milk used for soiling was plated and examined for red colonies. The contaminants recovered were also examined for red colonies. Neither platings showed *S. marcescens*, therefore, indicating microorganisms on the outside surfaces were not contributing to the contaminants of this study.

### *The effect of dry storage on the residual contamination*

It is generally assumed that a major difference in the microenvironment of CIP systems and the traditional open, hand-cleaned systems is the residual moisture for microbial survival and growth. The closed CIP systems dried slower.

To determine the comparative effect of an altered drying rate on the microflora, trials were made with an added step of drying immediately after the washing and rinsing operation. A corroded model system was soiled and cleaned in the usual way. Warm air at 35 C (95 F) was then circulated through the system for 1-2 hr to remove visible moisture from surfaces while avoiding a high temperature and the selective effect of heat. The equipment was then allowed to incubate as in the previous experiments, after which contamination from the model system was evaluated in the usual way. Data representing 5 trials showed a mean bacterial count of 170,000 per ml for the contamination. There was a lower number of contaminants from the dried treatment than from the usual storage treatment, but the counts were nearly three times those obtained from non-corroded equipment and the usual treatment.

The microflora, as judged by the frequency of occurrence in the various groups of isolates, was similar to that found in the previous treatments.

### *The effect of a flooded system on the residual contamination*

Another approach to evaluating the microenvironment of the model equipment was to fill the system with a solution of NaOH to provide a pH value of 11 during the 16 hr interval between cleaning and recovery of residual microorganisms, otherwise the soiling and evaluating techniques were the same as in the previous experiments. This approach provided conditions that would not allow growth where there was exposure. At the end of the storage period, the alkaline solution was removed and the usual procedure of filling, circulating, plating, and evaluating the contamination was followed. Ten complete trials were made including both new and corroded equipment. The mean bacterial count for the contamination was 99 per ml. This level was approximately one-thousandth that of the conventional system of storing the equipment untreated. There was no apparent difference between the new and the corroded equipment.

The 45 isolates from the evaluation of the contamination showed no apparent difference in the types involved when compared to earlier work with the usual storage system.

## DISCUSSION

The microflora of commercial and model CIP systems consists of a surprisingly great percentage of relatively inert bacteria. This is in contrast to the microflora where there is an abundance of soil, moisture, and other factors conducive to growth. Lactic streptococci and the *Escherichia-Aerobacter* group are expected to predominate. The limiting factors of the microenvironment have produced a selective effect of the microflora. The infrequent occurrence of spore forming bacteria, however, indicates heat and pH of the cleaning solution are not an overriding influence in establishing the microflora.

There is an increase in the total contamination recovered from corroded equipment. With increasing corrosion, changes in the nature of the microflora are slight. This change is not toward expected fast-growing bacteria able to cause normal spoilage of milk. The Gram-positive asporogenous rods are most common. Unknown factors influence the microenvironment and allow the growth of these bacteria. Thus, the significance of deterioration of equipment in commercial operations remains a question of public health interest.

Since the observations on the microflora of CIP systems produce data that are not in agreement with traditional concepts, the need for further understanding of this microenvironment and the residual microorganisms is apparent.

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## MICROTITER METHOD FOR ENUMERATING VIABLE BACTERIA IN MILK

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### ABSTRACT

A rapid microtiter method was investigated as a means of evaluating viable bacterial cells in milk samples, using the conventional Standard Plate Count method as a comparison. Statistical analyses showed high correlation between the two methods. The advantages of this new method are: (a) the ability to analyze many samples simultaneously and (b) savings of time, space, material, and labor. The practical application of this new method in dairy products was shown by a study of bacterial growth during refrigerated storage of milk.

Determination of the number of viable bacteria in milk is important from both the quality and public health aspects. The agar plate method has been used as the standard procedure for counting viable microbial cells in milk for many years (1). This method, however, is time consuming and cumbersome when large numbers of samples are involved. Recently, a microtiter method for the enumeration of viable cell cultures was described by Fung and Kraft (3). Also, this method was used to evaluate spore survival by Baldock et al. (2). The advantages of the method include savings of time, space, material, and labor.

This paper describes the application of the microtiter method to the enumeration of viable cells in milk samples. Parallel experiments with the Standard Plate Count were performed to establish the correlation between the two methods. The growth of bacteria in milk during refrigerated storage was also evaluated using the microtiter method to determine its usefulness for storage studies.

### MATERIAL AND METHODS

**Samples.** Thirty-four manufacturing-grade milk samples and 13 Grade A milk samples were used for comparisons between the Standard Plate Count and the microtiter method. Manufacturing-grade milk samples were evaluated after cold storage at 4 C for 1 to 5 days while the Grade A milk samples were evaluated within 1 day after receipt. Nine of the manufacturing-grade milk samples were also used to test bacterial growth in refrigerated storage at 4 C.

**Evaluation procedures.** Standard Plate Counts were made using the procedure described in *Standard Methods for the Examination of Dairy Products* (1). The microtiter method followed procedures described previously (3). The latter method consists of rapid serial dilution and spot plating procedures (4). All microtiter equipment was obtained from Cooke Engineering Co., Alexandria, Va. A sterile automatic

pipetting machine (Becton, Dickinson and Company, Rutherford, N. J.) was used to dispense 0.225 ml of sterile distilled water into each of 96 wells in a pre-sterilized, plastic microtiter "V" plate (8 x 12 wells). Small, 0.025-ml aliquots of milk samples were introduced into the first of each series of 8 wells by pre-calibrated sterile loops. The first row of wells gave 1:10 dilutions of the original samples. The loops were rotated rapidly in the dilution water 30 times to ensure homogeneity before carefully introducing into the next set of wells containing sterile dilution water. An intermediate procedure of drain-drying the loops on sterile blotting paper between each dilution was first used but later omitted because no significant advantages were found. Serial dilution in this manner to the eighth row of wells gave dilutions of the original sample of  $10^{-1}$  through  $10^{-8}$ . Six to 12 milk samples can be diluted simultaneously in approximately 2 min.

Two drops of each dilution to be tested were spotted on the surface of previously poured and thoroughly dried plates

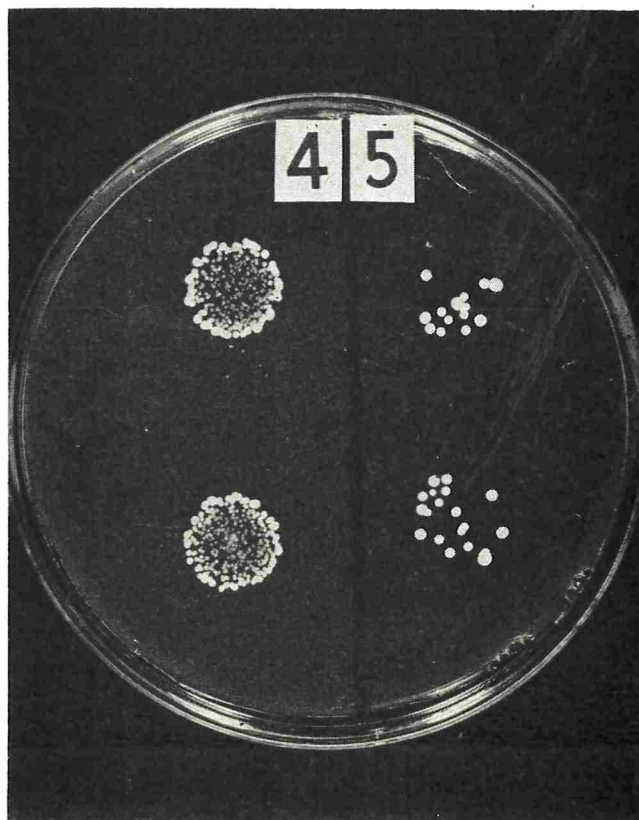


Figure 1. Duplicate spots of different dilutions from a milk sample. The numbers 4 and 5 represent  $10^{-4}$  and  $10^{-5}$  dilutions, respectively. Data obtained from the  $10^{-5}$  dilution were used to calculate cell density.

of Standard Plate Count agar by means of sterile 0.025- or 0.050-ml droppers. Four to 8 drops could be spotted on the surface of one petri dish. Droppers were sterilized before use by soaking in 1% Chlorox for 1 hr; the sterile droppers were then rinsed in sterile distilled water. The spotted plates, after drying for about 30 min at room temperature, were incubated at 32 C for 15 to 20 hr before counting the colonies.

*Enumeration of cell density.* For the Standard Plate Count, plates containing 30-300 colonies were used for calculating cell density. For the microtiter method, spots containing an arbitrary range of 10-100 colonies were used (Fig. 1). A stage microscope (Spencer, American Optical Co., Buffalo, N. Y.) at a magnification of 10 times was used to facilitate counting when desired. The counts were then multiplied by the appropriate dilution factors to estimate the cell densities in the original samples. To minimize personal error and bias, these experiments were performed separately by the investigators, one using the microtiter method and the other the Standard Plate Count method in evaluation of the same samples.

*Storage study.* Nine manufacturing-grade milk samples were stored at 4 C for a short-term storage study. At storage intervals of 3, 5, and 12 days, viable cell counts were estimated by the microtiter method.

### RESULTS

The viable cell counts of the 34 manufacturing-grade milk samples and the 13 Grade A milk samples determined by the two methods are tabulated in Table 1a and Table 1b, respectively. With the exception of eight samples (Nos. 4, 6, 7, 13, 26, 28, 29, and 34) of manufacturing-grade milk, the viable cell counts obtained by the Standard Plate Count were higher than those obtained by the microtiter method. However, among the Grade A milk samples, six (Nos. 37, 38, 39, 44, 45, and 46) provided higher counts for Standard Plate Count and the other six revealed higher counts for the microtiter method; No. 36 gave essentially the same count by both methods. Statistical analyses of the data of the 34 manufacturing-grade milk samples showed a correlation coefficient of 0.604 between the Standard Plate Count and the microtiter method. Since the critical value at 1% level for 32 degrees of freedom is 0.436, this correlation coefficient is significant at the 1% level (5). The same statistical analysis on the data obtained from Grade A milk samples showed a correlation coefficient of 0.651, which is significant at the 5% level with 11 degrees of freedom and a critical value of 0.553. The combined coefficient correlation is 0.623, which is significant at 1% level with 45 degrees of freedom and a critical value of 0.372.

The microtiter method has been found in this laboratory to be at least 12 times more efficient than the Standard Plate Count method in terms of time necessary to complete the procedures. Also, readable results could be obtained in approximately 30 hr earlier as well as providing a more rapid means of obtaining colony counts.

TABLE 1A. COMPARISON OF VIABLE-CELL COUNTS IN MANUFACTURING-GRADE MILK<sup>a</sup>

| Sample number | Standard plate count/ml<br>10 <sup>6</sup> | Microtiter method count/ml<br>10 <sup>6</sup> |
|---------------|--------------------------------------------|-----------------------------------------------|
| 1             | 6.20                                       | 2.00                                          |
| 2             | 3.10                                       | 2.50                                          |
| 3             | 6.00                                       | 1.20                                          |
| 4             | 0.91                                       | 2.00                                          |
| 5             | 19.00                                      | 10.00                                         |
| 6             | 20.00                                      | 62.00                                         |
| 7             | 0.27                                       | 2.00                                          |
| 8             | 8.50                                       | 3.80                                          |
| 9             | 0.03                                       | 0.02                                          |
| 10            | 35.00                                      | 8.00                                          |
| 11            | 15.00                                      | 7.00                                          |
| 12            | 0.74                                       | 0.16                                          |
| 13            | 12.00                                      | 49.00                                         |
| 14            | 0.48                                       | 0.17                                          |
| 15            | 0.72                                       | 0.02                                          |
| 16            | 350.00                                     | 80.00                                         |
| 17            | 18.00                                      | 11.00                                         |
| 18            | 20.00                                      | 13.00                                         |
| 19            | 0.20                                       | 0.01                                          |
| 20            | 2.80                                       | 2.00                                          |
| 21            | 3.00                                       | 1.10                                          |
| 22            | 1.20                                       | 0.31                                          |
| 23            | 11.00                                      | 3.20                                          |
| 24            | 3.10                                       | 1.10                                          |
| 25            | 16.00                                      | 4.10                                          |
| 26            | 30.00                                      | 89.00                                         |
| 27            | 33.00                                      | 8.20                                          |
| 28            | 8.50                                       | 13.00                                         |
| 29            | 3.60                                       | 7.90                                          |
| 30            | 69.00                                      | 20.00                                         |
| 31            | 0.03                                       | 0.01                                          |
| 32            | 48.00                                      | 19.00                                         |
| 33            | 3.20                                       | 0.27                                          |
| 34            | 1.60                                       | 1.60                                          |

<sup>a</sup>The numbers were calculated from counts obtained from duplicate plates or spots of appropriate dilutions of each sample. Correlation coefficient of these methods is 0.604.

The results of the storage study are tabulated in Table 2. Although no comparison of methods was made, the microtiter method demonstrated increases in bacterial numbers in milk samples during storage, as may be expected. The procedure was shown to be applicable to determinations of bacterial content of stored milk.

### DISCUSSION

The microtiter method is comparable to the Standard Plate Count in accuracy for estimating viable cell counts in both manufacturing-grade milk and Grade A milk. Higher counts obtained from the Standard Plate Count for manufacturing-grade milk may be a result of breaking up of clumps and chains of bacteria by the vigorous shaking of the stored high

TABLE 1B. COMPARISON OF VIABLE-CELL COUNTS IN GRADE A MILK<sup>a</sup>

| Sample number | Standard plate count/ml<br>10 <sup>4</sup> | Microtiter method count/ml<br>10 <sup>4</sup> |
|---------------|--------------------------------------------|-----------------------------------------------|
| 35            | 0.48                                       | 2.00                                          |
| 36            | 0.39                                       | 0.38                                          |
| 37            | 0.50                                       | 0.22                                          |
| 38            | 0.67                                       | 0.38                                          |
| 39            | 0.64                                       | 0.48                                          |
| 40            | 3.40                                       | 10.60                                         |
| 41            | 0.62                                       | 1.30                                          |
| 42            | 0.78                                       | 2.40                                          |
| 43            | 0.86                                       | 2.40                                          |
| 44            | 1.10                                       | 0.11                                          |
| 45            | 1.30                                       | 0.10                                          |
| 46            | 1.80                                       | 0.22                                          |
| 47            | 0.30                                       | 5.20                                          |

<sup>a</sup>The numbers were calculated from counts obtained from duplicate plates or spots of appropriate dilutions of each sample. Correlation coefficient of these methods is 0.651.

TABLE 2. MICROTITER METHOD COUNT OF MANUFACTURING-GRADE MILK IN COLD STORAGE<sup>a</sup>

| Sample number | Days of storage        |                        |                        |
|---------------|------------------------|------------------------|------------------------|
|               | 3                      | 5                      | 12                     |
| 1             | 1.50 x 10 <sup>5</sup> | 2.00 x 10 <sup>6</sup> | 4.60 x 10 <sup>6</sup> |
| 2             | 1.10 x 10 <sup>6</sup> | 2.50 x 10 <sup>6</sup> | 5.60 x 10 <sup>7</sup> |
| 3             | 4.80 x 10 <sup>5</sup> | 1.20 x 10 <sup>6</sup> | 3.80 x 10 <sup>7</sup> |
| 4             | 7.20 x 10 <sup>5</sup> | 2.00 x 10 <sup>6</sup> | 3.00 x 10 <sup>7</sup> |
| 5             | 2.70 x 10 <sup>6</sup> | 1.00 x 10 <sup>7</sup> | 0.80 x 10 <sup>7</sup> |
| 6             | 1.30 x 10 <sup>6</sup> | 6.20 x 10 <sup>7</sup> | 1.70 x 10 <sup>7</sup> |
| 7             | 1.90 x 10 <sup>6</sup> | 2.00 x 10 <sup>6</sup> | 3.80 x 10 <sup>7</sup> |
| 8             | 7.90 x 10 <sup>4</sup> | 3.80 x 10 <sup>6</sup> | 4.00 x 10 <sup>6</sup> |
| 9             | 5.00 x 10 <sup>3</sup> | 2.40 x 10 <sup>4</sup> | 3.80 x 10 <sup>7</sup> |

<sup>a</sup>At refrigerated temperature of 4 C.

bacterial count milk. Data from the Grade A milk, however, show even distribution of higher counts between the two methods. Statistical analysis of the two sets of milk samples showed that the correlation of the two methods was highly significant. This microtiter method has the advantage of savings of time, space, material, and labor over the conventional method. It has been estimated that the cost of supplies for the microtiter method is approximately one-tenth that of the Standard Plate Count Method. Practical application of this microtiter method was shown by evaluating bacterial population in milk during cold storage. Other practical applications are possible for use in dairy microbiology.

## ACKNOWLEDGEMENTS

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## Notice To Membership

Deadline for submission of nominations for the \$1,000.00 Sanitarians Award is June 1, 1969—state and federal employees only are eligible. Please send your nominations to Dr. P. R. Elliker, Dept. of Microbiology, Oregon State University, Corvallis, Oregon 97331. Form for submission of nominations may be obtained from IAMFES, Inc. P. O. Box 437, Shelbyville, Ind. 46176.



## COMPARISON OF SKIMMILK FAT TESTS AND NEW VERMONT METHOD<sup>1, 2</sup>

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### ABSTRACT

A comparative study of skimmilk fat tests indicated the need for a more accurate method. Such a method was developed at the Vermont Agricultural Experiment Station. Called the Vermont method, this uses Patton's aqueous reagent of n-butylamine and n-butanol, Babcock equipment and glassware, and the TeSa water bath. This Vermont method is simple, inexpensive, and no more time consuming than the Babcock procedure.

Twenty-two trials were performed whereby skimmilk samples were collected weekly from 6 milk dealers and tested by 5 or 6 methods. Several milk dealers sold skimmilk that consistently tested higher than 0.50% fat as determined by the Mojonnier procedure. It was apparent that results obtained with the Babcock, Wildasin Babcock (use of a quaternary ammonium compound), and American Association (modified Babcock using n-butanol) methods showed poor fat percentage agreement over the legal fat range, compared with the Mojonnier procedure. Data from the Gerber and Vermont methods showed very close agreement with that of the Mojonnier procedure. Statistical analysis indicated a significant difference ( $P < 0.01$ ) between fat percentages obtained using the Babcock, Wildasin Babcock, and American Association methods when compared with the Mojonnier technique. Results from the Gerber and Vermont methods were not significantly different from those obtained with the Mojonnier procedure.

Precision for the Vermont method was determined by testing 10 replicate samples of 2 different skimmilks. The means and standard deviations for the samples are as follows:  $0.12\% \pm 0.005$ , and  $0.44\% \pm 0.007$ . Use of the Vermont method must await results of studies from other laboratories.

Over the past decade skimmilk has become an increasingly popular beverage. Perhaps the consumer has recognized the nutritive value of skimmilk and the fact that it has fewer calories than whole milk products. Realizing the current nutritional attitudes of our society, we should expect increased sales in the future.

Milk fat remains the expensive constituent of milk. Precise, simple fat-testing methods that have close correlation with an accurate official method are essential. Unreliable fat tests can cause financial losses for both the farmer and milk plant operator. Nu-

merous comparative studies have been made to determine the fat content in milk and several dairy products, but not in skimmilk. Until recently, it was considered only a low-fat by-product of the cream and butter industry. Now, it is apparent that reliable skimmilk fat tests are needed for: (a) milk fat accounting for the Federal Milk Marketing Orders, (b) obtaining optimum separation efficiency in the plant, and (c) determining the legality of the product.

A literature review on comparative tests for fat in skimmilk showed several studies. In 1933 Wright and Holm (11) compared the Babcock, American Association (modified Babcock using n-butanol), Minnesota Babcock (alkaline reagent), and Roese-Gottlieb methods. Only the data obtained using the American Association method compared favorably with results from the Roese-Gottlieb (after the phospholipid content was subtracted from the total lipid recovered). Hileman et al. (3) reported that the Babcock test for fat in skimmilk shows only about one-seventh of the fat actually present according to the Mojonnier procedure. A subcommittee report of the American Dairy Science Association (2) evaluated methods for testing fat in a number of dairy products. It was agreed that no single testing method for skimmilk compared perfectly with the Mojonnier procedure. However, the committee recommended the method of the American Association even though no data were presented. McDowell (4) compared 9 skimmilk samples tested by the Roese-Gottlieb, American Association, and Gerber methods. The results of the 2 acid methods were slightly lower than those obtained by the Roese-Gottlieb method. Murphy (6) compared 16 skimmilk samples for fat content as determined by the sepascope, Mojonnier, and Gerber methods and found the Gerber results slightly higher than those of the Mojonnier technique.

Skimmilk samples were tested by the Babcock, American Association, and Mojonnier methods in our laboratory; results from the 2 simple tests did not agree with those from the Mojonnier method. These results led to the decision to devote time and effort to developing a new, simple procedure. For simplicity and economy, the new test was designed to use Babcock equipment and glassware. Because handling sulfuric acid is dangerous and Babcock

<sup>1</sup>This study was supported by the Walker Research Fund and Federal Grant HA-143.

<sup>2</sup>University of Vermont Agricultural Experiment Station Journal Article 210.

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skimmilk test bottles are extremely difficult to clean after a fat test, numerous other chemicals were studied. A reagent was needed that would remove the complex milk fat membrane of very small globules, thus releasing the fat and allowing it to rise by centrifugation in the small graduated bore of the Babcock skimmilk bottle.

Patton (8) studied many simple organic compounds for the de-emulsification of cream. He developed an aqueous reagent containing *n*-butylamine and *n*-butanol which readily recovered milk fat from numerous dairy products other than skimmilk. His purpose was to develop a simple procedure for recovering pure milk fat for analyses of its physical and chemical constants (9).

In this study Patton's reagent was used to develop a simple procedure for determining the milk fat in skimmilk. The results from this new fat test (named the Vermont method) were compared with results from routine skimmilk fat tests and the Mojonnier procedure to determine its value and reliability.

#### PROCEDURES

Skimmilk samples were obtained each week from 5 local dairy plants and the University Creamery. Four of the 6 dealers fortified their skimmilks with nonfat milk solids. Six different retail samples were acquired to compare skimmilks of various fat percentages.

The skimmilk samples were tested for fat by 6 different methods. The procedures outlined by Newlander and Atherton (7) were used for the Babcock, American Association, and Gerber tests. Wildasin's modification of the Babcock test (with a quaternary ammonium compound) for testing fat in homogenized milk was also studied (10). Directions outlined by the company (5) were used for the Mojonnier method; this was considered the most accurate. The Vermont method is discussed below.

#### Vermont method

*Equipment.* Regular Babcock testing equipment and glassware, including 18 g, 0.5% skimmilk test bottles, were used. The TeSa boiling water and tempering bath was used for initial digestion of the samples and final tempering before reading the fat percentage.

*Reagents.* The test reagent was prepared as reported by Patton (8): "To 310 ml of water in a 1 liter reagent bottle are added 420 ml of *n*-butylamine and 132 ml of *n*-butanol. The contents of the bottle are shaken to yield the reagent which should be single-phased. This reagent is stable, easily prepared, and its constituents are inexpensive and readily available." The indicator solution was prepared by dissolving 1 g of phenolphthalein in 100 ml of absolute ethyl alcohol.

#### Procedure

1. Place 2.5 ml of test reagent in the skimmilk test bottle. (Numerous different volumes of this reagent were studied; 2.5 ml yielded optimum fat percentages for skimmilk.)

2. Heat skimmilk sample to 60 C.

3. Add 17.5 ml of heated skimmilk sample to test bottle and shake contents well. (One-half minute in a mechanical shaker is sufficient.)

4. Place the sample in a boiling water bath for 2 min.

(Temperature and time must be closely controlled. Preheating the skimmilk bottle rack in a TeSa boiling water bath before adding the sample bottles to the rack worked well in our laboratory. Heating the samples in a boiling water bath for 2 min yielded optimum fat percentages for skimmilk. Heating beyond 3 min caused charred fat columns.)

5. Remove sample from boiling water bath and add 10 drops of 1% phenolphthalein and shake. (Phenolphthalein causes a red color to develop in the basic-aqueous system and results in a color contrast which makes the fat in the graduated bore easier to read.)

6. Centrifuge in a cold machine for 5 min, then add water at 67-73 C to within 0.25 inch of the bottle neck.

7. Centrifuge 2 min, then add water at 67-73 C to bring fat column into the neck of the bottle.

8. Centrifuge 1 min, then place the sample bottle in a water bath at 57-60 C for 5 min.

9. Remove sample bottle from tempering bath and read.

#### RESULTS AND DISCUSSION

During the final developmental stages of the Vermont method, skimmilks were tested for fat by 4 selected simple methods and the Mojonnier procedure. The purposes were to gain experience with the methods and to acquire data to determine their acceptability. The Mojonnier procedure was selected as most accurate.

Initially, 11 trials were performed whereby skimmilk samples were collected weekly from 6 milk dealers and tested by 5 methods. After the Vermont method was developed, 11 additional trials were made on samples collected from 6 dealers and tested by 6 methods. During the 22-week testing period, several laboratory accidents occurred with specific methods, necessitating removal of those sample results from the final summary. The Babcock, Wildasin Babcock, and Vermont methods employ the Babcock skimmilk bottle; thus, samples containing more than 0.50% fat could not be read. The skimmilk from dealer 6 consistently tested above 0.50% fat and the data could not be included in the summary. Skimmilk testing above 0.50% fat is not legal in Vermont. The illegal samples had been fortified with nonfat milk solids.

Statistical analysis was performed using the complete-block design for more than 1 observation per experimental unit. To determine source of significant difference between methods, Tukey's multiple range test was used. Data from 5 comparative trials for the first 11-week testing period and 6 comparative trials for the second 11-week testing period were examined statistically.

Skimmilk from 5 dealers tested by 5 different methods is compared in Table 1. It is apparent that results obtained using the Babcock, American Association, and Wildasin Babcock methods have poor fat percentage agreement over the legal fat range, compared with the Mojonnier procedure. The Gerber method agrees closely, but results are consistent-

TABLE 1. COMPARISON OF FAT CONTENT IN 46 RETAIL SKIMMILKS OBTAINED FROM 5 DEALERS AND TESTED BY 5 METHODS

| Trials | Dealer | Methods |         |                  |         |                      |         |        |         |           |         |
|--------|--------|---------|---------|------------------|---------|----------------------|---------|--------|---------|-----------|---------|
|        |        | Babcock |         | Wildasin Babcock |         | American Association |         | Gerber |         | Mojonnier |         |
|        |        | mean    | range   | mean             | range   | mean                 | range   | mean   | range   | mean      | range   |
| 8      | 1      | .01     | .01-.02 | .01              | .00-.02 | .02                  | .01-.04 | .11    | .10-.15 | .07       | .00-.13 |
| 11     | 2      | .02     | .01-.03 | .02              | .01-.04 | .03                  | .01-.06 | .12    | .10-.15 | .10       | .06-.14 |
| 10     | 3      | .10     | .02-.33 | .17              | .01-.47 | .18                  | .04-.46 | .31    | .12-.65 | .29       | .11-.60 |
| 9      | 4      | .17     | .00-.29 | .32              | .01-.50 | .25                  | .00-.50 | .45    | .10-.70 | .44       | .09-.63 |
| 8      | 5      | .14     | .09-.23 | .38              | .27-.43 | .32                  | .20-.42 | .51    | .40-.60 | .48       | .39-.52 |

TABLE 2. COMPARISON OF FAT CONTENT IN 42 RETAIL SKIMMILKS OBTAINED FROM 5 DEALERS AND TESTED BY 6 METHODS

| Trials | Dealer | Methods |         |                  |         |                      |         |         |         |        |         |           |         |
|--------|--------|---------|---------|------------------|---------|----------------------|---------|---------|---------|--------|---------|-----------|---------|
|        |        | Babcock |         | Wildasin Babcock |         | American Association |         | Vermont |         | Gerber |         | Mojonnier |         |
|        |        | mean    | range   | mean             | range   | mean                 | range   | mean    | range   | mean   | range   | mean      | range   |
| 10     | 1      | .03     | .02-.06 | .04              | .01-.13 | .05                  | .02-.10 | .12     | .07-.26 | .15    | .10-.27 | .13       | .05-.20 |
| 11     | 2      | .08     | .01-.29 | .08              | .01-.30 | .09                  | .01-.30 | .15     | .01-.39 | .15    | .10-.30 | .16       | .02-.38 |
| 11     | 3      | .05     | .03-.09 | .12              | .06-.17 | .15                  | .10-.23 | .21     | .08-.31 | .24    | .17-.30 | .23       | .16-.28 |
| 7      | 4      | .11     | .02-.20 | .24              | .07-.41 | .22                  | .06-.41 | .34     | .21-.45 | .33    | .22-.45 | .34       | .21-.46 |
| 3      | 5      | .13     | .12-.16 | .35              | .30-.40 | .39                  | .36-.44 | .44     | .44-.45 | .47    | .40-.50 | .45       | .44-.47 |

ly higher than the Mojonnier values. If the Gerber fat correction factor for samples testing below 0.25% had been omitted, agreement would have been closer. Statistical analysis showed the Mojonnier data significantly different ( $P < 0.01$ ) from the Babcock, American Association, and Wildasin Babcock results. The Gerber fat tests were not significantly different from those obtained using the Mojonnier method. Of the 4 simple methods compared, the most accurate was the Gerber.

Skimmilk from 5 dealers tested by 6 different methods is compared in Table 2. It can be seen that the data collected using the Babcock, American Association, and Wildasin Babcock methods agree poorly with the Mojonnier results over the fat test range. Data from Gerber and Vermont methods show very close agreement with the Mojonnier values. Statistical analysis showed a significant difference ( $P < 0.01$ ) between the fat contents obtained using the Babcock, American Association, and Wildasin Babcock methods, compared with the Mojonnier results. The Gerber and Vermont data were not significantly different from that recorded with the Mojonnier procedure. Of the 5 simple methods compared, the accurate ones were the Gerber and Vermont.

Precision for the Vermont method was determined by conducting 10 replicate tests on 2 different skim-milks. The means and standard deviations for the

2 samples are as follows:  $0.12\% \pm 0.005$ , and  $0.44\% \pm 0.007$ .

Foulkes (1) recently analyzed skimmilk lipids recovered by the Babcock, American Association, Vermont, and Mojonnier methods. Phospholipids were found only in the Mojonnier extract. The neutral lipid classes varied, depending upon the extraction method; those recovered by the Vermont method were closely similar to the Mojonnier. The mean weight recoveries of the skimmilk lipids by the American Association and Vermont methods were similar and significantly less than the Mojonnier. This evidence confirms that the Vermont method has material other than normal lipids in the fat column. The Vermont method apparently has an inborn correction factor which is responsible for its agreement with the Mojonnier procedure.

These research data show a significantly close agreement between the Mojonnier, Gerber, and Vermont methods over the legal (Vermont) range of fat in skimmilk. Since most laboratories in this country use Babcock rather than Gerber testing equipment, the Vermont method may prove useful for testing fat in skimmilk. But its applicability must await confirming studies from other laboratories.

## ACKNOWLEDGMENTS

The technical assistance of James Drown and Lee White is

greatly appreciated. We also thank David Sylvester, Assistant Professor of Mathematics at the University of Vermont, for help in performing the statistical analysis.

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## ASSOCIATION AFFAIRS

### KENTUCKY FIELDMEN AND SANITARIANS CONFERENCE



H. L. "Red" Thomasson, Exec.-Sec'y., Mg. Ed. IAMFES, C. Bronson Lane, President Kentucky AMFES and Wally Mann, Editor Dairy Plant Fieldman.

Over two hundred dairy plant managers, fieldmen, sanitarians, University personnel, and dairy equipment representatives attended the 1969 Kentucky Fieldmen's and Sanitarians' Conference at Mammoth Cave, Kentucky on February 25 and 26. The conferees received the latest information on the status of the proposed manufacturing milk regulations, mastitis control, proper cleaning and sanitizing procedures, and milk quality control procedures.

Following are the 1969 officers elected for the Kentucky Association of Milk, Food, and Environmental Sanitarians: President, Dr. C. Bronson Lane, Univer-

sity of Kentucky, Lexington, Kentucky; President-elect, Mr. Jim McDowell, Dairymen, Inc.—Kyana Division, Louisville, Kentucky; Vice-President, Mr. Lyman Knierem, Sepko-Chemical Co., Louisville, Kentucky and Secretary-Treasurer, Mr. Leon Townsend, Kentucky State Department of Health, Frankfort, Kentucky.

Mr. Ken Mennen, Armour Creameries, Springfield, Kentucky, received the outstanding Kentucky industry man award at the Awards luncheon on February 26. Mr. Calvin Moran, Christian County Health Department, Hopkinsville, Kentucky, was selected as the outstanding Kentucky sanitarian, and Mr. Jim Perkins, Dean Milk Company, Louisville, Kentucky, won the outstanding fieldman award.

### DR. MILTON J. FOTER

Dr. Milton J. Foter, a long time member of IAMFES, Inc., died Friday, March 7, at Emory University Hospital, Atlanta, Ga. He was assistant to the administrator at the Communicable Disease Center in Atlanta.

He conducted milk and food research at the Robert A. Taft Engineering Center, Cincinnati, from 1945 to 1964.

He is survived by two daughters, Mrs. Richard Deeds, Columbus, Ohio, and Mrs. Tony Santalucia, State College in Pennsylvania; his mother, Mrs. Barbara Foter, Atlanta and three grandchildren.

### CIP SEMINAR—DENVER, COLORADO— MARCH 6, 1969

Mr. Dick B. Whitehead, 1st Vice President of IAMFES and Consulting Sanitarian for the Diversey Chemical Company, and Mr. Paul A. Freebarin, Market Manager of the Distributor Sales Department of Pennsalt Chemicals Corporation, conducted a day long Seminar on the cleaning and sanitizing of dairy plant equipment in Denver, Colorado, March 6, 1969. Sixty-four representatives of federal, state and local regulatory agencies, dairy plant and dairy equipment supply and competitive cleaner industries attended.

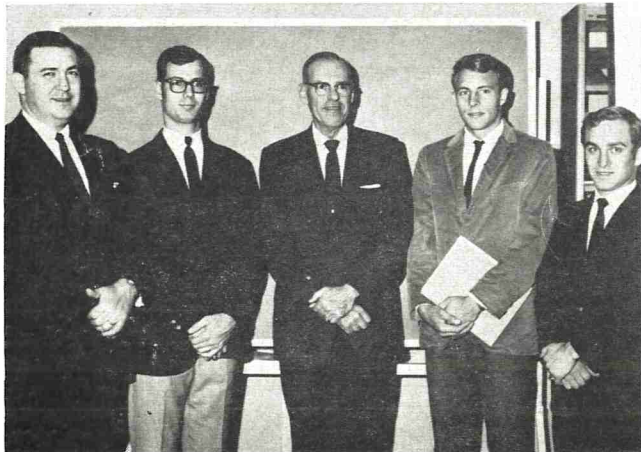
The material presented consisted of the basic essentials and requirements for CIP equipment design, installation and operation. The elementary chemistry of cleaning and sanitizing was discussed with special emphasis on programming the operation and

use of the basic essentials of time, temperature and concentration. The 3-A Sanitary Standards for CIP were emphasized and explained throughout the Seminar with appropriate visual aids showing the right and wrong in equipment, installation and operation. The theme of 98% clean and 2% dirty was use throughout to call attention to the fact that this 2% is what causes the majority of quality problems such as poor keeping quality, inadequate shelf life and the development of undesirable flavors and odors. 100% clean is necessary if consumer satisfaction is to be maintained and to compete with substitutes.

Mr. Whitehead was the speaker at the monthly meeting of the Colorado Dairy Technology Society on March 5. His subject was the 3-A Sanitary Standards—what they are—how developed—and their importance and significance to public health and the dairy industry.

## NEWS AND EVENTS

### BORDEN OFFICIAL SPEAKS TO STUDENTS AT TEXAS A & M



Left to Right. Dr. H. E. Randolph, Department of Animal Science, Texas A&M. James N. Chastain, Mr. Newton Lamb, Borden Company, Houston. Randall R. Holdridge, and James R. Flusche.

Mr. Newton Lamb, Director of Quality Control, Southern Division of the Borden Company, Houston, Texas, was a recent speaker for the Food Plant Management Class at Texas A&M. The subject of Mr. Lamb's presentation was "New Developments and Trends in the Food Industry." Mr. Lamb reviewed some of the major changes and trends in the food industry, and encouraged the students to obtain a broad and basic education in order to prepare themselves for a career in the dynamic food industry.

### SIXTH HOMESTUDY COURSE ANNOUNCED

The National Communicable Disease Center announces the availability of its sixth Homestudy Course "Foodborne Disease Control." This as well as other homestudy activities are offered to qualified students. All materials with the exception of major reference textbooks are furnished free.

Other courses in the NCDC homestudy series are: Community Hygiene, Basic Mathematics for the Sanitarian, Communicable Disease Control for the Sanitarian, Vectorborne Disease Control, Waterborne Disease Control.

Inquiries may be addressed to: National Communicable Disease Center, Atlanta, Georgia 30333, Attention: Training Program.

### 44TH ANNUAL MEETING OF THE AMERICAN DRY MILK INSTITUTE

The American Dry Milk Institute will hold its 44th Annual Meeting at the LaSalle Hotel in Chicago on April 24 and 25th, it has been announced by J. T. Walsh, Executive Director. Another record attendance is anticipated at this annual meeting of dry milk manufacturers and allied industries. The program will include qualified and informed speakers from industry, government, universities and the Institute staff. Among the program topics to be discussed will be a high-light report on sales, utilization by markets, quality control procedures, proteins from

new sources, plant operation efficiencies, government programs and other matters of interest to dry milk manufacturers.

According to Walsh, all dry milk manufacturers and allied industry friends with interest in dry milk processing and marketing are cordially invited to attend this 44th Annual Meeting. More detailed program information will be forthcoming.

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### **NEW FROZEN CULTURES FOR PRODUCTION OF YOGURT**

A new series of deep frozen cultures for the production of yogurt has recently been introduced by Chr. Hansen's Laboratory. They are members of Hansen's Redi-Set line of direct set bulk starters and are said to eliminate many of the variables that plague the commercial production of yogurt. According to Tom Daines, sales manager of the Milwaukee based producer of dairy industry products, the Hansen's yogurt cultures, if recommended procedures are followed, are able to sustain their bacterial composition during the period of incubation so that a balance is always maintained, and the yogurt flavor will remain constant batch after batch.

Mr. Daines stated that one 2-ounce can of frozen culture would set 300 gallons of product without any need for an intermediary. At this time, Hansen's are providing three culture strains for yogurt and a fourth strain is now in its final phase of testing. All cultures are delivered to the dairy plant in heavily insulated containers of liquid nitrogen at a temperature of  $-320^{\circ}$  F.

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### **NEW REPORT DETAILS LIQUID MANURE HANDLING**

A report on design, construction, operation and maintenance of liquid manure handling systems for dairy farms has just been released by a committee of governmental agencies, University of Wisconsin specialists and industry representatives. The guidelines and suggestions meet at least minimum legal requirements, plus the needs of efficient manure disposal on dairy farms. Increasing concern over pollution of surface and ground waters, and the problems of farm labor have produced considerable interest in more efficient and safer ways of manure disposal.

Although committee members developed the guidelines and suggestion for dairy farms selling milk, most of the principles will apply to all livestock farms. Committee members based their recommendations on research data, observations of existing systems, and experience. The specialists used six

basic objectives in developing liquid manure handling guidelines and suggestions. To meet legal requirements the system should: (1) Keep cows and areas occupied by them clean and attractive for convenient production of clean, wholesome milk. (2) prevent contamination of water in wells, ponds, lakes, streams and springs. (3) Control odors and fly breeding.

To meet requirements of efficient farming, committee members said the system should: (1) Save as much of the fertility value of the manure as possible. (2) Save labor, and be economical and convenient for dairymen. (3) Allow dairymen to select the best time to apply manure to cropland.

The report includes guidelines for locating, determining size, and constructing the liquid manure storage tank. Detailed drawings included in the report offer further information. Agitation and water facilities, methods for emptying storage tanks, and handling, spreading, scraping and cleaning equipment are also discussed. Special sections give suggestions for designing liquid manure handling systems in stall barns. A final section explains safety precautions and ways of protecting milk quality. While the report is complete to the point of showing construction details, the committee recommends that farmers get further advice before starting construction. Farmers interested in developing a liquid manure handling system must have design plans approved by the agency supervising legal requirements of milk sales from that particular farm before construction begins. Dairy plant fieldmen can help file plans with proper authorities.

Guidelines and suggestions in the report were developed by representatives from University Extension; University of Wisconsin; Wisconsin Department of Agriculture; local, state and U.S. public health departments; the dairy industry and press; Portland Cement Assn.; and Farmstead Equipment Council. Additional copies are available from the University of Wisconsin Department of Agricultural Engineering; the University Extension office in your county; or the Food Division, Wisconsin Department of Agriculture.

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### **MEETING OF JOINT FAO/WHO CODEX ALIMENTARIUS COMMISSION—GENEVA, MARCH 4-14, 1969<sup>1</sup>**

Progress toward harmonization of food laws may be expected to proceed satisfactorily, but at a slow pace. While the delegates paid lip service to harmonization, it was apparent that differences in laws, in commercial interests and food habits, influenced many of the actions taken. For instance, the present Rules of the Commission provide that, at the request

of a majority of the countries constituting a region, the countries of that region may proceed to establish a regional standard. The Canadian delegation suggested at last year's session that such regional standards should be restricted to foods produced in the region and mainly consumed therein. The Executive Committee, at its June 1968 meeting, recommended another solution to the problem of regional standards whereby the Commission would control their elaboration, namely, that such regions could only proceed with regional standards if the Commission so determined. After lengthy debate a vote was taken on the Executive Committee proposal. The vote showed 37 countries present with 22 for, 14 against and 1 abstention. As the Rules require a 2/3 vote for a change in the Rules the proposal failed.

*General Principles*—Another item debated at length was a proposed amendment to the General Principles of the Codex Alimentarius Commission as they relate to the Purpose of the Codex, specifically to provide for codes of practice, guidelines and other recommended measures. The need to express the purpose of protecting the consumer was stressed and the Delegate of the International Association of Consumers' Unions (IACU) expressed her appreciation of this view. It was stated that at the outset the Codex could only be expected to be a compendium of food legislation in the various countries which would make it easier to learn what the differences in the various countries' laws are, rather than result in an immediate harmonization of them. The view was expressed that this would lead little by little to harmonization.

*Labeling Standard*—The European countries objected strenuously to the proposal in the Labeling Standard that all ingredients be declared on the label. It was proposed that where national legislation did not require this, the acceptance could be on the basis that the information provided on the label need only be sufficient to enable the consumer to understand the nature and worth of the food. IACU supported the need of a general standard for unstandardized food and the showing of ingredients. The Labeling Standard, as amended to provide for acceptance without a showing of all ingredients if a country so decided, was passed to Step 9.

*Additives in Fats and Oils*—There was substantial opposition to permission to use colors and emulsifiers in the General Standard for Edible Oils and Fats. Switzerland suggested a vote to eliminate their use in such oils. It was pointed out by the United States that the Chairman should define the difference between fats and oils before a vote be taken on the matter. The Chairman said that, as the experts had been unable to do this in the Fats and Oils Committee, he could not do so and no vote was taken. France sug-

gested that, as there was so much disagreement about the standard, it should be given a further chance to ripen by being sent back to the Committee rather than being passed to Step 9. Otherwise the standard might be accepted with many reservations which would be undesirable. The Chairman suggested that the Commission reflected the same division that had been expressed in the Committee and that there was remarkable unanimity except with respect to the additives. On a vote the Standard for Edible Oils and Fats was passed to Step 9-11 for, 10 against and 15 abstentions.

*Honey Standard*—Further evidence of the difficulties in securing worldwide harmonization may be found in the actions taken with respect to the standard for honey. Canada proposed that reconsideration be given to the decision taken last year that this standard be a regional one. This proposal was defeated by 15 votes to 9 with 11 abstentions. The United States objected to the values established for diastase activity and hydroxymethylfurfural content, on the ground that much of the honey produced and consumed in the U.S. would not meet those values. These provisions of the honey standard are not in conformity with the Codex principle of establishing minimum standards for wholesome acceptable products. The honey standard contains criteria for a special quality product which excludes much good and wholesome honey.

*Sugar Standard*—The inconsistency of the European countries with respect to additives was reflected by the decision that sulphur dioxide need not be declared as an additive on the labels of sugar. My discussion with industry delegates to the various European delegations shows that they are in favor of the approval of as many additives as possible in the interest of their companies. However, many have not been able to persuade their official delegations to accept this view.

*Food Colors*—Eight food colors found acceptable for use in food by the Codex Committee on Food Additives and which had been given acceptable daily intakes for man by the Joint FAO/WHO Expert Committee on Food Additives, were approved by the Commission for the information of governments.

*Dietary Foods*—The Commission approved Guidelines for the Elaboration of Codex Standards for Foods for Special Dietary Uses. These included the provision that foods for special dietary uses should be freely available wherever foods are sold and without licensing requirements not imposed on foods generally.

*European Common Market*—Dr. H. Steiger in behalf of the European Economic Community (EEC) reported that free trade was required to occur in that region by January 1, 1970 pursuant to treaty. He

expressed the hope that many food law problems would be resolved prior to that date. He submitted a written report on the state of work relating to harmonization of food legislation in the EEC. Industry leaders tell me that actual progress on this program may be slow and that this program is not likely to be completed by January 1, 1970.

*Standards Work in Asia and Latin America*—The Secretariat submitted reports on food standards work in Asia and Latin America. In commenting on the report relating to Latin America, Peru and Venezuela stated that too much emphasis was placed on the value of the Latin American Food Code. It was stated that this Code no longer had a practical effect in Latin America. However, the practical value of this Code must be recognized in any future movements for a Latin American model law.

*Work Accomplished*—In all there were 21 standards advanced to Step 9 for acceptance by governments. These included the General Standard for Labeling, the Standards for Fats and Oils, including margarine, and the Standards for White, Powdered and Icing Sugars. With respect to additives proposed for use in fats and oils, it was agreed that the Joint FAO/WHO Expert Committee on Food Additives will be requested to consider at its next session those additives in the standard which have not yet been evaluated toxicologically. The Codex Committee on Food Additives will then be requested to consider at its next session the endorsement of those food additives in the standard which it has not yet endorsed, and for which the Export Committee was able to establish an acceptable daily intake (A.D.I.) or temporary A.D.I. When sent to governments the standards will contain only those additives which have been previously endorsed, or temporarily endorsed, and those which may be endorsed or temporarily endorsed at the next session of the Codex Committee on Food Additives. Any additives not so accepted will be deleted from the standard at that time. However, the possibility was left over of reconsidering them at the next session of the Fats & Oils Committee and to again refer them to the Additives Committee for ultimate inclusion in the standards. It is thus essential for American industry to work closely with these Committees to assure the approval of any additives felt to be needed.

<sup>1</sup>From Reports of Food Law Institute by Franklin M. Depew, Pres.

### NEW POWERFUL CLEANER

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### THE PENNSYLVANIA STATE UNIVERSITY 27TH ANNUAL DAIRY FIELDMEN'S CONFERENCE JUNE 10-11, 1969

The 1969 Dairy Fieldmen's Conference is going to be held at The Pennsylvania State University. All meetings will be held in the auditorium of the J. Orvis Keller Building and the banquet will be on Tuesday evening at the Nittany Lion Inn. A list of the hotels and motels in the State College area is enclosed. Registrants should make reservations directly with the hotel or motel of their choice at their earliest opportunity, as several other large conferences will be meeting concurrently.

The fee is \$12.50 per person and includes: Registration, conference proceedings, banquet, and Dairy Fieldmen's Scholarship. Please send in this form with a check payable to The Pennsylvania State University. If more than one individual from a company or other association is attending, a pre-registration form should be completed for each individual; but one check will suffice for the entire group. All pre-registration forms and checks (payable to The Pennsylvania State University) should be sent to: Agricultural Conference Coordinator, Room 410 J. Orvis Keller Building, The Pennsylvania State University, University Park, Pennsylvania 16802. A large crowd is expected, so advance registration is very important.

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**3-A SANITARY STANDARDS FOR EGG EQUIPMENT ADOPTED BY POULTRY INDUSTRY REPRESENTATIVES**

At its charter meeting at Palm Springs, California, March 13, the 3-A Sanitary Standards Committees for the Egg Industry completed four new sanitary standards for egg processing equipment. Authorized for signing and publication, and designated "E-3-A Sanitary Standards," are cleanability and sanitation guidelines for sanitary pumps, homogenizers, thermometer fittings, and dry egg sifters. These four new E-3-A Sanitary Standards will be published officially in the Journal of Milk and Food Technology later in the year. Distribution of E-3-A Standards to the industry will be by re-printing from the Journal, where copies are available at nominal cost.

Other tentative E-3-A Sanitary Standards were considered for rubber and rubber-like materials. Accepted practices for air under pressure, and for permanently installed sanitary pipelines were also studied. These preliminary drafts were reviewed and passed on to the next action body for completion at the Fall 3-A meeting.

Participating in the Palm Springs meeting were the Sanitary Standards Committee of the Institute of American Poultry Industries; Technical Committee of the Dairy & Food Industries Supply Association; Poultry Division, C&MS, USDA; Committee on Sanitary Procedure—International Association of Milk, Food, and Environmental Sanitarians; and Environmental Sanitation Program representatives from USPHS.

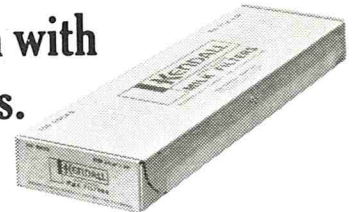
The 3-A Sanitary Standards have been regarded as the greatest single factor contributing to the uniformity of equipment requirements, and reciprocity of acceptance, among state and local regulatory jurisdictions.

Three-A Sanitary Standards are published officially in the Journal of Milk and Food Technology. Complete sets of published 3-A Standards are available at a nominal cost from the Journal at Box 437, Shelbyville, Indiana 46176.

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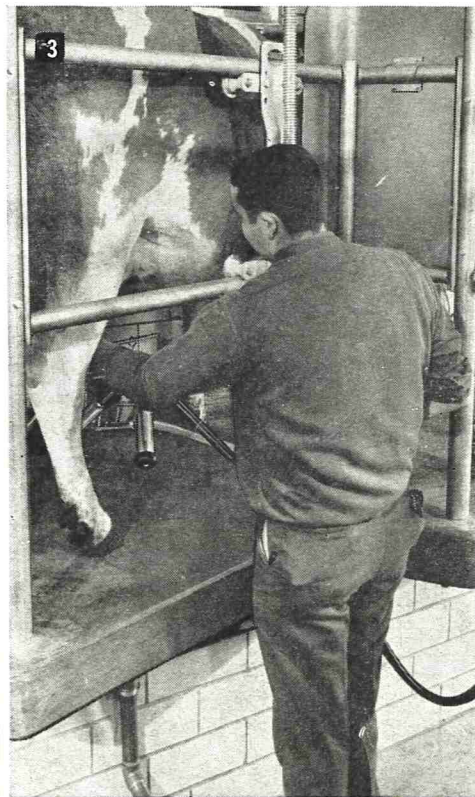
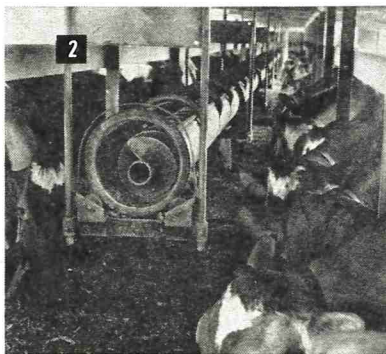
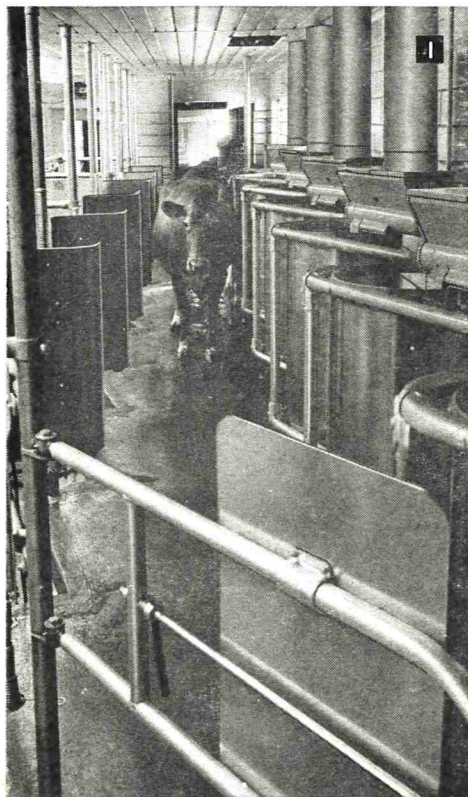
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