MICROBIOLOGICAL CRITERIA IN PROCESSED MEATS*

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The subject matter which I will briefly discuss today is far from being new. Microbiological criteria have been used for quality control purposes for years by many meat processing firms. Additionally, the safety of many meat processing procedures has been established through microbiological research. Federal, State and local food regulatory agencies have historically taken action on those microbiological findings which indicate a clear hazard to health. For example, food products containing botulinal toxin, staphyloccal enterotoxin or salmonellae have resulted in seizures, industry recalls and even public recalls. Investigations of the causes of these incidents inevitably point to a breakdown in handling controls at the food service level or faulty distribution practices or improper processing at the plant level. The goal of all food processors, food microbiologists and food scientists is to prevent these incidents. Faulty practices in the home are not regulated, thus improvement in this area is an educational problem. Improper practices in the distribution and retailing area are partially regulated by a myriad of agencies; again, however, educational efforts to establish and enforce food handling codes appear to be the most effective corrective action. At the food processing level, the use of microbial criteria appear to be an effective means of improving the microbial quality of a product and thereby decreasing the possibility of health hazard incidents. This includes the determination of the so-called sanitary indicator bacteria as an adjunct to visual inspection of facilities and sanitary practices.

At the food processing level, it is more important to analyse for the so-called sanitary indicators than for pathogenic or toxigenic bacteria. The latter are normally not present, thus a great amount of negative data could mislead the quality control supervisor. Sanitary indicators are often present and provide positive findings that change on a day to day basis. These findings also can be used to compare different processors, different geographical problems, and different levels of inspectional activity.

For most meat products, the sanitary indicator bacteria include determinations for the levels of aerobic plate count, coliform group, E. coli and S. aureus. Microbiological criteria define the levels of these organisms that are associated with a specific product or class of products produced under good manufacturing conditions. In order to establish such criteria, a great amount of laboratory work must be done on the specific commodity in question. It is impossible to use the same microbiological criteria for both dry fermented sausage and cooked bologna.

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The processes and the normal bacteria levels of these two products differ significantly. It is also impossible to apply the same microbiological criteria to freshly prepared luncheon meat and the same product held in the refrigerator for several weeks. In this case, we are measuring the growth of psychropilic bacteria during the refrigeration period rather than the sanitary conditions under which the product was prepared. For these reasons, most of our microbiological quality work has been done on meat products at the point of production. In newer terminology, this is a microbial evaluation at a very important critical control point.

Recently, we have been surveying the production of cooked meat and gravy products. The results of this study indicate how background information is obtained and the variations in bacterial levels that were found.

The products sampled included sliced or diced meat and gravy, sliced or diced poultry and gravy, and meat patties and gravy; slightly more than 50% of the samples were sliced beef and gravy. In some cases, the meat and gravy was the main course portion of frozen prepared dinners. In all cases, the meat and the gravy were cooked separately, chilled separately, and then combined along a filling-packaging line prior to freezing. This survey does not include those meat and gravy products which are cooked in combination, packaged hot, and transferred to a freezer while still hot. Thirty four high volume producers were visited. The firms were located throughout the country.

A total of 541 production line samples and 535 finished, frozen product samples were collected and analyzed. Each set of samples included samples of all ingredients used in the product, samples at each stage of processing, and units of the finished frozen product related to the production line samples. In most cases, 10 finished product units per set were collected. Each set of samples was placed promptly in a freezer or under dry ice and shipped frozen to the laboratory for microbiological analysis. Generally, the analysis was begun two to four weeks after collection.

During the visits to the firms, sanitary practices were evaluated visually.

Observations were made with respect to:

1. The personal hygiene of the food handlers.

2. The cleaning and sanitization regimen of food contact surfaces including interior areas such as gravy lines.

3. The times and temperatures to which the products had been exposed prior to freezing.

The laboratory results of the survey are shown in table 1.

TABLE 1. MEAT AND GRAVY
INDICATOR ORGANISMS, GOOD PRACTICE

	Number of samples		
	Analysed	Positive	% positive
Coliform group	375	87	23
E. coli	375	16	4
S. aureus	375	26	7
Salmonella	375	0	0

Of the 375 finished product units produced under good commercial practices, 288 (77%) were coliform negative, 359 (96%) were E. coli negative, 349 (93%) were S. aureus negative and all were negative for salmonellae. When present, these indicator organisms were at low levels. Coliforms were recovered only in 0.1 g portions from 70 of the 87 coliform positive units; E. coli only in 0.1 g portions from the 16 E. coli positive units; and S. aureus only in 0.1 g portions from 22 of the 26 S. aureus positive units. Only one unit each was positive for coliforms and S. aureus at the 0.001 g portion.

TABLE 2. MEAT AND GRAVY
INDICATOR ORGANISMS, MARGINAL PRACTICE

	Number of samples		
	Analysed	Positive	% positive
Coliform group	160	119	74
E. coli	160	67	42
S. aureus	160	21	13
Salmonella	160	0	0

Of the 160 finished product units produced under marginal commercial practices, the percent positive units increased, 74% were coliform positive, 42% were E. coli positive and 13% were S. aureus positive. These results represent the production from 9 firms as opposed to the previous figures which represented 32 firms.

All finished product units (535) were salmonellae negative in 25 g portions. Only 2 of the 541 ingredient and production line samples were salmonellae positive; one sample was cooked beef "scraps" collected from under the blade of a slicing machine, the other was a hand trimmed raw beef round which had been bagged with gelatin and spices for cooking.

TABLE 3. MEAT AND GRAVY
AEROBIC PLATE COUNTS, GOOD PRACTICE

Number of sets analysed	Number of sets with APC			
	< 1,000	1,000-10,000	10,000-50,000	50,000-100,000
33	7 (21%)	20 (61%)	5 (15%)	1 (3%)

Of the 33 sets of finished product units produced under good commercial practices, the geometric means of the aerobic plate counts of 27 sets (82%) were less than 10,000/g. Only 1 set (at 79,000/g) was over 50,000/g.

TABLE 4. MEAT AND GRAVY
AEROBIC PLATE COUNTS, MARGINAL PRACTICE

Number of sets analysed	Number of sets with APC			
	10^4-10^5	10^5-10^6	10^6-10^7	> 10^7
13	5 (38%)	4 (31%)	2 (15%)	2 (15%)

Of the 13 sets of finished product units produced under marginal commercial practices, the geometric means of the aerobic plate counts of 8 sets (62%) were in excess of 100,000.

TABLE 5. MEAT AND GRAVY

Organism	% positive samples	
	Good practice	Marginal practice
Coliforms	23	74
E. coli	4	42
S. aureus	7	13
Salmonella	0	0

This table shows the effect of manufacturing practices on the incidence of indicator organisms in frozen cooked meat and gravy products. The freshly cooked meat and gravy ingredients do not contain these organisms and their presence in the final product is a function of the degree of recontamination. It is apparent that close attention to sanitary practices limits the number of samples containing E. coli, coliforms and S. aureus in that order.

TABLE 6. MEAT AND GRAVY

Level	Number of sets with APC's in	
	Good practice	Marginal practice
$< 10^{-3}$	7	0
$10^3 - 10^4$	18	0
$10^4 - 10^5$	6	5
$10^5 - 10^6$	0	4
$10^6 - 10^7$	0	2
$> 10^7$	0	2

Table 6 shows the effect of manufacturing practices on the aerobic plate counts in frozen cooked meat and gravy products. The freshly cooked meat and gravy ingredients contain only very low bacterial counts. Here again, close attention to sanitary practices limits the contribution of bacteria from equipment or from time-temperature abuses.

This survey demonstrates that more than 70% of the sets of frozen cooked meat and gravy units (10 units/set) produced under good commercial practice had:

1. Four or fewer coliform-positive units

2. Two or fewer E. coli-positive units

3. Three or fewer S. aureus-positive units

4. APC (geometric mean of 10 units) of less than 50,000/g

Corrections have been made in those firms listed as marginal and additional plant visits are underway.

It appears that corrective compliance is not too difficult to attain. Further, the use of comparative microbiological data, such as that presented today, is an invaluable aid to Meat and Poultry Inspection Program inspectors. Bacteriological analysis of products samples objectively at plant level may detect the need for correction of plant practices that contribute bacteria to foodstuffs.

The data presented today, along with our follow up data, are being evaluated by our Statistical Staff for establishing appropriate criteria. The approach under study, as developed by the International Commission on Microbiological Specifications for Foods, has been described by R. Paul Elliott in the 1972 Proceedings of the Meat Industry Research Conference.

S. SIMON: Thank you, Ralph. We have time for questions or comments. Please give name and affiliation.

OSTOVAR, PENNSYLVANIA STATE: Since Clostridium perfringens is the number two organism causing food poisoning in the U.S., I was wondering why you didn't look at Clostridium perfringens since there has been quite a few reports lately that this organism has been isolated from gravy?

RALPH W. JOHNSTON: A very good point. One of the reasons is that the organism does not survive well either under refrigeration or under frozen conditions. If you refrigerate the product, it does not grow. Another very important aspect of Clostridium perfringens is that in cooked food products you don't get rid of the organism. The spore is heat stable and survives; therefore, it's meaning as a sanitary indicator isn't quite as clear as other organisms that are more heat sensitive.

OSTOVAR, PENN STATE: Well, here at Penn State, we've been looking at the frozen dinners for the past year and a half and we've been looking at Staphylococcus aureus growth and toxin production as well as Clostridium perfringens, and we have come across some Clostridium perfringens strains which we have isolated from gravy.

R. W. JOHNSTON: Yes, one problem here is where did they come from. Did the organisms come from the spices, improper sanitary practices, the meat, or equipment in the plant. The fact is when you have a heat resistant spore as Clostridium perfringens, unless you determine the history of these samples, you have no idea where they came from; therefore, their association as a sanitary indicator is of a lower order than non-heat resistant indicator organisms.

OSTOVAR, PENN STATE: But, still you find them in the final product?

R. W. JOHNSTON: Oh, you'll find them in many kinds of products. As a matter of fact, we have done work which I didn't present here showing that ground crops such as celery, lettuce and spices frequently contribute Clostridium perfringens. Thus, when found in a cooked item, it is difficult to determine whether or not they were incorporated by the meat, vegetables, or processing equipment.

OSTOVAR, PENN STATE: May I have one more question, Mr. Chairman? In our studies on Staphylococcus aureus from frozen food items, our counts were much higher than yours. I was wondering what method you used for isolation?

R. W. JOHNSTON: We are using basically the AOAC procedure.

OSTOVAR, PENN STATE: Which medium are you using? Baird-Parker or Vogel-Johnson?

R. W. JOHNSTON: Baird-Parker.

V. R. CAHILL, OHIO STATE: Do you have information regarding the extent of food contamination and level of the human body defense mechanism?

R. W. JOHNSTON: We have some information with regard to the extent of food contamination or recontamination. Part of that was presented today. I have no comments and don't wish to get involved with the situation regarding the immune response of the human, relative to these particular levels of bacteria. Basically, we consider those organisms that we presented today, at the levels that we presented them to be quality criteria, not health hazard criteria. Throughout the study, I might add that I did not see any single food product that I would consider an imminent food hazard.

S. SIMON: Thank you, Ralph. Before returning the podium to John Sink, I want to thank again the speakers for their efforts and the contributions they made this morning, and in addition to the committee, I want to express our appreciation to Warren Tauber for his part in coordinating the activities of the processed meats committee with the desires of the executive committee.

JOHN SINK: Thank you, very much, Sy, for a fine committee report.

JOHN SINK: This morning the Continuing Education Committee chaired by Dr. W. C. Stringer will give its report. Bill received his Ph.D. from Missouri and is currently Associate Professor of Food Science and Nutrition at that institution.

W. C. STRINGER: Thank you, John. I would like to thank the Continuing Education Committee--Dick Epley, Bob Terrell, John Miller, Dixon Hubbard and Dave Schafer for their help and suggestions in planning the program.

Our first speaker this morning is Mr. Lewis F. Norwood, Jr., of USDA. Lew has been very active in food marketing and distribution in the Extension Service and currently serves as "Leader, Food Distribution Programs." Lew will now speak on the subject, "The Challenge for Meat Scientists in Adult Education."