UPDATE: MICROBIOLOGY OF FRESH MEAT
A RETAIL PERSPECTIVE*

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I'm extremely pleased that Gary Smith invited me to speak at our conference. I must confess that this is the first such meeting that I have attended even though I have been a member of American Meat Science Association for the past several years.

The National Association of Food Chains Quality Assurance and Sanitation Committee, which I chair, came into existence about three years ago with the general assignment of communications in those areas between Food Store management and Federal, State and Regulatory Agencies, and with the technical committees of other trade associations. We were challenged to do more than talk--to be an action committee and to respond to the needs of both the industry that supports the committee, and the regulatory and legislative bodies, that at least most of the time, help that industry to satisfy our customers--yours and mine.

We are trying to do just that! We did have some success with warehouse sanitation--as most of you know this committee instituted--and with assistance and cooperation from many groups in the food industry--published a Warehouse Voluntary Sanitation Guideline that helped increase the compliance rate of FDA warehouse inspections to a percentage that pleasantly surprised us all.

Our second major task has been to examine the current status of the Microbiological Standards existant and proposed for foods. The place to start was with Microbiological Standards for Fresh and Fresh Frozen Meats--especially hamburger.

The National Association of Food Chains Committee felt that problems of fresh meat bacteriology--real, imposed, or imagined--were joint problems to be shared with the American Meat Institute and its technical committee. I'm extremely pleased that both Dr. John Birdsall, and Dr. Richard Greenberg, the chairmen of the Scientific Committee agreed that there were common problems. Our committee exchanged much conversation with the American Meat Institute Scientific Committee and we are grateful for their assistance and encouragement.

We have met with U.S.D.A. State and local officials and with the executive board of the Association of Food and Drug Officials to discuss the existing and proposed laws and regulations for fresh meat microbiology.

As a result of the efforts of many including E. M. Foster, E. M. Traisman and J. M. Goepfert, of the Food Research Institute, several states have adopted guidelines instead of proposed standards. Other states—including Oregon, have modified or are studying modifications of existing regulations. A committee formed in Oregon to study this question has its second meeting today.

I reached this meeting just yesterday afternoon. Monday I spoke to the Association of Food and Drug Officials meeting in Atlanta and distributed copies of a paper entitled "Microbiology of Fresh Meat--A Retail Perspective." I'd like to just chat for the balance of my time about that paper—and meat bacteriology, but I think you'll know more about the retail view of bacteriological standards if I review these same remarks today. I will then distribute the paper which I hope can be included as a part of this presentation in the meeting transcripts.

It seems unclear that anyone could attempt to speak for an entire industry on any subject. I can, with much confidence, though, state the opinion of National Association of Foods Chains members as we talk about Microbiological Standards. Through the Quality Assurance and Sanitation Committee, and the several other N.A.F.C. committees involved, and the N.A.F.C. board, we have formed a consensus opinion. Our committee has worked closely with Supermarket Institute and with the American Meat Institute Scientific Committee and as a result has prepared for publication a paper that takes very technical facts and attempts to communicate those facts in language that could be reasonably understood by the average person who is not a microbiologist or who does not know the microbiology of fresh meat, but who is responsible for establishing regulatory or legislative procedures; also for those consumers and consumer representatives who would seek to influence such regulatory or legislative people or industry; and prepared so that individuals who are not scientists, in the food industry, could begin to understand the discussion that has been going on about Microbiology of Fresh Meats. One of the areas that I definitely want to emphasize is that our paper addresses, and I am addressing myself, the subject of fresh or unprocessed meat products.

In the preparation of this material we have depended heavily on the advice and consultation of qualified microbiologists to help us present this kind of technical information in a way that would not be misconstrued or might not be as technically correct even though it might be more easily understood if it were to have been done by professional editors. As a result I feel that we have abstracted into one document information pertinent to fresh ground beef that will give a clear and concise understanding of its microbiology in a way that the non-microbiologist can understand--I think this makes our paper unique.

We have cautioned in our document, that when ground beef is consumed raw it must be an individual decision. This is a practice that we did not recommend, nor do we think any other responsible individual in the food industry would.
These things involve personal assumptions of unnecessary risk for which the rest of society should not be made to adjust its general standards. We must not reject our responsibility to communicate this information through on-going educational programs.

The paper discusses the advantages and disadvantages of Microbiological Standards and questions whether the microbiological testing that is currently being done on hamburger would truly give a picture of the sanitation procedures from the farm to the feed lot, through the slaughter house to the wholesaler. These results would not necessarily reflect even the sanitation level at the point of preparation--meat processing plant or retail market backroom. The low count might--as we know--be a result of the addition of chemicals or antibiotics--generally considered to be quite illegal--or repeated freezing and thawing. High counts could result from the use of trimmings from aged beef--low counts from frozen cow meat. I'll take the aged beef with its higher counts for my medium cooked hamburger.

The Animal and Plant Health Inspection Service of U.S.D.A. recognizes these variations of counts in fresh meats--and the economics and technical impact of Microbiological Standards for Fresh Meats and ground beef. As a result, APHIS has proposed an advisory committee to review this entire subject and to make recommendations for Microbiological Guidelines.

Guidelines, together with organoleptic data--plant inspections and the full knowledge of product and procedures--can give information to help both the public health official, the industry and--if costs are properly controlled so there is no unreasonable economic burden the consumer, as well. We invite all of you to join with us in encouraging the guideline approach of U.S.D.A.--APHIS.

The use of indicator bacteria and their application for use in the study of ground beef is also discussed. Unfortunately many of those who look at ground beef tend to view indicator organisms in ground beef the same way as they would view these organisms in pasteurized milk. There is no question that many of these organisms when found in milk demonstrate poor handling after pasteurization, or inadequate pasteurization. When these tests are applied to a raw agriculture product such as ground beef, however, what conclusions can be reached, since those organisms are naturally present? How can the presence of these organisms establish mishandling--or poor heat treatment.

A good portion of the White paper is devoted to the reliability of sampling methods, and to the actual microbiological testing itself. It is difficult to understand how finite numbers can be used as a standard to determine quality, when there is so much variation in sampling and so much variability in test methods. If we may assume that at 4,900,000 organisms per gram, the product is entirely satisfactory, wholesome and safe, and has a good shelf life, do we then assume it is entirely different than the same hamburger after only several hours, when the organisms that grow at low temperatures such as some of the Lactics--have increased the count to perhaps 6,000,000. Also we must
realize that the sample is affected not only by analytical and sampling variation, but also by the time lapse for lunch hour, or even coffee or smoke breaks! And certainly, what affects the sample cannot accurately reflect the actual condition of the meat product at the time of sampling.

When the health and safety of our customers and employees is not a factor, both the public and private sector have a joint obligation to reduce the cost of food to the consumer.

Now that we have begun to face the reality of the limits of both energy and food resources, industry and government are becoming more aware of the need to evaluate cost/benefit relationships.

We encourage those who are involved with public health aspects to do everything that’s practical to protect the public health of the consumer. Those of us in food distribution are well aware of the fact that consumers who have become ill from any source--and particularly those who have not survived don't eat very much! Therefore, it is to the economic advantage of the food industry to have consumers that are healthy, and happy with the product they have purchased. We need them to return to our food distribution systems to buy more food.

It is time to stress that the attitude of the Quality Assurance and Sanitation Committee and the N.A.F.C. membership is a positive one. While we believe that no scientific or public health basis exists for Microbiological Standards for Fresh Meats, we do want to endorse and promote good quality assurance and good sanitation.

In conjunction with the document I will distribute to you this afternoon¹, we have also in preparation a Voluntary Market Sanitation Guideline, that we hope will influence every meat market in the country to maintain its present levels of sanitation, where they are acceptable, or to make the improvements necessary to bring those markets needing improvement to the minimums recommended in the Voluntary Guidelines.

We hope these market sanitation guidelines are well received and will assist every market to provide products of high quality, and to continue the excellent safety record thus far enjoyed by our meat supply.

The Quality Assurance and Sanitation Committee has an additional positive goal that I want to share with you. The food chains--and the total food industry--have probably not done their full share in discussing the excellent safety record of our food supply, nor have we told about the industry and regulatory efforts to maintain that good record. That mission has been left to the public health administrator. We would like to see you get more help, at least in this area, from our industry.

We respect and do appreciate the work that has been done by public health people. With limited budgets, restricted resources, and much determination, public health agencies at every level through regulation

¹ See addendum at the end of this paper.
and education help us all. Let us not divert our limited resources or yours to programs that neither provide public health education, protect the health of the consumer, nor improve the quality of the food product, but instead add to the cost, restrict the supply, or even contribute to public health dangers by giving a false sense of security.

It is, therefore, time to take another look at our regulations, existing or proposed—particularly those referring to, or including, Microbiological Standards.

I hope that my comments this afternoon and those that I made Monday afternoon do result in that second look—not only by government and by industry—but by all of us as consumers—and that our soon to be published paper will result in a better informed look at Microbiological regulations and standards and guidelines—in the area of fresh meats—especially ground beef.

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THE MICROBIOLOGY OF FRESH MEAT: A RETAILER'S PERSPECTIVE

THE NATIONAL ASSOCIATION OF FOOD CHAINS

Introduction

To most Americans, beef is the most important single item in the diet, and certainly one of the most significant sources of protein. In 1975, as a nation we consumed over 18 billion pounds of beef (retail weight) for an average of 89 pounds per person,\(^1\) and of this total about 22\(\%\) is prepared and eaten as one of the many forms of ground beef, including hamburgers, meat loaf, and meatballs, to name just a few.

The popularity of ground beef is not only well-recognized, but is increasing. Not so well-known generally, however, is the excellent record of wholesomeness which this product has achieved. Despite this background some well-meaning persons have raised the question of whether it may be desirable to establish microbiological standards for ground beef. To help in understanding of the factors involved, this paper has been prepared to review the public health aspects and microbiology of ground beef. Our comments are limited to fresh and fresh frozen ground beef and do not include processed or prepared foods.

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\(^1\) U.S. Department of Agriculture, Livestock and Meat Situation—Dec 1975 (Carcass weight of 25.4 billion pounds converted to retail weight with factor of .74).

At the outset of such a study, the clear difference between sanitation requirements and microbiological standards should be recognized. Ground beef prepared according to sound sanitation guidelines may still contain large numbers of microorganisms. This raises the basic question of whether these organisms represent potential health hazards, or are merely harmless bacteria normally present in our environment.

How is Ground Beef Made?

"'Ground Beef' is just what the name implies. No water, extenders or binders are permitted. Seasonings, however, may be added as long as they are identified on the label."*

Through the years, to economize and to make the most of the food supply, the less tender and less popular cuts of beef have been used for ground beef, often with the addition of trimmings from higher priced cuts, such as steaks and roasts. These different cuts of beef contain varying ratios of lean meat to fat--but by federal law, ground beef may contain up to, but not more than, thirty percent fat. Ground beef with lower fat levels is often made available to meet the specific needs or taste of customers who prefer a leaner product. Sometimes this demand can be supplied by grinding portions of more expensive cuts, such as the chuck and round, which contain much less than 30% fat. Because customers buy more ground beef than any other item in the meat case, most supermarkets do not generate enough trimmings from the other cuts of beef which they sell to meet the demand. Consequently, stores may purchase trimmings or wholesale cuts specifically for grinding, and often blend trimmings of varying lean content to achieve a desirable flavor level and alleviate dryness. Fat content is the constituent that contributes significantly to the flavor and juiciness of ground beef.

In practice, ground beef is prepared from the raw materials just described in either central processing facilities, in retail stores, or in a combination of both. At the central processing plant the beef may receive a first or 'coarse' grind before shipment in bulk to the individual supermarket which then performs a second grind and packages the product for retail sale. Alternatively, it may receive this second or final grind at the central facility and be packaged and shipped to the retail store ready for sale. In many stores, all grinding is done at the supermarket from a combination of trimmings generated in the meat cutting operation and cuts purchased specifically for grinding. In either procedure, however, cutting and the grinding operations are normally performed at refrigeration temperatures in meat preparation areas. It is this adherence to temperature control during preparation which contributes to the keeping quality of the product.

What Color Should it Be?

Consumers often wonder about the significance of the color of ground beef, especially since its surface may be bright red while the inside is duller in color. The simple scientific explanation is that when the natural meat pigment is exposed to oxygen (air) a red color referred to as "bloom" appears on the outer surface. The center of the ground beef in the package often is not exposed to the same amount of air, and the "bloom" does not form. This difference in color should not cause concern, however, and the interior portion of the packaged ground beef will be equal in quality, wholesomeness and flavor to the exterior. (See reference in footnote on preceding page).

What About Microbiological Standards?

In recent years a controversy has been developing concerning the advisability of establishing microbiological standards for raw meat, including ground beef (6, 13). A few states and municipalities have already adopted standards because they believe them to be in the best interest of the consumer.

Health Considerations

An examination of food-borne illness records for the eight years 1966-1973 compiled by the United States government's Center for Disease Control (CDC) in Atlanta, Georgia, shows that a total of 2464 reports of "food poisoning" were received. In only 9 instances (0.3%) could ground beef legitimately be considered to be the food involved in the report(s), and when the reports are examined more carefully, it is noted that of the 9 instances, 8 were attributed to consumer mishandling of the product after purchase (5). Moreover, in the single instance attributable to mishandling prior to customer purchase, the presence of the illness-causing agent could not have been detected or prevented by any current or proposed microbiological standards. Considering the tremendous volume (billions of pounds) of product consumed during that 8-year period, ground beef must certainly be considered a safe food, and this same conclusion was reached by the officials at CDC who published these data in Morbidity and Mortality Weekly Report (5). On the question of microbiological standards, it is worth reviewing what the CDC data show concerning two of the major causes of food-borne illness, the bacteria Salmonella and Staphylococcus aureus. Standards are sometimes suggested for both of these organisms. There is not, however, a single published report of illness attributed to staphylococci in ground beef, and only three of the 1966-1973 CDC reports pertaining to ground beef involved salmonellae. In the three instances in which salmonellae were involved, the ground beef was consumed raw, a practice that is not recommended. Individual decisions to consume raw beef--like those to consume raw pork or raw milk, or to smoke cigarettes, involve personal assumptions of unnecessary risks for which the rest of society should not be made to adjust its general standards.
Why Has Ground Beef Been Such a Safe Food?

There are several reasons. Normally it is cooked before consumption, and normal cooking will destroy both harmless and harmful microorganisms. Even before the product is cooked, however, the fact that it has been kept under refrigeration during its distribution, and processing prevents most bacteria—and all potentially harmful bacteria—from multiplying significantly. The Food Research Institute at the University of Wisconsin recently completed a study (12) which underscores the importance of low temperature. The investigators took disease-causing bacteria which are sometimes found in food and inoculated them into samples of ground beef. The beef was then packaged and different samples were stored at various temperatures representing good and poor refrigeration. Only one of the disease-causing bacterial types was able to multiply at any of the temperature levels used—and this was only in those packages stored at 55°F. Fifty-five degrees is 10 to 20 degrees F higher than the temperatures which should be found in either retail meat cases or home refrigerators. The Food Research Institute study confirmed that disease-producing bacteria neither grow nor produce toxins (poisons) at normal refrigeration temperatures.

In summary, ground beef is not a health hazard (5, 12). The studies and data show that ground beef is a safe product and, almost without exception, the problems that have been documented occurred only when the product was mishandled after purchase. Ground beef, like other refrigerated food products, should be placed under proper refrigeration as soon as possible after purchase. It should not be exposed to contamination after the package is opened; and it should be cooked, and served reasonably promptly after cooking. Clearly, microbiological standards applied at the store level can have no effect on the most important factor—how the food is handled after purchase.

What Questions Would Microbiological Testing Answer?

It is certainly important to ask whether the quantity of harmless bacteria can be used as an indication of the presence or absence of disease-causing microorganisms. For products such as water, for example, finding large numbers of certain bacteria indicate there might be a proportional number of disease-causing forms. For ground beef, however, this is not the case. There is no question that bacteria are usually found in ground beef. They may come from a variety of sources. Some microorganisms are unavoidably transferred to the carcass from the hide of the animal during the hide removal process and this results in ground beef also containing some of those microorganisms (16). Because of the current emphasis on microbiology, both industry and the federal agencies are currently investigating several methods for reducing total bacterial content of carcasses before they are processed into smaller cuts. If we test for bacteria, we will therefore find them. Unfortunately, the routine total bacterial count does not tell us what kinds of bacteria we have found. Since most bacteria are not harmful, we would like to know what the test for total bacteria count means to us from a health
standard. We have never been able to establish scientifically, however, that there is any relationship between total numbers of all bacteria present and the numbers—or the presence or absence—of disease-producing bacteria in ground beef. Thus, "total counts"—or counts of a specific type or types of harmless bacteria—do not help us to detect or measure potential health hazards, and therefore cannot contribute to our efforts to protect public health.

If testing for total numbers of bacteria does not contribute to health protection, a second logical question is would examination of ground beef for specific disease-causing bacteria be beneficial? The only organism for which such testing might be appropriate would be Salmonella. To evaluate this approach, we have to consider several factors: Salmonella analyses are time consuming (3-7 days), and the batches of meat upon which the tests were being run would either be sold or be too old to sell before the test results were available. (See Appendix 1). Of equal importance, even if they were present, salmonella bacteria would be so unevenly distributed throughout a given batch—or even a single package—of a food such as ground beef, that whether we did or did not find organisms in one sample would not tell us whether or not they are present in other portions of the same batch or package. Moreover, in view of recent surveys (14) which have shown that salmonellae are seldom found in ground beef (0.1-2.0 percent of the samples), it would be difficult to justify such testing in terms of benefit to the consumer. This is even more the case in view of the fact that proper refrigeration and cooking the meat prior to eating it have provided the safeguard to health which history has borne out (5).

Wouldn't Microbiological Tests Reflect Sanitary Quality?

Can bacterial counts be used as an indication of sanitary quality? It is extremely important to remember the basic nature of raw meat. It is a "perishable" food, which means it does contain bacteria and that, in time, it will spoil. Even at refrigeration temperatures, many of the harmless types of bacteria often found in meat can grow, although slowly. This means it is quite likely that ground beef will contain numbers of bacteria which in some cases will appear large, when measured against arbitrary standards. It also means that it is impossible to determine whether the number of bacteria found in the ground beef resulted from insanitary conditions or from the growth of the normal meat bacteria while the product was processed and held. Thus, it is simply not possible to use a total count of bacteria as a meaningful indication of sanitation or lack of it in a food product which will allow bacterial growth (19).

What About General "Quality" and "Wholesomeness"?

Does the presence of large numbers of bacteria automatically establish that the quality of a food is poor or that the product is unwholesome? Not at all. For example, very large numbers of bacteria
are essential for the manufacture of cheese, certain sausages, sauerkraut, yogurt and various other dairy products. In these fermented foods, the acceptability of the product depends on development of populations of bacteria to a level of 100 million to 5 billion per gram. And in aging beef, it is the action of large numbers of bacteria which enhances the flavor and produces the tenderness of the finished product. These same "beneficial" bacteria make up a sizeable proportion of the total number of bacteria found naturally in raw beef.

Are Tests for "Indicator Bacteria" Applicable for Ground Beef?

For many years groups of so-called "indicator" bacteria have been useful for telling something about the history of particular substances. For example, the level of Escherichia Coli has been particularly valuable as one measure of water quality. In pasteurized milk, the presence of the coliform group of bacteria can indicate poor handling practices including recontamination after pasteurization. In each of these cases, however, the "indicators" measure the effectiveness of certain specific and controlled processes which are supposed to include a treatment designed to kill the indicator organisms. Employed appropriately and interpreted correctly, the indicator organism tool can provide substantive information.

Unfortunately, what is applicable in one set of circumstances may be completely irrelevant in another. This is precisely the case with coliforms and E. coli in raw meat. Their presence has often been emphasized because of the meaningful role they play in analyzing water or milk. The presence of either in raw meat, however, is not necessarily an indication of insanitary practice. Some confusion results because E. coli is often defined as a "fecal" bacterium, and it does live in the intestine of men and other animals. It is a hardy organism, however, and can live in many places outside of the intestinal tract. Since it can gain entry to raw meat from so many sources completely unrelated to feces, the presence of E. coli in raw meat cannot be taken to mean that there has been either direct or indirect contamination with fecal material. In the case of coliform bacteria, without further analysis to determine whether or not they are or include E. coli, there cannot even be an inference of fecal contamination. There are coliform bacteria that will increase in number in raw meat while it is held at refrigeration temperatures (18). The presence of even sizeable numbers of these organisms does not mean that insanitation or improper handling has occurred. As a further effort to determine whether these particular transplanted "indicator organisms" can indicate anything helpful to us in the case of ground beef, a search of the literature has been made. It failed to show any documented correlation between the presence of either E. coli or of coliforms generally and the presence of Salmonella in raw beef.
What About "Spoilage"?

Couldn't bacteriological testing be used to detect or prevent spoilage? To answer this question, we first tried to find out how many bacteria it takes to produce spoilage. Several research studies which approached this question indicated that these numbers are very high—several hundred million per gram in meat (1,7,17). The reports confirmed that almost without exception, no bacteriological tests are necessary to detect spoilage. In most instances they will only confirm what you and I would have detected long before the results came in, i.e., the product has an off-odor, off-flavor or is slimy.

How Quick are the Test Results?

This leads us on to one of the biggest drawbacks to any of the testing programs which have been developed to date—a very practical problem. The tests require that the organisms being tested for grow into populations large enough to be identified and take at least two to three days for completion. When the results do arrive, they do not bear any relationship to the current microbiological content of the sample product if it is still on hand, because the bacteria have been growing and creating changes for two or three days. The product could not have been held off sale for those two or three days, but would either have been destroyed or would have been sold and eaten before the test results would be available (appendix 1).

Recent Microbiological Surveys

To gain some perspective on the subject of bacteria and ground beef, several different groups have recently surveyed ground beef sold at retail (1, 11). Bacterial counts were made and were reported in relation to various count levels which have been adopted or proposed as standards.

In one of the studies (11), samples were taken from numerous retail outlets representing ten supermarket chains spread across the U.S. Nine hundred and fifty-five samples were tested, both for total bacterial count and for levels of E. coli bacteria. Fifty-nine and one-half percent of the samples had more than one million bacteria per gram of meat, thirty-four percent contained above five million bacteria per gram, and more than one-third of the samples tested had more than fifty E. coli per gram.

A similar survey conducted by the Canadian government found that more than a fourth of the samples it studied contained more than five million organisms per gram and an even higher percentage of samples contained more than fifty E. coli per gram.

A small survey of retail outlets in one midwest city found thirty-six percent of the samples to have more than five million bacteria per gram (15).
Local surveys in Alberta, Canada revealed findings similar to those contained in the other reports (1).

The data presented indicate that bacterial populations in the ranges shown apparently are normal. These bacterial levels against which comparisons were made in the studies do not have any particular scientific or even sanitation significance, but are the standards currently existing or proposed in several jurisdictions. None of the surveys described in the scientific literature reported finding any spoiled product among the samples examined. Even though the meat tested was wholesome and nutritious, it would have been branded "adulterated" and legally "unfit for human consumption" if sold in a state or country which had adopted the levels shown as standards. Based upon all of the information we have been able to assemble, we must conclude that adoption of microbiological standards for ground beef is not in the best interest of the consumer.

Reliability of Sampling and Laboratory Test Methods

Some understanding of the nature of customary laboratory methods and the affect of analytical procedures on test results is another essential element in evaluating microbiological studies of ground beef. A good example is the test for E. coli. Since the bacterium is present in only very small numbers compared to other bacteria in the meat, specialized techniques have to be employed to ensure that only E. coli are counted and other bacteria do not interfere. To do this, a technique euphemistically called the Most Probable Number (MPN) method is used. This is a method originally developed for water, a fluid medium in which the bacteria are uniformly distributed. The first problem encountered in testing non-liquid foods by the MPN technique is that any bacteria which are present in these foods are likely to be distributed helter-skelter or massed at one location. This means that any one sample is extremely unlikely to be representative of any given batch. Secondly, a form of the most probable number method known as the "three-tube MPN" is the one most commonly used. This is not intended to develop an exact count, but merely gives a very rough estimate of the bacterial population. A publication by deMan (10) points out just how imprecise the "three-tube MPN" actually is. Dr. deMan shows that when water is examined and an MPN value of 50 is obtained, this means that you can be 95% sure that the "real" number lies anywhere between 20 and 240. Since even this degree of precision can only be obtained where there is the homogeneous distribution of the bacteria found in water, it is apparent that only a dramatically lower degree of the accuracy can be obtained when the method is applied to ground beef. Experience with solid food products shows that there may be a hundredfold difference in bacterial counts between two samples from the same container. In view of this, it is bewildering to see a "3 tube MPN" of 50 or 100 used as a legal standard by which a store or individual is to be judged—but this has been done in at least one jurisdiction and has been proposed in others.
"Direct plate count" methods for counting coliform bacteria in meat are equally inadequate. Similarly, the "total plate count" approach for estimating the total number of all of the bacteria present in a gram of product represents only a very rough approximation of the actual microbial content of the food. Moreover, the results of these types of analyses are dependent on how the samples were taken, how they were held prior to analysis, how they were analyzed, temperature of incubation during analysis, and numerous other factors. The inherent error and/or lack of ability to get the same answer twice in a row on the same sample has led some investigators to suggest that unless one of two test results is at least ten times greater than the other, the differences between the two counts aren't really significant (8,9).

Each of these factors is, of course, compounded by the fact that the results are not only too little (in terms of accuracy and significance), but too late (in terms of permitting action to be taken concerning the product on hand when the test began).

Again, we have been forced to conclude that for ground beef the use of microbiological standards, especially with today's test methods, is not an effective or realistic method for protecting the health or insuring the satisfaction of the American consumer.

Microbiological Guidelines

Many companies and public health agencies, including the Animal and Plant Health Inspection Service, USDA, do use microbiological guidelines, established with an understanding of the technical and economic factors discussed in this paper.

Exceeding microbiological guidelines numbers carries no automatic economic, civil, or criminal penalties, nor is product seized or destroyed on the basis of the guidelines alone. When accompanied with specific product and processing information and history, microbiological data can provide information that can help maintain a good operation or help result in improvements as indicated.

What Factors Influence the Retailer's Desire to Supply High-Quality Meat?

An important factor at the top of the shopper's list in determining store selection is satisfaction with the quality of the fresh meat being offered (2). The retailer's economic survival depends on repeat purchases by satisfied customers who return week after week. A shopper who is dissatisfied with the ground beef he or she has purchased at a store, will complain, return the product and/or shop elsewhere. On the other hand, offering high quality products will retain and attract customers. Since ground beef is such a significant part of total fresh meat purchases, the retailer's efforts to respond to the customer's needs and desires will be more effective in ensuring the wholesomeness and acceptability of the ground beef sold at retail than any standard based upon bacteria count could ever be.
Economic Factors

If the consumer will not benefit in terms of public health improvement or prevention of spoilage, what will be the effects of microbial standards on fresh meat? First, there will be a very significant economic impact on the costs of production. To monitor a company's performance in an effort to meet standards, additional laboratory facilities and services will be required. One estimate (6) has placed the initial cost of adding laboratory facilities to a processing plant at $35,000 to $50,000 and the services of a microbiologist or technician (estimated at $15,000 annually). The cost of appropriate backup personnel must also be added.

Since it would not be feasible for each retail store to establish its own laboratory, centralized or outside testing services would be necessitated. Even if simpler and more rapid analytical procedures can be developed, the economic impact to the retailer for routine testing would still be significant. Added to this cost would be the expenditure of taxpayers' money for sampling and analysis by regulatory agencies in their efforts to enforce such standards.

The surveys referred to earlier showed that one-third or more of the ground beef samples studied exceeded one or more of the existing proposed standards. Assuming for the moment that more rapid testing methods were developed, so that the product exceeding those standards could be isolated, what is to be the fate of this ground beef? Can we justify, in today's protein hungry world, the loss of an estimated 1.3 billion pounds of wholesome nutritious food? And, if so, the severe economic effect on the price of the remaining ground beef should be apparent.

The food distribution system requires that both the retailer and the consumer share the responsibility for providing and maintaining fresh, wholesome meat (3). Mishandling after purchase, most particularly failure to refrigerate promptly and properly will cause the meat to spoil. If this occurs, all efforts on the part of the retailer and the government to provide fresh wholesome product will have been in vain.

At the same time, the retail industry has recognized that it must ensure that sanitary conditions are maintained in order to protect the quality of its products. Success as a food retailer requires constant attention to many details of sanitation. Wide use of the sanitation training materials developed by the Supermarket Institute (SMI) demonstrates the industry's determination to maintain high standards. (21) These materials had their basis in part on several university studies (22), and within the last year the SMI sanitation training materials have been updated with publication of the SMI Cleaning and Sanitizing Manual and The Monitoring Manual for the Meat Department. (23) Concurrent with the preparation of this paper, the industry is developing a document which will outline voluntary sanitation guidelines for retail markets. This document will provide the basic information and outline the procedures for all who are interested in meat market sanitation. (Copies of this document will be available upon request--see bibliography (24)).
We believe the scientific literature demonstrates that there are very substantial questions facing those who must make decisions on the issue of whether or not the industry, the consumer, and government are to live with microbiological standards for raw meat products. We are confident that these officials wish to act in the best interests of the consumer and will avail themselves of the factual materials that are available and the guidance that can be provided by knowledgeable scientists throughout this country. We will be anxious to provide any information we can to any of you who have questions concerning this paper or its references. We wish to continue to work with you to maintain the high standards that American consumers have come to expect for the foods they purchase—including ground beef. Thank you for taking the time to review our comments.

References


Cost and Returns of Improved Sanitation Management in a Retail Meat Industry, 1967, New Mexico State University, Cooperative Extension Service Circular 416.


24. Voluntary Sanitation Guideline for Meat and Deli Departments of Retail Food Store--NAFC.
APPENDIX I

COMPARATIVE TIME FRAMES OF PROCESSING, DISTRIBUTION, AND MICROBIOLOGICAL TESTING

<table>
<thead>
<tr>
<th>Samples Taken and Testing Begun</th>
<th>Test in Progress</th>
<th>Total Count Results</th>
<th>E. coli Results</th>
<th>Salmonella Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Product displayed for Purchase</td>
<td>Product Consumed</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Slaughter and Dressing</th>
<th>Chilling and Grading</th>
<th>Shipment to Retail or Central Processing</th>
<th>Retail Cutting and Grinding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>2</td>
<td>3</td>
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</tbody>
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DAYS
Gary Smith: Are there any questions for Mr. McClory?

Tony Kotula, USDA: There's one point that you made in your talk that I'd like you to clarify a little bit more. When you talked about going from questioning when your account goes from a log 5 to log 6, whether this is significant, especially with active facilities. What I'm concerned about is you realized that microbial growth is a continuum. I think what we as a Meat Science Association should be looking at is good manufacturing practices. Then an arbitrary line has to be set somewhere to identify those who are not following good manufacturing practices. But, if you give the impression that there is no importance between log 5 and log 6, then you can say the same about any arbitrary level. It is going to be an arbitrary level that is established. But, it should be based on the fact of good manufacturing practice and should be a point that you should start looking at in your sanitation program, if you reach that level.

M. J. McClory: If you take my comment, and think about the Oregon regulation and look at them in that context, you'll see why I picked the difference between 4.9 and 6. According to the Oregon regulation, anything less than 5 million, the hamburger is perfectly acceptable and fine. It's free of all dangers and everything is great and wonderful. As soon as it goes over 5 million, technically, the store manager of the market that made that sale becomes a criminal and subject to conviction of the criminal acts of that state. What you say is true. I accept that as a bacteriologist, but as a person who is functioning and trying to provide meat products economically within the reason of good common sense, I somehow take a different view when that pin point makes those kinds of differences.

Tony Kotula: If I may comment on that. If you noticed that pendulum did swing a little too much in Oregon and they are re-evaluating their situation. You are talking, I think, about not standards, but guidelines. So guidelines would not have the strictness of what we find in Oregon. It could do the industry some good to point out the areas where problems in manufacturing practices might exist. We recognize that certain micro-organisms are inherent in the product and are in fact desirable or added. But, I think that looking at each product, you can come up with levels that should alert the individual manufacturer that his product is no longer going to produce an acceptable product, if he continues to disregard certain sanitation practices that are presently available that he could implement, and is not implementing, for one reason or another.

M. J. McClory: Let me respond to that by reading from page 9 of the paper that you have in your hand, under the general title "Microbiological Guidelines." "Many companies and public health agencies, including the Animal and Plant Health Inspection Service, USDA, do use microbiological guidelines established with an understanding of the technical and economic factors discussed in this paper. Exceeding microbiological guideline numbers carried no automatic economic, civil, or criminal penalties, nor is product seized or destroyed on the basis of the guidelines alone. When accompanied with specific product and
processing information and history, microbiological data can provide information that can help maintain a good operation or help result in improvements as indicated." I think that's just what you said.

Gary Smith: Are there other questions? If you, we'll turn the program over to Stringer.

* * *

Bill Stringer: Our subject this afternoon is the reports of the Committee on Biochemistry and Biophysics. Dr. Bob Merkel has coordinated this program. Bob has had to leave, but he's left it in the good hands of Dennis Campion who will be presiding this afternoon.

Dennis Campion: The subject of this afternoon's session is the biochemistry and biophysics of connective tissue. In the first two presentations we will learn about the protein collagen, from its cellular biosynthesis to its extra-cellular assembly into a connective tissue network. This information, while significant in its own right, will also serve to aid our understanding of the role of connective tissue in muscle structure and meat tenderness and in the formation of sausage casings. These later two topics will be addressed in the last two papers.

Our first speaker this afternoon is Dr. Thayne Dutson, who will talk about the biosynthesis and structure of collagen. Dr. Dutson received his Bachelor's Degree at Utah State University and his M.S. and Ph.D. at Michigan State University. Dr. Dutson did his post-doctorate with Dr. Lawrie in Nottingham, and then went to Texas A & M where he is currently a member of the Meats and Meat Chemistry Section. Dr. Dutson.

Thayne Dutson: Thank you. My topic today is the biosynthesis and structure of collagen. As you're all aware, there has been quite a bit of information published on both of these topics. So, I've decided to give an overview of collagen structure, give some information on the different collagen types that are presently known to exist, and then give another overview of the collagen biosynthesis.