

Economic Impact of Meat Spoilage Organisms

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When I agreed to present a paper at the RMC on the economic impact due to microbiological spoilage organisms in the meat industry, I did not realize that there was very little published information on the subject. Every food company and segment of the food distribution system has losses associated with microbiological spoilage but few document those losses.

I am not a microbiologist but I have been closely associated with programs that have used many of the things that will be discussed here. I rely heavily on my microbiologist friends to provide the technical expertise whenever I feel there are things too big or complex to handle. Their advice, assistance and information has been greatly appreciated.

One of the objectives in presenting papers at the RMC is to stimulate thought and discussion on many topics. I hope that the information presented does both. There are few things in life that have a closer relationship to man than the many bacteria, yeasts and molds that we are constantly in contact with from our food sources and the environment in which we live.

One of the questions we need to ask is why there isn't more work published on economic losses of meat due to microbiological spoilage. There may be several reasons. Dr. E.M. Foster stated in a report to the Meat Industry Research Conference in 1977: "There was a time when spoilage problems were the major concern of the meat microbiologist. We were interested in the cause and prevention of discoloration, slime, mold, gas, off odors and other insults to the consumer senses. Beyond an occasional bout of staphylococcal poisoning from hams, we rarely thought about microbial health hazards. Today the situation is reversed. Spoilage problems receive little attention, either because they have been solved or because they seem insignificant in comparison with botulism, perfringens poisoning, salmonellosis, staphylococcal intoxication and all the other ills that occupy our thoughts and conversation today. My own interests and those of my colleagues have followed this course until now we are concerned almost entirely with the public health aspects of food. Thus I have elected to emphasize disease problems in our discussion today rather than spoilage."

The next two speakers are going to talk about health issues as related to microbiological situations and conditions so I will limit my comments on health-related issues. Dr.

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Foster's remarks probably explain to a great extent why there is so little recent work published on losses due to microbial spoilage. Public health issues have been and are a major concern today and undoubtedly will be for some time in the future.

Another reason for limited information on the economic losses can be attributed to the nature of the meat industry. The meat process starts on many farms and ranches, moves to numerous slaughter and processing facilities, into the market either as a fresh or processed product, to a retail or foodservice outlet and finally to the consumer. Because of the variation present in each of these steps in the production and marketing system, it is difficult to establish losses that are representative of each segment of the industry. The multitude of products produced also contributes to the complexity of the problem.

The problem of spoilage of meat by microorganisms is less today than many years ago. Cleanliness in the slaughtering and dressing of animals at slaughter plants has improved. The USDA has established control standards not only relating to the health of the animal during slaughter but to cleanliness as well. The emphasis is to keep the carcass clean as it moves through the slaughter process. We must eliminate and prevent any ingesta or intestinal material from contaminating the carcass. "Good Manufacturing Practices" and "Hazard Analysis Critical Control Points" are present in the USDA regulations and inspection procedures. These are written procedures followed in all USDA-inspected slaughter and meat processing facilities. These procedures have been developed, revised and put into practice adapting to the changes in manufacturing technology as well as changes in scientific information.

Many processing and handling procedures have been validated by microbiological research. Regulatory agencies take quick action where there are indications of a public health hazard. Food products containing unsafe levels of salmonella, staphylococcal enterotoxin or botulinum toxin result in product seizures and product recall. Generally, unsafe levels of these are an indication of a breakdown in handling procedures at the food service level, faulty distribution practices or improper handling or processing at the production facility. The prevention of these incidences is the goal of all food processors, food microbiologists and food scientists. The cost associated with a seizure or recall can be catastrophic to a small company with limited resources. Public confidence in a product and/or company can be severely damaged unless recalls and seizures are expedited rapidly and systematically. The contaminated milk incident in Chicago is an example of what can happen with microbiologically-contaminated food products.

The requirements to obtain good shelf life for meat products are stated in a simple rule: Keep it clean and keep it cold. Proper refrigeration is so important for fresh and processed meat quality that it can't be overemphasized. Processed meats must be brought down to acceptable temperature quickly soon after cooking temperature is reached. All unfrozen meat products should be maintained at temperatures in the 28° to 32°F range for good shelf life. Cleanliness is important, starting with a clean product, clean equipment and clean facilities, as well as having employees who practice a high level of cleanliness and good personal hygiene. Many of the USDA regulations for meat plants relate to controlled temperature and proper sanitation procedures.

Microbiological spoilage at a slaughter facility is not a major problem today. Carcasses are washed and trimmed of extraneous material prior to moving into the chill box. Bruises and blemishes are trimmed. Carcasses then go into the chill box which is maintained at 26° to 32°F. Internal temperature of deep muscles of beef reaches 50°F or less in about 20 hours. Some coolers are equipped with cold water sprays to reduce shrink in the cooler and bring about more rapid chilling. Pork carcasses are cut about 24 hours post mortem. Their temperature should be less than 40°F. Those cuts sold as fresh items may be packed, gas-flushed and sealed in bags, to extend shelf life. The cuts used for curing may be boned, pumped with brine and smoked in 36 to 48 hours after slaughter and packaged soon after chilling.

The USDA requires a wash up of the processing area if it is not less than 50°F after 4 hours production time. Because of the temperature of the processing area, temperature of the carcass, the short time interval from slaughter to processing and the cleanliness of the equipment and carcass, there is not much opportunity for microbial spoilage. Most beef carcasses are fabricated into boxed beef products within 36 to 96 hours of slaughter. Beef muscle temperature is usually 45°F or less at the time it is boxed. Trimmings from both beef and pork may be made into sausage items. If they are processed in the facility where they were made, processing will occur in 24 to 96 hours after the animal was slaughtered. These trimmings should be stored in coolers with temperature of 28° to 32°F. When trimmings are sold to other companies, they generally require the temperature to be less than 40°F at delivery. In warm seasons, it is a common practice to use CO₂ snow or pellets to insure that the temperature is kept at less than 40°F to delivery.

Ground beef is an important product produced in high-volume beef fabrication operations. Many of these operations are designed so that the ground beef program is continuous with the fabrication-boxing process. Trimmings moving to the grinding area are 36° to 44°F. Either some frozen meat or CO₂ snow or pellets can be used to keep the grinding temperature around 40°F or less. The packaged ground beef (generally a sealed 8 to 15-pound package in film) can be chilled within ½ to 3 hours to 30°F, depending on post-packaging chill procedures.

Warehouse temperatures are maintained at 32° to 36°F. Most companies establish procedures for storage times for products produced under the conditions described. These storage times are shorter than the time necessary for the products to develop high bacteria numbers and spoilage. The purchaser of the product has reasonable time to merchan-

dise the product. If a product is not sold within the procedural guidelines, it is commonly moved to freezer storage for later sales.

If there is microbial spoilage at the slaughter or processing facility, it can be attributed to mishandling of the product, unsanitary conditions, malfunctioning equipment, inferior packaging materials, poor refrigeration and in some cases a market calamity. Generally, in cases of extremely unfavorable market conditions, products will be discounted or moved into freezer storage long before microbiological spoilage occurs.

The retailer has a much greater potential for microbiological losses than the packer and/or processor. Most retailers want their fresh meat items to be delivered at 40°F or less. When I managed a beef facility for Land O Lakes, high temperature was the most frequent complaint by our customers. High temperature may be caused by refrigeration problems in transit and not related to plant temperatures. Some retailers specify the time interval from processing to delivery. They have learned by experience that their shelf life on fresh beef and pork items is related to the post-processing age of the boxed items they buy. The longer the post-processing time, the shorter the shelf life.

Retail meat storage chests should be kept around 30°F for best shelf life. Cutting rooms should be 45°F or less and product should be kept in the cutting room as short a time as possible. Case temperatures should be 28° to 30°F with defrost cycle controlled, so products are not in extremely variable display temperatures. Boxed beef and some of the boneless pork items require considerably less time to prepare for the case than was true many years ago. The cutting should be related to sales of an item to keep the case as fresh as possible.

Spoilage and trimming loss at the retail market could be the result of many factors. The one that was most common when I was with Stop and Shop was overproduction, because it was easy to cut large amounts of vacuum-packaged primals in short spans of time. Some retail markets are highly dependent on customer traffic into other shops in close proximity. Anticipated store traffic does not always materialize as expected. The weather may have taken a sudden unexpected change, reducing store traffic. A competitor may have advertised a more attractive special or the same items at a lower price. As mentioned earlier, the shelf life of fresh meat is related to post-processing time. Generally, the fresher the better.

Vacuum-packaged bone-in items, especially the chuck, will have some trim losses after 12 to 15 days storage. Boneless beef items with good vacuum should have little trim loss at 20 days. Pork items, even with gas-flushed packaging, may show some spoilage after 12 to 15 days. Vacuum-packaged boneless pork items handled under ideal temperature conditions will have good shelf life up to 20 days post-processing. The loss of vacuum or low vacuum in boxed beef items will result in microbial spoilage of the surface of beef primals. The inability to examine vacuum packages when they arrive at the retail store due to the cardboard shipping container is a contributor to microbiological spoilage. Spoilage losses can be reduced if the leakers are cut first, leaving the packages with good vacuum to be cut at a later time.

The losses at foodservice establishments due to micro-

biological spoilage should be minimal if good sanitation practices are adhered to, product is properly refrigerated, cooking is at correct temperatures and the food is served at proper temperatures, either hot or cold, within an acceptable time interval. The public health issue is more critical to the food service establishment than to other segments of the food distribution system. Many restaurants or other foodservice facilities serve large numbers of people similar menu items. Their exposure to serving large groups of people food that has the potential of food poisoning or food infection contaminants is greater than other food markets. The risk of costly law suits is ever present in foodservice outlets.

The Safe Food Book, Your Kitchen Guide, Home and Garden Bulletin Number 241, issued in 1984 by the USDA, FSIS provides useful information for the homemaker. This is important because most of the roughly 2 million cases of food poisoning which now occur each year in the U.S. are due to improper handling of food in the home.

By this time, you are wondering when I will discuss economic losses of meat caused by microbiological spoilage. Much of the information presented so far has emphasized prevention of spoilage. Companies which slaughter animals, process fresh and processed meats and distribute their products to either retail or foodservice companies spend huge sums of money to prevent or reduce food spoilage and provide meat products that are free from or have very low levels of food poisoning organisms and toxins. Certainly the buyer wants quality, good packaging, and controlled fat levels in the products; but the most stressed criteria in meat processing are "keep it cold and keep it clean." Combined with these two criteria, the pressure is to keep it moving, and sell it for consumption long before microbiological spoilage occurs.

Determining the costs associated with prevention of food spoilage from microorganisms is difficult. Costs will vary from plant to plant due to geographic location, age of the plant, products produced in the plant and degree of intensity of each plant's programs.

The cost range estimates presented exclude the cost of raw material. Raw material purchases make up approximately 80% to 85% of the cost associated with operating a meat packing and/or processing plant. Costs are for a full line packer-processor.

Sanitation costs may be from 2% to 4% of the operating costs, excluding raw material. Quality control programs, which are difficult in some cases to separate from sanitation programs, will add another 1.5% to 3% to the costs. The two combined equal 4% to 7% of the cost.

Refrigeration costs, including utilities, will be from 5% to 8%, excluding raw material. The amount of cooked and frozen products produced influences this cost.

Another way to state costs is in finished products sold from the company. Sanitation costs can be estimated to be 0.3 to 0.5 cent per pound of finished goods. Combining quality control and sanitation makes the cost range from 0.5 to 0.8 cent per pound. Refrigeration costs estimated are from 0.6 to 1.0 cents per pounds. Every 100 pounds of finished product has an added cost of \$1.10 to \$1.80 when sanitation, quality control and refrigeration costs are combined. Every one million pounds of finished product has from \$11,000 to \$18,000 costs associated with these factors in a prevention program.

I have no way of estimating costs of the preventive programs at retail, foodservice or in the home.

Meat Facts, 1985 edition from the American Meat Institute shows sales from the meat packing industry of almost 50 billion dollars in 1983. I estimate that about 32 billion pounds of saleable meat came from the approximately 40 billion pounds of carcasses. Assuming microbiological spoilage at packing plants to be .025%, one pound per 4,000 pounds finished product, there would be 8,000,000 pounds lost to spoilage.

If we assume further that 70% of the 32 million pounds is sold to retail companies, that means 22 billion pounds of meat and meat products ended up in retail outlets. If microbiological spoilage at retail amounts to .05%, then 11 million pounds of meat would have spoiled.

The remaining 10 billion pounds of meat is assumed to go to foodservice outlets. A microbiological spoilage of .01% would amount to 1 million pounds.

Combining the spoilage from the meat packing industry, retailers and foodservice outlets, these numbers add up to 20 million pounds of meat lost to microbiological spoilage in 1983.

How realistic are these numbers? They may not represent what is happening as far as microbiological spoilage. We do know that spoilage does occur, but the quantity is unknown.

Searching the literature for information on economic losses from microbiological sources revealed work published by Ewen C.D. Todd. This made up the majority found. One, "Economic Loss from Foodborne Disease Outbreaks Associated with Food Service Establishment," was published in February, 1985, *Journal of Food Protection*. The outbreaks reported originated in four countries. All involved mishandling in different types of foodservice establishments: restaurants (4), hotels (2), college (1), hospital (3), home for the aged (2) and catering establishments (5). The agents responsible for the illnesses were *Salmonella* (12 outbreaks), *Staphylococcus aureus* enterotoxin (2), *Clostridium perfringens* (1), *Clostridium botulinum* toxin (1), and monosodium glutamate (1).

Costs ranged from \$16,690 to over \$1 million, with the median of the average cost per case for the 17 incidences of \$788. The economic impact of foodborne illness was generally greater for restaurants, hotels and institutions than for catering establishments. Loss of business and law suits were the major factors in the cost, but loss of income for victims and infected food handlers was also considerable.

If \$788 is considered to be a typical cost for a case of foodborne illness, the estimated 5 million cases that occur in the United States would cost about \$4 billion. The author stated that the total cost for Canada would be between \$100 and \$400 million.

These cost estimates are not concerned with only those associated with meat or meat products but all foods. They serve to bring us to the realization that foodborne disease outbreaks do occur; when they do, there can be large economic losses resulting from them.

Another interesting study published in the November, 1985, *Journal of Food Protection* was "Microbial and Quality Assessment of Household Food Discards," by Shirley J. Vanderiet and Margy J. Woodburn, Oregon State. Quality aspects and microbial counts of household food discards

were determined. Samples were analyzed to total aerobic and anaerobic plate counts, total coliforms, *Staphylococcus aureus*, total anaerobes, *Clostridium perfringens* and molds. The length of household storage time, the householder's reason for discard, the householder's safety assessment of the food and laboratory panel evaluations of off-odor, off-color, and off-texture were compared to the laboratory microbial analyses. In 62% of the microbiologically-analyzed foods, the householder did not make correct safety assessments. In 9% of the microbiologically-analyzed foods, an assessment of safety was made by the householder for foods which were determined to be at risk.

This information points to the fact that few of us know when food is unsafe to eat. It also shows that most of us are going to be safe and waste food rather than risk an attack of food poisoning.

"Food Waste Behavior in an Urban Population" was published by Gail G. Harrison and others in the January-March 1985 *Journal of Nutrition Education*. They found that 9.7% of the total food by weight was wasted in the households

studied in 1973 and 8.9% in 1974. The percentage of the total waste as meat, poultry and fish was 12% in 1973 and only 3% in 1974.

These are the types of recent publications found in the literature. Not much has been published relating to economic losses caused by microbiological spoilage. You can draw your own conclusions as to whether more work needs to be done on this topic. The comments have been a combination of published information and conclusions drawn from my experiences in the meat industry.

I realize that some of the information is elementary to many of those present. However, we all need to review and understand why microbial spoilage occurs before we can institute good manufacturing and food handling procedures to constantly supply a wholesome product to our customers.

I have presented some information on the reason why food spoilage from microbes is not the concern it has been in the past, some estimates of losses and a recognition that health aspects have a higher priority in today's society, and appear to be increasing.