Status of Hot Processing of Meat in the United States

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Story in Brief

Industrial application of hot processing beef and pork are presented. Even though the research community has presented many glowing advantages for processing the meat animal immediately after dressing, the commercial processing industry has been slow in adopting this innovative system of processing. The whole concept of hot processing requires such a vast change in the present segmented operation that it will take time and innovative thinkers to make the system work. Some industrial impediments discussed are: perception, facilities, grading, fat trim, sanitation, packaging, investment cost and heat removal. New research data on cost of heat removal is given along with areas of research which will require further study before the corporate leaders will accept the hot processing concept.

Introduction

Man has cut and cooked meat soon after slaughter ever since he learned to hunt. This system of processing is still practiced in some parts of the world where refrigeration has not become readily available. Even in the United States some chicken, rabbit and game are cut and cooked soon after dressing. In countries where energy has been plentiful, refrigeration became so abundant that the meat industry adopted facilities supplied by the refrigeration industry which were not necessarily economical or best for the meat product being cooled. As a result, the meat industry now has massive, uneconomical storage rooms for carcasses rather than efficient systems for cooling edible meat. When these facilities are combined with the practice of chilling, reheating, and rechilling tons of product each day, the need for efficient processing systems becomes evident. It was this extravagant use of refrigeration and the immense "thermal backtracking" of product which led to hot processing. There must be processing efficiency along with production efficiency to provide the consumer with the best quality at the lowest price. Hot processing helps to achieve this goal.

Results and Discussion

Industry application

There appears to be very little direct industry application of hot processing of primal cuts in the United States, even though most research evidence points to many advantages for the various available processing systems. The

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success of the pork sausage industry can be attributed directly to the short processing period from slaughter to the chilled or frozen package. The system makes raw seasoned sausage available to the consumer in less than 90 minutes after slaughter. This process not only takes advantage of economics in processing and chilling, but provides the consumer with a sanitary, longer shelf-life product. The major bulk of the raw pork sausage industry now uses pre-rigor pork.

The raw pork sausage industry uses young sows with the proper ratio of fat to lean. This careful selection of the animal makes it possible to blend a product without a great amount of excess fat. Lean meat and fat are separated from the bone, chopped into uniform pieces, partially cooled, seasoned, ground, and stuffed into one and two pound grease-proof casings in a matter of minutes. The chubs are then cooled, using an ethylene glycol bath system. Pork sausage links can be extruded with or without casing directly onto a liquid nitrogen enclosed endless belt. By the time each link reaches the end of the belt it has absorbed sufficient refrigeration to be case frozen. The case hardened links are then packaged and tempered to 0°F for marketing.

Pork tissue (lean and fat) to be used for further manufacture is generally salted (2-4 percent) during the coarse chopping step and then placed in 50-60 pound boxes to be frozen. The pre-salted meat is used in sausage manufacture because of its ability to yield myosin for binding.

Even though pre-rigor pork has been shown to have numerous advantages, the industry has been reluctant to process animal cuts directly from the slaughter floor without some cooling. The prospect of cutting hog carcasses directly from the dressing line prior to chilling makes the average packing house worker shudder. The reason most often given is that one cannot trim hot cuts to presentable standards of appearance. This, of course, is invalid since most the of the primal cuts do not require a high standard appearance value. All pork cuts except the loin and spare rib are subjected to some manner of forming either by can, package, stockinette, casing or press. Therefore, the only primal cut which may require some form of smoothness is the loin. Smoothness of the loin can even be attained by leaving the back fat intact, conveyorizing the loin through a blast chill and then trimming. A few minutes in a blast chill at -50°F should provide ample firmness for the necessary trim. An alternative would be to market a completely boneless loin, since the consumer is now discriminating against fat and bone. The whole concept of hot processing not only requires converting practices of plant and market, but the thinking of personnel. Some progress has been made in this regard during the past thirty years. Perhaps the process will gain more rapid adoption during the next decade.

Even though the pork industry has been reluctant to adopt hot processing for primal cuts, it has reduced the period from kill to package. High volume (880 hogs per hour) ham production (kill to can in three days) has been practiced since 1965. Pickle solution is automatically injected into the meat and the cure is equalized in a matter of hours. A flexible vacuum wrapper makes the product ready for shipment and distribution in less than three days. Hot processing could reduce this time by an additional day.

Beef

The beef industry has been equally slow to adopt hot processing. At present the only beef plants hot-boning are those which produce meat for further manufacturing. Three plants are known to be hot-boning cow beef carcasses. On-the-rail boning of young cow carcasses appears to be the most economical system. This system can provide cow tenders, rounds, and meat pieces for fur-

ther manufacturing. All products are generally boxed (60 lbs) and palatized for air blast chilling or freezing. Air blast chilling requires 24 hours, while the freezing period takes 48 hours. When meat is placed in a 2000 pound combo, it is chilled with cryogenic compounds. It takes one pound of dry ice (carbon dioxide) to reduce five pounds of meat from 85°F to 35°F. Carbon dioxide at a cost of 12.5 cents per pound would equate to a cooling cost of 2.5 cents per pound of meat. Since many processing plants are accustomed to receiving meat for further processing by combo, it would be more economical to conveyorize meat during chilling using an air blast system. However, few of these systems are now being used.

Industry impediments

On-the-rail hot de-boning of the beef carcass has not been readily accepted, even though many potential advantages appear evident. A move toward hot processing of the beef carcass would cause great change in the slaughter and processing industries. At present, much of the livestock is slaughtered in one plant and the products processed within another plant. This industry segmentation has caused the corporate leaders to worry about systems of operation, new products, and consumer satisfaction with the new product forms.

Perception

The whole concept of hot processing requires such a vast change in the present segmented operating concept that it will take time and innovative thinkers to make the system work. Perhaps the major obstacle to hot processing is the need to change the thinking of people. Not only does the market manager think that the consumer would not accept hot processed meat, but the plant foreman visualizes operating problems. Plant workers trained to cut cold meat perceive difficulties in trimming soft warm meat. When this is coupled with the use of equipment designed specifically for cold meat, perhaps there are reasons for their concern. Quality and sanitary control personnel feel that microbial problems will prevent hot processing systems from being used. Research evidence suggests that hot processing could provide a more sanitary product. The plant manager, while ready to accept new economical, energy-saving methods of processing, immediately perceives labor relation problems. When hot processing was first conceived by our research team in 1957, attempts were made to include the labor unions as consultants. They were not at all interested in making the process work. People dealing in the futures market were also very outspoken against the hot processing concept. It was perceived by the brokers as a hindrance to the future trading of bellies and hams. While this marketing system deals in only a small part of the total carcass, it does represent a large dollar segment of the industry. These are but a few examples of how the attitudes of people make the difference. Many people still perceive hot processing as a viable system, and some of the industry innovators have risen to the challenge.

Facilities

A major impediment faced by the industry is its financial status and the money needed to construct new facilities or retrofit the old plant for handling a slaughter-processing system within the same plant. Processing would involve boneless uniform cuts, along with a range of comminuted and reformed products that may include mechanically deboned meat. A new beef plant doing

hot-boning must be capable of handling over 400 beef per hour, while a hog processing plant must consider a capacity of 1000 head per hour. This slaughter capability would challenge present material handling systems. It would not only require conveyorized cooling, but robotic handling of some products. These added new processing systems would require additional skilled labor to handle the unfrozen and frozen retail vacuum packaged products.

Grading

A third impediment relates to the industrial tie to a grading system. Since grading is based on marbling, lean area, maturity and fat cover, it is obvious that marbling level, the one factor difficult to measure in unchilled meat, is the limiting main concern. The price differential between the choice and good grade continues to influence the importance of grading. These factors, along with industry's concept of the sales value of the term "choice" and the need to reeducate the consumer, have delayed the acceptance of hot processing.

Fat trim

Fat trim on the individual meat cuts must be uniformly close in order to provide the consuming public with lean, palatable meat. The trend toward leaner meat favors hot-boning since it is easier to remove fat from the warm cut. In this attempt to meet the demand for lean meat, care must be taken to maintain palatability. It will be important to reduce fat variability rather than cause it to increase.

On-the-rail hot de-boning would provide a greater amount of fat to render and more bone to be placed through the mechanical de-boner. Both of these products will cause a need for larger facilities.

Sanitation

Warm, sticky meat, due to high surface moisture, favors microbial growth. Therefore, greater awareness of facilities and handling hygiene will be required. Not only will there be more pieces to handle, but the cut surface area will be greater. A sanitation program must be provided with slaughtering, de-boning, and processing lines. It is these material handling systems that must be clearly outlined before hot-boning can be fully implemented.

Packaging

Packaging the de-boned cuts or muscle systems to retain their shape and fiber orientation suitable for consumer acceptance has caused some concern to those considering hot-boning of the choice beef carcass. The difficulty of placing warm meat in a vacuum barrier bag has presented a challenge to the packaging industry. Vacuum packaging hot-boned beef presents numerous problems, including loss of vacuum, higher leak rate, shape distortion, and color loss. Meat to be placed in a box also provides some concern. Not only must the box have strength, but it must allow for a rapid means of cooling the product. This means that holes for air flow and a box of suitable dimension must be provided. Since the edible product from hot-boning would be several more pieces than the bone-in boxed beef, one must consider the additional handling cost.

Investment cost

A large-scale adoption of the hot processing technology will be delayed while the interest rate on money is high. There may be little justification for a company to borrow money at 14 to 16 percent interest while the margin of profit is low. The cost to retrofit an old plant may not be economical, even though one may save 50 percent in energy and reduce the in-plant storage period by one day. Even though there are other economical advantages to the system, it may cost several million dollars to fully adapt the process. Consequently, the dollar savings may not be enough to cover the short-term cost, and industry innovators are now looking at the total concept of hot processing and its advantages to their long term profit margin.

Heat removal

In view of the rapid increase in energy cost of refrigeration and freezing, improved design of the cooling system, based on the heat transfer characteristics of a food, is a very important factor in keeping the processing costs low. In addition, the efficiency of cooling can be improved by altering the geometry of the products without changing their quality characteristics. For the chilling of beef carcasses, both of these factors were duly explored in a series of studies by Ferguson and Henrickson, 1979.

The thermodynamic considerations of heat exchange systems suggest that a counter-flow design is relatively more effective than other systems. Three energy inputs are involved in this design. One energy source is used to create a temperature potential for energy transfer, the second provides a pressure difference to maintain circulation, and the third must involve the energy necessary to conveyorize the product through the chamber. A counter-flow conveyorized design was shown by Ganni, 1979, to have the highest effectiveness with regard to optimum heat transfer, energy expenditure and uniformity in the quantity and velocity of cooling air flow at minimum cost. This design is thought to be very close to the ideal system. Factors considered in this design were product geometry, energy consumption, and plant location.

Research Needs

Research evidence advanced to date provides many advantages for hot processing systems. Among them are space, energy savings, low refrigeration cost, lower transportation cost, greater product yield, one day less ownership, lower operating cost, good color meat with high functional properties, etc. However, there remain research problems to be answered. Among these are the best methods for dividing the choice beef carcasses. It may be that initially one should hot-bone only the forequarter and flank, leaving the remaining higher priced sections attached to the skeleton for cooling and cold processing. The facilities required and the economics of such a dual processing system must be determined. There needs to be more information assembled on the functional characteristics of hot beef for the manufacturing of restructured meat products and ground beef. A means of removing dense connective tissue from the low value meat will be needed; suitable particle reduction equipment for ground beef and formed meat will be important. Since ground beef and restructured meat items are destined to become one of the major products from the choice beef carcass, future studies should include product shelf life. Not only

must this research involve particle definition, texture, flavor, water binding, and appearance, but some concern must be given to evidence of rigor in the meat used for these products. Appearance and shelf life may not be a major problem with hot processed ground meat, but it would be of interest to know the advantages of using ingredients like nitrite or a starter culture for controlling microbial growth. Can warm meat be ground, flaked or chopped for immediate delivery to the pattie former? If not, what temperature will be best suited for each meat formulation?

In large volume plants, material handling and smooth flow of each meat item will be important. While it appears from the computer model that a multiple conveyorized cooling system would be useful for the different size subprimal boneless cuts, further material handling studies would be needed.

Conclusion

The advantages offered by hot processing are significant and will be given serious consideration by the meat processing industry. It will be necessary for a large major processor to adopt the concept and show by innovative example the commercial advantages. This will take place first using pork, since "thermal back-tracking" is prevalent. Chilling, reheating, and rechilling tons of product each day is expensive and wasteful. Suitable facilities, refrigeration, material handling, packaging systems, and interest rates will all be integrated in a new facility.

The meat industry has been gradually making changes over the past three decades. Hot processing will take its rightful place as a few more facts are exposed and more commercial people accept the basic concept.

Literature Cited

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