Hot Processing of Pork Whole Muscle Cuts

J. O. Reagan*

During the past decade, we have all read and heard many reports concerning the hot processing of meat. The majority of these reports have dealt with the hot processing of beef. At the University of Georgia, we have been extensively involved in evaluating systems for the hot processing of pork. We believe that pork is a "natural" for hot processing since many of the inherent problems which have been associated with the hot processing of beef are non-existent in pork carcases. The purpose of this review is to bring you up to date on the current state of hot processing whole muscle pork cuts, to give you an overview of the most recent work in this area, and perhaps to give you some insight into the future of hot processing systems for pork.

In the literature, the terms hot processing, hot boning and prerigor are often used interchangeably. The favorite term today seems to be either hot processing or accelerated processing. It is important to note that the definition for hot processing has actually changed through the years as we have advanced in our research studies in this area. In earlier work, hot processing would have been defined as the processing of meat prior to the onset of rigor mortis; however, as one views the research being conducted today, the term "hot processing" would probably be better defined as the processing of meat prior to chilling.

As with any new system, there have been many advantages associated with hot processing and several of these are presented in Table 1. These advantages include a decreased amount of cooler space needed for this type of system, and the superior binding quality of meat proteins. Some studies have indicated that there will be a reduced labor requirement with this system, while other studies have stressed the importance of reduced energy consumption using a hot processing system. It has also been suggested that in-plant holding times for meat from hot processed systems will be much less than with conventional systems. These advantages have been discussed in great detail in reviews by Kastner et al. (1977) and Reagan (1983), therefore, they will not be discussed in detail here.

In addition to those already mentioned, there are many other advantages which may be associated with hot processing systems in the future (Table 2). One proposed advantage would be the ability for meat packers to maintain the identity of their product all the way through the marketing system. When a packer's product enters the current marketing chain, it essentially goes in as a commodity item. However, if this product is deboned and packaged prior to leaving the plant, it would offer packers the opportunity to place their insignia or brand name on this product before it enters the marketing chain. Another proposed advantage is that of improved shelf life of hot processed vacuum packaged cuts. Previous studies have indicated that the rapid chilling of a product in connection with vacuum packaging would generally result in longer shelf life for this product. Along with this, it is important to mention that if industry moves toward a vacuum packaging system for hot boned pork, it would most likely reduce the amount of shrinkage normally seen for these products.

Table 2. Proposed Advantages of Hot Processing Systems for Pork.

| 1. Product identity |
| 2. Improved shelf life |
| 3. More uniform quality |
| 4. Creative marketing |
| 5. Reduced shrinkage |
| 6. Reduced levels of purge |
| 7. Increased rendering efficiency |

Whenever new systems are developed, there is a need for new marketing ideas so industry must consider the possibility of creative marketing for these new types of products.

Bowling (1981) indicated that the use of hot fat in rendering systems would greatly increase the efficiency of those systems. This would have to be considered another possible advantage for the hot processing of pork.

Most people are familiar with the major problems that have been associated with the hot processing of beef (Table 3). The majority of the research in the area of hot processed pork has indicated that many of these same problems also exist in the development of hot processing systems for pork. One of the major problems faced is the development of chilling systems which not only can handle large quantities of

*J. O. Reagan, Associate Professor, University of Georgia

The development of a system for pork may not be as difficult as most workers have found when dealing with a beef system. Marsh et al. (1972) reported that cold shortening does exist in porcine muscle; however, these workers observed that the degree of cold shortening is much less than that found in either beef or lamb muscles. Therefore, we may be able to chill hot processed pork muscle much more rapidly than hot processed beef muscle with minimal effects from cold shortening.

Cut distortion is a problem which is also found in porcine muscle. However, it may be possible to alleviate this problem by using some type of conditioning or electrical stimulation.

Another major problem associated with hot processed pork is the development of packaging systems for this type of product. Those who have conducted research in this area know how difficult it is to place a piece of hot, sticky meat into some type of vacuum packaging bag. To solve this problem, some people have tried to use larger bag sizes. However, with oversized bags increased levels of purge occur after short periods of storage. Others have felt that the answer to this problem is the use of thermo-form type packages where roll stock materials are used to form the vacuum packages. The cuts are much easier to insert into the blister part of the package. However, other problems occur: either a moisture or fat buildup is generally found along the seams of these packages. Moisture, meat juices or fat present at the seams generally leads to a high percentage of leaking packages.

One other major problem encountered by most people working in the area of hot processed pork is that a system for hot processing whole-muscle fresh cuts may not necessarily be the most desirable system for cured meats. Those researchers considering working in the area of hot processed pork must realize the importance of designing their research projects to examine both types of products obtained from pork carcasses. Experience has shown that some systems work very well for fresh meat. However, when applied to cured meat products, we find the system far from satisfactory.

Several different approaches have been taken in the development of hot processing systems for pork. One approach maintained that carcasses should be fabricated immediately after slaughter, while another conditioned carcasses at a certain temperature for a set period of time prior to fabrication. Other systems have looked at electrical stimulation of carcasses prior to fabrication. A unique approach is the system presently being examined in Denmark. This system involves chilling intact carcasses at $-24^\circ C$ for 45 min, then chilling at $4^\circ C$ for 30 min. Following these two chilling periods, carcasses are fabricated into primal cuts and vacuum packaged within 3 h postmortem. The loins in this system are chilled at $7^\circ C$ for an additional 3 h. The Danish packers have found this method necessary to alleviate some of the problems of cut distortion and packaging of the product.

The most recent research in this area in the U.S. has been in two different types of postmortem treatments: conditioning prior to fabrication and electrical stimulation prior to fabrication. Marriott et al. (1980) compared cuts from carcasses conditioned at $25^\circ C$ for 4 h prior to fabrication with those conventionally processed. These workers reported that cuts from the conventionally processed carcasses exhibited superior color and overall appearance and lower surface microbial numbers during the first 120 h postmortem. However, after 120 h postmortem these differences between the conventionally processed and conditioned cuts of meat were no longer present. These workers did note no significant differences in palatability between these two treatments.

At the University of Georgia, Wynne (1980) compared boneless loins and Boston shoulders from conventionally processed carcasses with those from carcasses that had been conditioned either 4, 6 or 8 h at $17^\circ C$ prior to fabrication. In this study, all cuts were vacuum packaged at the time of fabrication and stored in a $-1^\circ C$ cooler. This study indicated that there appeared to be no advantage to conditioning carcasses beyond 4 h at $17^\circ C$. Primal cuts from each of the conditioning periods were essentially equal in all of the parameters evaluated. Wynne (1980) also found that the hot processed loins were either equal to or superior to conventionally processed loins in microbial quality, percent purge, and palatability after 21 d of storage at $1^\circ C$. These results were used in developing another study at Georgia by Miller et al. (1983) where pork carcasses were conditioned for 1, 2, 3 and 4 h postmortem at $17^\circ C$ prior to fabrication. The purpose of this study was to determine the minimal time needed to condition pork carcasses prior to fabrication to offset any adverse effects of hot processing. In general, microbial numbers, muscle color scores and palatability traits were not significantly influenced by length of conditioning. These workers did find, however, that boneless loins and Boston shoulders obtained from carcasses conditioned for 3 h at $17^\circ C$ exhibited the lowest values for percent purge, thaw loss and cumulative weight loss.

Abu-Bakar et al. (1983) and Wiley et al. (1983) studied the effects of carcass conditioning upon yield and palatability traits of cured hams and bellies. Overall, the workers reported that hot and cold processed hams were similar in processing yields, sensory traits, cured meat color and level of residual nitrate. However, both studies found that bacon produced from conditioned carcasses exhibited lower smokehouse yields, lower slicing yields and in some cases would shatter upon cooking.

The four studies highlighted here are good examples of the point made earlier that systems which may be desirable for fresh cuts of meat may not be desirable for the production of cured meat items.

The majority of work concerned with the utilization of electrical stimulation in hot processing systems has been in the development of systems for beef. Very few studies have been done on hot processed pork where electrical stimulation has been included in the design of the study. Johnson et
al. (1982) and Swasdee (1983) conducted studies where pork carcasses were stimulated approximately 30 min postmortem. In general, these workers found that electrical stimulation had only minimal effects on carcass quality characteristics, weight loss and palatability traits. Crenwelge et al. (1980) evaluated retail cuts from pork carcasses that had been stimulated at either 10 min postmortem or 30 min postmortem. These workers found that electrically stimulated intact carcasses exhibited lower muscle firmness scores than carcasses stimulated 30 min postmortem. No significant differences in palatability traits were noted. This was one of the first studies to suggest that the time of electrical stimulation of pork carcasses may have an effect on the overall quality of meat from those carcasses. Earlier electrical stimulation studies with beef have indicated that beef carcasses must be stimulated within 45 min postmortem to see any effects from electrical stimulation. The work of Crenwelge et al. (1980) and some unpublished data from the University of Georgia suggest that pork carcasses must be stimulated within 10 min postmortem to see any effects of electrical stimulation.

Wiley et al. (1983) conducted a study to compare both fresh and cured cuts from pork carcasses which were electrically stimulated 10 min postmortem with those from conventionally processed carcasses. These workers observed that electrically stimulated carcasses exhibited quality characteristics, packaging traits, cooking losses and cured meat products that were similar to those of conventionally processed carcasses. It was noted, however, that loins from the electrically stimulated carcasses produced chops which were lower in sensory panel tenderness than those from the non-stimulated carcasses.

The use of electrical stimulation in hot processing systems for pork may prove to be very useful in solving several major problems. Since the number of studies utilizing electrical stimulation have been few in number, it appears that this area of research needs to be expanded in the future to determine if electrical stimulation should be incorporated into the development of optimal hot processing systems for industry.

Whenever the development of hot processing systems for red meat is discussed, it seems there is always a question concerning the current acceptance of these systems by industry. At this time, there are no major U.S. packers utilizing hot processing for whole muscle cuts of pork carcasses. There is a great deal of interest in the European countries and it appears that some Danish packers may possibly have an in-line system for hot boning pork within the next 6 to 12 months. Several major concerns have been voiced by U.S. packers concerning the incorporation of hot processing systems into a commercial operation, especially with synchronizing a plant's kill floor with the cutting room. Management is concerned that with labor costs for meat cutters in the boning room running at $8 to $10 per hour, these people must be kept busy at all times. There has also been concern about the identification of both PSE and DFD-type carcasses. Many packers will not consider using a hot processing system until the problem of chilling systems has been solved. One of the biggest concerns that has been expressed repeatedly by most packers is solving problems that occur with bacon production from hot-boned meat. As previously indicated, hot processing generally leads to lower smokehouse yields and may also produce lower slicing yields, due to distortion of the bellies during the cooking process.

It is difficult to predict what the future of hot processed pork may be. It appears that the future of this system may be dependent upon three factors. First, the development of technological advancements in the area of efficient chilling systems for hot processed pork; second, successful research which provides specific parameters for developing effective and efficient systems for hot processing fresh pork as well as for further processing cured meat products; and third, the development of a system which maximizes the advantages associated with hot processing while minimizing the capital expenditures necessary to implement the system.

References