Cooked Meats Packaging Technology

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The concept of cooking meat in flexible plastics followed by distribution in the same materials has been one of the most significant food packaging accomplishments of the past two decades. Processors have gained higher returns through yield improvements and labor savings while end users have grown to expect higher quality products with extended shelf lives (Terlizzi et al., 1984). Due to the success of the "cook-in" packaging approach, both suppliers and processors have continued to invest research dollars and time to expand product offerings. This paper will review some of the more significant accomplishments and will shed light on the path which the industry is taking as we head into the 90's.

A successful cook-in packaging material must be extremely versatile to function throughout the various processing procedures and environments which are encountered during the production and distribution of cooked meats. These materials are typically multilayered films which are coextruded so that the unique properties of a wide array of plastic polymers can be engineered into one structure (Harte, 1987). Let us briefly review a few of the primary attributes that these polymer building blocks provide to the total structure which enables a cook-in package to survive these various environments while maintaining the stability of the meat product itself.

Cook-in Material Attributes

A cook-in package must be scuff-, tear- and puncture-resistant to survive the abusive handling practices which are encountered during product loading and subsequent distribution. The material must be resistant to elevated temperatures while offering flexibility when exposed to the low temperatures used during chilling and, in some cases, freezing. The structure should be dimensionally stable for product size control while retaining enough elasticity to follow meat expansion during heat processing and contraction as the product cools. To maximize cooking yields and retard the accumulation of purge or refrigerated weep, processors often require a cook-in film which provides product-to-material adhesion (Rosinski et al., 1989). Oriented films which shrink upon exposure to elevated temperatures are necessary to achieve a proper product profile and shape, and to optimize final package appearance by minimizing excess material. Oxygen barrier properties are often desired to stabilize cured meat color and to minimize the development of rancid off-odors and flavors that can result from lipid oxidation (Lundquist, 1987). Some additional material characteristics which are of primary importance include printability, grease resistance, clipability, heat sealability and optical properties such as clarity and gloss (Terlizzi et al., 1984).

Packaging Applications

Meat processors who are enjoying these attributes through the implementation of cook-in technologies at their facilities have a variety of flexible packaging options to choose from. Most operations have selected thermoformed laminates and either shrink or non-shrink films as each of these packaging alternatives offers distinct advantages, depending on the end use application under consideration. Within the broad framework of ham, poultry and beef applications, we will examine some of the benefits offered by each of these packaging concepts. These broad classifications will be subdivided on the basis of whether the material which is used to cook the meat remains on the product for distribution (cook-and-ship applications) or is removed prior to additional processing (cook-and-strip applications).

The cook-and-ship process has the advantage of extending the shelf-life of the product, as the cooked meat is not re-exposed to spoilage bacteria. In addition, labor costs are dramatically reduced, because clean-up is held to a minimum and a subsequent packaging operation is not required. However, there are products which must be further processed, sliced, or portioned into retail-size units prior to distribution. These cook-and-strip items will have a lower shelf-life potential but will retain the high cooking yields and improved flavor attributes which are typical of cook-and-ship packages (Rosinski, 1988).

Deli Ham Packaging

Cook-and-ship ham packaging is used primarily for the production of boiled ham which is destined for the supermarket deli or the HRI trade. Packaging materials utilized for this end use must have barrier properties, heat shrink capabilities and should provide product-to-material adhesion (Terlizzi et al., 1984). Both shrink films and thermoformed laminates can be selected as they provide the necessary attributes and can be coupled with equipment systems which allow productivity and versatility (Muller, 1990).

Shrink films are available as clipped casings, shirred tubing or heat-sealed bags. Smaller operations using hand loading procedures and those accounts which utilize semi-automatic sizing equipment, such as the Tipper Tie Revolv-A-Clip or Poly Clip SFC, would employ clipped casings. To maximize the utilization of material, reduce labor requirements and achieve outputs as high as 10-12 ppm, shrink films are available in a shirred format and could be utilized on more automated sizing equipment, such as the Shirmatic

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Reciprocal Meat Conference Proceedings, Volume 43, 1990.

600 or the Tipper Tie RS4201.

Operations which prefer a heat-sealed package can employ new-generation shrink bags and rotary vertical chamber equipment. With this approach, taped bags are automatically positioned, filled with product and advanced to a pair of oscillating vacuum chambers. While under peak vacuum, the cook-in bag is hermetically heat-sealed, producing a product of superior quality and overall presentation.

Thermoformed laminate equipment also produces a clip-free package. In this case, a heavy-gauge bottom web is heated and vacuum formed over a die having the desired shape of the finished package. The formed pocket is loaded by hand or with an automatic filler and indexes under an evacuating and sealing head. As a second web is draped across the top of the filled pocket, the package is vacuumized and heat sealed (Siegel, 1982).

After filling, the clipped or heat-sealed packages are molded into 4x4 or 4x6 top loading, spring-tensioned molds to shape the product. Ham is typically water cooked at 165°F to 170°F, followed by chilling in circulating baths or blast freezers.

Due to a number of advantages, the vast majority of boiled ham operations have moved away from the once-popular thermoformed laminate package and are currently employing shrink barrier films. When compared to thermoformed laminates, shrink bags and casings offer more uniform oxygen barrier protection to maintain cured meat color. Forming the laminate pocket thins out the corners of the drawn film and thus the barrier layer. Upon extended exposure to retail lighting, the stability of the cured meat pigments may be compromised and a dull gray color will form on the surface of the product.

Free shrink is also an important attribute which distinguishes bags and casings from thermoformed materials. As mentioned previously, the second skin which results when an oriented film is exposed to elevated temperatures assists in optimizing product yields and improving final package appearance (Perdue et al., 1975). The forming process exhausts a healthy portion of a laminate's residual shrink, and crevices in the product, as well as cook-out, may result when excess material folds and wrinkles are not removed.

The forming process also distorts labeling information so that only basic scatter print designs are possible. With the importance of graphics and brand identification at the retail level, this is truly an important deficiency with the thermoforming approach.

The integrity of the package closure is a high priority, as a failure translates into reduced yields and increased labor due to rework. Rollstock laminate equipment typically houses a guard to cover the seal area during filling (Siegel, 1982), but the horizontal orientation of the seal area and its proximity to the product during filling represents a potential for seal area contamination. This phenomenon can be overcome by stationing additional employees on-line to wipe the seal areas clean. While significant improvements in filling procedure and the evolution of advanced forming films have reduced laminate seal failures considerably, both clipped and heat-sealed shrink films offer superior closure integrity which can be produced at reduced labor costs.

When comparing the packaging approaches for cook-and-ship ham production, the equipment systems must also be considered. The rollstock laminate machine, when optimized, can result in higher productivity than the sizing equipment used with shirred casings, but the rotary vertical chamber machine has the highest potential with a capability of 14-15 ppm. Versatility is also a key to a line's productivity. To change product size or shape with either of the shrink film systems simply requires a change in material sizing and minor adjustments to the equipment. What may take a few minutes with these systems can exhaust an hour or more with a rollstock machine as all of the tooling must be changed. In summary, for cook-and-ship ham production, shrink films have been the material of choice. Thermoformed laminates do have a number of advantages which will become more apparent in the discussion on poultry applications.

Cook-and-Strip Ham Packaging

Cook-and-strip boiled ham applications include further processed deli items and long molded products destined for slicing operations. The expense of barrier materials is not required unless extended holding periods or distribution to other facilities are encountered; therefore, non-barrier adhesion materials are in the greatest demand. The only instance where product-to-material adhesion may not be desirable is on hams which undergo a smoke treatment in an oven following cooking, chilling and stripping. To allow adherence of smoke color constituents, the meat surface must be dried (Pearson and Tauber, 1984) and this is an instance where the increased moisture retention from adhesion materials may not be of benefit. Any of the previously-mentioned systems may be combined with non-barrier adhesion materials to produce cook-and-strip deli hams or long slicing hams, provided that top loading molds are available. The industry has typically used end-loading 4×4 and 4×6 molds on the longer slicing products and this necessitates an alternate procedure.

The long slicing products are customarily produced in shrink or non-shrink bags. Production involves the use of an extended stuffing horn that has been modified with a delrin tip which matches the conformation of the end loading mold. A mold lined with a heat-sealed bag is stuffed and hand retracted off of a vacuum stuffer or the molds can be automatically retracted as the bag is filled, utilizing a dual loading system such as the type made by Mepaco. Non-shrink, nylon-based bags can be gusseted and backseamed. The controversy is that this material form plus the elongation of nylon when exposed to moisture has been reported to fill out the corners of the mold more completely, thereby optimizing slicing yields. Unfortunately, the lack of shrink properties can result in material folds and wrinkles which mar the product surface and represent areas where cook-out can collect, as the intimate contact and subsequent adhesion between the film and the meat surface is not realized. As with cook-and-ship ham applications, we are promoting shrink films for cook-and-strip end uses.

Processed Poultry Packaging

The poultry applications which will be reviewed present a different situation and will include discussion on oven-roasted and oven-prepared breasts in addition to roll items. The procedures for cook-and-ship and cook-and-strip poultry products are identical with the exception of the utilization of barrier and non-barrier films, respectively. Adhesion materials would be desirable on all items to maximize yields, with the exception of skin-on turkey breasts. Material adhesion can be strong enough to remove the skin from the remainder of the breast when the package is stripped from the product. One reason the poultry industry has made such significant inroads over the last few years is a commitment to sell products which exhibit a superior overall presentation; as a result, non-shrink films do not play an important role in poultry end-use applications.

Processors attempt to duplicate the shape of a natural turkey breast when manufacturing processed poultry breasts. Since spring-loaded molds are not customarily used to shape poultry products, only shrink bags and thermoformed laminates are applicable to breast production. For smaller operations, bags can be hand-loaded on a vacuum stuffer, and following a deareation step can be clip-closed for heat processing and distribution. The standard practice for skin-on or skinless breasts, though, employs rotary vertical chamber equipment and to a much greater extent the rollstock laminate machine, using the same procedures which were discussed for ham (Rosinski, 1988). One reason that the rollstock system commands a more favorable position is related to its earlier introduction into the marketplace in comparison to vertical chamber equipment.

The shrink bag system would offer advantages in terms of line productivity resulting from increased packaging speeds, machine versatility and labor savings, but the laminate package has two distinct advantages. The horizontal presentation of the formed pocket allows processors to hand-construct breasts which have a specific muscle orientation without the threat of any additional seal area contamination (Weiner, 1987). Products with exact muscle alignment or the so-called "sweetheart" breasts represent a relatively small portion of the total market, but premium pricing has resulted in the ongoing development of whole-muscle bag loaders by several firms so that the various advantages of the rotary vertical chamber system can be realized. The concept of a formed pocket also allows rollstock owners to produce a multitude of product sizes and shapes. While varying bag size and seal jaw configuration on rotary chamber equipment can result in final breast shapes which would satisfy a number of operations, the rollstock machine can produce additional variations. For example, a firm which desires a turkey breast having a tapered end and a sloping profile would choose the latter approach.

Whether oven-roasted or oven-prepared breasts are produced is simply a marketing decision based on perceived quality considerations. To be classified as an oven-roasted breast, USDA labeling requires that the product has the potential to lose moisture when cooked. To satisfy this requirement, shrink bags and laminates can be hand-perforated following packaging on the aforementioned equipment. Since these products must be rebagged or over-bagged in barrier materials for distribution, there may be a cost incentive or production benefit to use a third concept.

In this process, perforated bags obtained from film suppliers would be hand-loaded off a vacuum stuffer, pressed to remove entrapped air and racked for high-humidity cooking after the excess bag neck is tucked underneath each breast (Anonymous, 1985). When turkey breasts first entered the market, this alternate procedure was the norm for all breast production and polyethylene bags were the material of choice. With the dramatic yield advantages offered by adhesion materials, processors soon moved to the more advanced structures that are still in use today on oven-roasted breasts.

One practice which has not changed dramatically over the years is the procedure used for the production of poultry rolls. Like turkey breasts, a specific shape is required for roll items and clipped casings, in the form of piece stock or shirred tubing, are selected depending on the sizing equipment which is available. The other applications which were reviewed involved the use of clear plastics, but the poultry roll industry has traditionally employed white opaque materials. Both shrink films and moisture-proof fibrous casings are available in pigmented form and these two options are the most prevalent in the industry at present. Due to their exact width capabilities, fibrous casings would be selected for applications where precise diameter control is a necessity, such as a slicing operation using thermoformed retail packages. White opaque shrink casings are recommended for all but the in-house slicing operation, as these materials can be obtained at a substantial price reduction without sacrificing any of the quality parameters of the product. Another meat category that can be produced in cook-in materials to yield a high quality product is roast beef (O'Neil, 1985).

Roast Beef Packaging

Roast beef production in the U.S. can be segregated into whole-muscle and chunked-and-formed products which would differ substantially in the processing procedures and the materials which are selected. Chunked-and-formed roast beef would follow a similar production scheme to that found with ham and poultry applications. Bags, casings, shirred tubing and thermoformed laminates are all applicable. Due to the extraction of myofibrillar proteins with chunked-and-formed roast beef, product-to-material adhesion is possible and a film with an appropriate sealant layer would be selected. Cooking uncured beef results in a dull gray product surface; as a result, non-barrier cook-and-strip procedures are often instituted to allow surface coloration with caramel-based seasonings. Methods have been developed for coating the inside of a laminate package with beef rubs so that a cook-and-ship product can be produced; however, this technique can interfere with product-to-material adhesion and cook-out levels of 4% to 6% may result. The benefits which were previously presented for each of the available packaging systems would also hold true with chunked-and-formed beef.

Cooking yield losses between 15% and 25%, depending on the degree of doneness, are commonly found with whole-muscle roast beef. Unlike sectioned-and-formed products, utilizing split inside rounds or the entire cut provides very little opportunity for exposure of myofibrillar protein across a wide surface area. The outcome is a lack of product-to-material adhesion; as a result, non-adhesion packaging has a command of this market segment. Bags and casings are the primary options and while deep draw rollstock systems are feasible, there are disadvantages for this process and justifications are not possible for the large capital outlays which would be required. Casings would be hand-loaded through a stuffing horn or jet netter and vacuumized on any of a variety of nozzle systems. Bags with a second end clip-closure can be processed in a similar fashion or a total heat-sealed package with speeds as high as 20 ppm can be achieved by utilizing horizontal vacuum chamber equipment. Heat-shrinking the packages before cooking or adjusting cook-house schedules will provide a second skin which can assist in shaping the product and also in achieving higher cook yields.

Beef cuts are either rubbed with a spice/seasoning blend before packaging in cook-in films or they are stripped, rubbed and rebagged after cooking. The former produces a cook-and-ship wet pack, while rebagging offers the opportunity to market a dry product, but only at the expense of a reduced shelf-life due to a re-exposure to spoilage organisms. One benefit of the clip-closure is that an excess bag neck can be intentionally left on the package. Following cooking and chilling, the juices can be drained from the package without direct contact with the product. The excess material allows one to vacuumize and re-clip the package for distribution. Non-barrier formulations would be used in the production of dry-packed roast beef and barrier films would be used for products which are shipped with juices or which are drained and re-clipped to produce a dry pack.

New Packaging Concepts

The reader has been introduced to cook-in material attributes which are of importance to the processed meat industry. Within the broad classifications of ham, poultry and roast beef, we have examined the major cook-in applications. We have seen that shrink and non-shrink packaging, as well as thermoformed laminates, offer their own unique benefits. The remainder of this paper will focus on packaging concepts which would be advantageous for all processed meats.

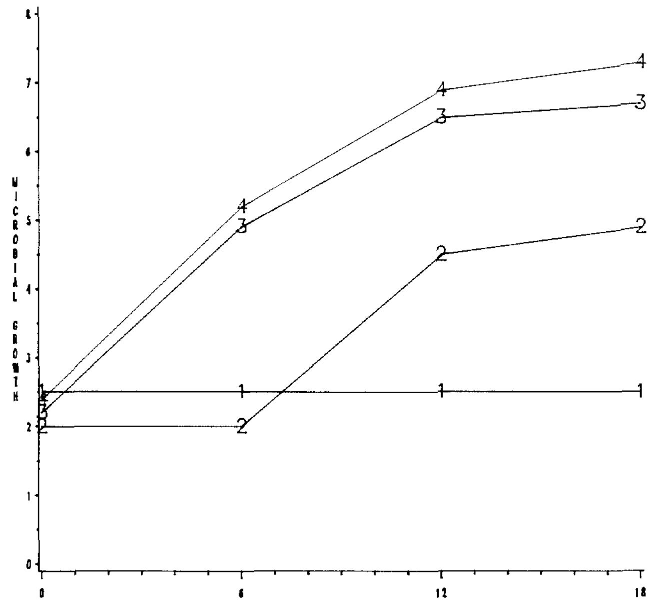
Surface Pasteurization

As we have discussed, there are a number of cook-in products which must be stripped after cooking to enable additional processing. Split insides are stripped, rubbed with seasoning, halved to display a cut face and rebagged. An oven-roasted turkey breast may be glazed with caramel or smoked hams may be stripped from fibrous casings and portioned into retail-size units. In fact, any product which is rehandled, reprocessed or repackaged, subsequent to the cooking operation, has the potential for becoming recontaminated on the product surface. Exposure to machinery, personnel and the environment may all contribute to the reintroduction of a variety of organisms. If that recontamination is with spoilage bacteria, then the shelf-life of the product may be reduced while an exposure to pathogenic organisms may compromise the safety of the packaged meat (Barwart, 1979).

Research has shown that pasteurization of the product surface at fairly high temperatures ranging from 160° to 205°F for relatively short exposure times of 30 seconds to 5 minutes may be beneficial in extending product shelf-life. Figure 1 was taken from a study which was conducted with

Figure 1

MICROBIAL GROWTH (LOG CFU/G)
OF HALF HAMS POST-PASTEURIZED
IN CN 530 AND HELD AT 40F FOR 18 WEEKS



WEEKS OF STORAGE

1 = POST-PASTEURIZED AT 205F FOR 90 SECONDS
2 = POST-PASTEURIZED AT 205F FOR 60 SECONDS
3 = POST-PASTEURIZED AT 205F FOR 30 SECONDS
4 = NO POST-PASTEURIZATION

half hams that were repackaged in heat-resistant shrink bags and surface pasteurized at 205°F for either 30, 60 or 90 seconds. A generalized title of "Organisms per Gram" has been used in this graph as the data would be indicative of the response which was reported for total aerobic counts, total anaerobic counts or lactic acid organisms. This study, and numerous others like it, have demonstrated that an extension in the lag phase of bacterial growth is possible with a pasteurization treatment. Prolonging this stage means increased product shelf-life as the onset of rapid bacterial growth and the resultant product spoilage is delayed. One point to mention is that a post-pasteurization process should not be used as a "band-aid" to clean up poor processing techniques. It should only be used as an adjunct to good manufacturing practices.

Laminate Overbagging

Another practice which may be of benefit to a number of processed meat producers is laminate overbagging. Overbagging cook-in laminates with shrink bags prior to distribution is a standard procedure used by the industry to provide a package with printed graphics and excellent eye appeal. An alternative concept is to overbag the laminate package before cooking. If conducted with printed heat-resistant shrink bags, a number of benefits may be possible. The higher shrink energy of an oriented bag can assist in the development of product profiles. In comparison to over-bagging after cooking, this procedure may better accommodate product flow through a facility. Most importantly, the outer cook-in bag offers support to the laminate seal during heat processing. This will reduce rejects and in the event that a laminate seal failure does occur, the outer bag will prevent bacterial recontamination and will supply the necessary barrier protection needed for retail distribution.

Conclusions

It would be misleading to say that the applications for cook-in packaging end here. Other commercial applications include deli-bologna, pizza toppings, pasteurized crab meat, pork and veal roasts, cooked tuna loins, corned beef, baby back ribs, cooked roasters and oven-roasted beef. One area where cook-in packaging has received a great deal of interest is in the preparation of cooked entrees. The heat resistance and moisture barrier properties of cook-in structures allows microwave preparation of a variety of consumer-ready cooked meats. This exciting and continually expanding concept for the production of cooked meats is only bound by one's imagination. The truly unique properties that have been incorporated into flexible cook-in materials are finding new uses every day.

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Discussion

N. Marriott: Are you making any progress with edible films that can be used for cook-in applications?

T. DeMasi: We have not investigated that area at all. Are you talking about collagen type materials? (Norman's response — Yes). No, we're not involved in that area.

A. Booren: I've got a question and it's relative to your thoughts on functionality and protein adhesion. Many of us in this room look at protein functionality relative to protein bind and water-holding capacity. Is there a need or are there tests established that look at protein functionality relative to adhesion of the film? Or are we talking the same thing?

DeMasi: Yes, basically you're talking about the same thing, Al. The same procedures that would be utilized to get an idea of intramuscular bind between the meat pieces will provide the adhesion to the packaging film. If you do want to specifically look at the functionality of those proteins in relationship to the packaging film, Jim Acton at Clemson University has come up with some test methods which would measure the force which is required to remove that packaging film from a product. From that you can make comparative evaluations between different packaging films and thereby measure the functionality of the protein.