Enhancement of Cooked Meat Quality & Safety via Packaging

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Introduction

Manufacturers of cooked meat products select packaging for two major reasons: preservation of product quality (appearance, flavor, odor and texture) and inhibition of microbial growth. Product quality attributes are paramount to consumer acceptance. The inhibition of microbial growth becomes more important each year with increased sales of sliced, diced, and shredded cooked products. Retail and foodservice operators are demanding products with longer shelf lives to accommodate the increasing complexity of distribution and warehousing. Customers are also demanding consumer-friendly packaging such as, easy open, recloseable, dual-ovenable and microwaveable packaging. A variety of antimicrobial agents have been incorporated into packaging films to extend shelf life or improve product quality. Except for oxygen scavenger techniques, these technologies are not commercially available to the meat industry. Post-packaging pasteurization technologies to extend shelf life and retain product quality have received copious attention. Several developments in packaging have been initiated in response to these technologies.

Cooked Meat Packaging

Vacuum Packaging

The common methods of vacuum packaging with cooked meats are the vacuum bag and rollstock form-fill-seal equipment. Historically, cook-in/ship-in vacuum packaging was very common. This process refers to cooking and shipping the product in the same vacuum bag. The disadvantage of this packaging was the unwanted cook juice and the cost of shipping it. Cook-in/ship-in technology does provide excellent shelf life (generally 90 days or more). For this reason, cook-in/ship-in recently has regained popularity with manufacturers of home meal replacement (HMR) products. These manufacturers are using starches and seasoning to produce gravy from the cook juice and sell the meal as a meat and gravy combination.

Appearance is another problem with cook-in/ship-in products. The packages are generally unsightly after cooking. Therefore, cook-in/ship-in packages are normally hidden with over-wrap packaging such as cardboard sleeves or trays with preprinted film. These over-wrap packages are printed with up-scale graphics that glorify the presentation of the food. Consumers may frown on these packaging techniques due to the inability see the food.

The appearance of vacuum packaging can be improved by stripping the product from the cook bag and re-vacuum packaging. The cook juice is, of course, removed and the product can then be sliced, diced or shredded after cooking. Further processing after cooking results in improved appearance that can be visualized by the retail consumer. The disadvantages of processing after cooking is reduced shelf life, generally 45-55 days.

Cooked products that have been sliced, diced, or shredded are excellent candidates for vacuum skin packaging (VSP). Excellent product definition can be achieved with VSP and retail presentation of foods is improved. An excellent new technology that is being investigated is combining vacuum skin packaging with cook-in/ship-in technology. Raw product is placed into microwaveable trays, the VSP film is applied to the top of the tray/product, and then the trays are cooked upside down. The cook juice and fat rise to the top (now the bottom of the tray) and solidify during chilling. When the product is turned right side up the entrée has excellent appearance for consumers. The extended shelf life of cook-in/ship-in technology is also achieved. The most intriguing part of this technology may be the ease of re-heating. Consumers simply place the VSP microwaveable tray in the microwave and cook for two to three minutes. The VSP film bubbles up, and then the pressure is released between the tray and film before the film bursts. This type of convenience meets consumers' desires.

Modified Atmosphere Packaging

Modified atmosphere packaging (MAP) is an excellent method of physically preserving a fluff-type product presentation. Cooked products are normally MAP packed using a

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combination of 70-80% nitrogen and 20-30% carbon dioxide. Cook-in/ship-in is not utilized with MAP, due to expanding gases in the package during cooking. The shelf life of MAP is similar to vacuum packaging when both techniques are performed correctly. MAP packaging is very economical when utilized with a form-fill-seal machine. MAP is also commonly used with plastic or foam trays that are over-wrapped with film or lid sealed. A disadvantage of MAP packaging cooked meats is keeping the product stationary within the package. The meat product often touches the package top and leaves isolated meat juice. This juice is unsightly and warms faster when separated from the cold meat mass, therefore providing a hospitable environment for microbial growth. This is the reason products are often double packaged, first in a vacuum pack, which is then placed in a sealed tray with no gas mixture. The result is excess packaging costs for consumers.

Easy Open and Resealable Packages

Recently, the importance of package opening and closure has escalated. Consumers are demanding packages that open easily and they prefer resealable packaging features. Initially, when zipper packaging of meat products gained prominence in the marketplace, it was used on packages with considerable weight. Many companies rationalized that consumers would not pay for zipper on packages of eight ounces or less, since they might be opened only once or twice. Today, consumers are demanding zipper closures on lightweight products because they perceive added freshness and food safety.

New Packaging Technologies

Oxygen Scavengers

Polymer additives with oxygen scavenging abilities are the most promising antimicrobial packaging systems (Han, 2000). The reduction of oxygen inhibits aerobic organisms, especially mold, and prevents oxidative rancidity (Smith, 1990). Oxygen scavengers systems are commonly used with MAP packaged cook meats. Foam tray overwrap packaging necessitates the use of oxygen scavengers to combat the oxygen trapped in the foam tray. Tray lid sealing MAP technology often does not require oxygen scavengers since the packages can be manufactured with less than 0.2% residual oxygen. Oxygen scavengers are required when the product placed into the tray creates areas where oxygen is hard to remove. Oxygen scavengers are also used in cooked products susceptible to mold, such as jerky, dried beef and dry sausages. Research on films with oxygen scavenging abilities has been promising. (Rooney, 1981) Oxygen scavenging film can improve the appearance of the food package and eliminate the risk of the scavenger packet becoming mixed with the food. Oxygen scavenging packets currently are more cost effective than scavenging film.

Antimicrobial Packaging Films

Packaging materials can possess antimicrobial activity when subjected to radiation methods. Radiation methods may include use of radioactive material, UV light or laser-excited materials. However, the FDA has not yet approved these technologies.

Antimicrobial agents that have been incorporated into packaging materials include: propionic acid, peroxide, ozone, chlorine oxide, eugenol, cinnamaldehyde, allyl isothiocyanate, lysozyme, nisin and EDTA (Han, 2000). Sorbic acid and potassium sorbate have been incorporated into a variety of food packaging materials to improve product shelf life. Han (1996) reported on the controlled release of potassium sorbate from low-density polyethylene film into cheese. Fungicides and antibiotics have been added to food packaging films to delay mold growth. Weng and Hotchkiss (1992) reported control of fungus on cheese with shrink-wrapping of polyethylene containing imazalil.

Post-Packaging Pasteurization Technologies

Post Pasteurization

Today, numerous manufacturers carry post-pasteurization equipment, but five years ago, only two companies provided heat pasteurization equipment (Howard, 2001). The process involves re-heating the surface of cooked and chilled meat products in their shipping package for 60-90 seconds at a temperature of 195-205°F. This heat can be provided by water or steam. The goal is to heat the exterior 2-3 mm of the product to 160°F for a period of 15-30 seconds. After pasteurization, the product is immediately chilled to remove heat. Inoculation studies of post-pasteurized cooked turkey roasts have reported a 3-4 log reduction of *Listeria monocytogenes* (Muriana, 1999). Emmpak Foods started post-pasteurizing whole muscle roasts in the spring of 2000. Shelf life of post pasteurized products has increased 25-33%. Post pasteurization requires special ship bags that can resist 190-205°F for 60-90 seconds. These bags shrink less than normal ship bags.

Table 1. Effect of ultra-high pressure (UHP, 87,000 psi for 3 min) on *Salmonella* inoculated sliced turkey breast & roast beef.

	Sliced Turkey Breast (CFU/g)		Sliced Roast Beef (CFU/g)	
Day	No UHP	UHP	No UHP	UHP
1	3.8×10^6	<100	4.9×10^6	<100
11	TNTC	<100	TNTC	<100
19	TNTC	<100	TNTC	<100
27	5.8×10^8	<100	6.9×10^8	<100

Salmonella inoculation: 4.7×10^6 CFU/g

Table 2. Effect of ultra-high pressure (UHP, 87,000 psi for 3 min) on *Listeria monocytogenes* inoculated sliced turkey breast & roast beef.

	Sliced Turkey Breast (CFU/g)		Sliced Roast Beef (CFU/g)	
Day	**No UHP**	**UHP**	**No UHP**	**UHP**
1	5.5 x 10^6	<100	4.9 x 10^6	<100
11	TNTC	500	TNTC	<100
19	TNTC	600	TNTC	<100
27	5.7 x 10^8	800	1.3 x 10^8	<100

Listeria monocytogenes inoculation: 1.5 x 10^6 CFU/g

In addition, some melted fat may accumulate on the surface of the cooked roasts reducing product appearance.

Irradiation

Emmpak research with irradiated deli meats has been very successful when products were irradiated to 1.2-1.6 kGy. Comparison of products irradiated with gamma, e-beam and x-ray resulted in no differences between irradiation technologies when absorbed dose and min/max ratios were similar. Cured cooked products are extremely compatible to irradiation technology. Even products with low levels of cure such as smoked turkey breast benefit from its presence when subjected to irradiation. Emmpak organoleptic testing of cured deli meats irradiated to 1.2-1.6 kGy have resulted in acceptable color, flavor and texture after six months of refrigerated storage. Uncured irradiated roast beef and turkey are less desirable in flavor than non-irradiated controls. The magnitude of off-flavor development in these uncured irradiated products varies with consumers, but almost all can taste a difference.

Ultra-High Pressure

Ultra-high pressure is an extremely interesting technology for microbial reduction in pre-packaged cooked meat products. The process involves placing pre-packaged product into a cylinder filled with water. The cylinder is sealed, and then 15% more water is added via a high pressure pump creating a pressure of 87,000 psi. The product is subjected to this pressure for three minutes, and then the pressure is rapidly released. The anti-microbial mode of action is thought to be similar to the bends (the condition deep-sea divers encounter when they surface too quickly).

Ultra-high pressure processing doubles product shelf life (Raghhubeer, 2001). Inoculation trials of Emmpak product with *Salmonella* and *Listeria monocytogenes* revealed a five to seven log reduction during 27 days of refrigerated storage for both organisms on sliced roast beef and turkey (Table 1 and 2). In another Emmpak study, sliced roast beef and turkey were inoculated with *Salmonella* and *Listeria* at intermediate levels (2,400 and 1,100 CFU/g, respectively). Over 27 days of storage at 2°C, the products were tested for presence of these pathogens. Ultra-high pressure treated products did not reveal a positive for *Salmonella* or *Listeria* during the 27 day storage period. (Table 3).

Summary

Consumers are demanding more sophisticated meat products and packaging from processors. Convenience and food safety are the paramount issues of the current and future marketplace. A variety of new packaging technologies are being developed to meet or exceed consumer desires. In addition, post packaging pasteurization technologies are being refined to improve the quality and safety of cooked meat products.

Table 3. Effect of ultra-high pressure on intermediate inoculation levels of *Salmonella* and *Listeria* on sliced turkey breast & roast beef.

	Salmonella (CFU/g)				*Listeria* (CFU/g)			
	Turkey Breast		Roast Beef		Turkey Breast		Roast Beef	
Day	**No UHP**	**UHP**	**No UHP**	**UHP**	**No UHP**	**UHP**	**No UHP**	**UHP**
1	2,900	Neg	2,700	Neg	3,500	Neg	2,000	Neg
11	54,000	Neg	61,000	Neg	96,000	Neg	89,000	Neg
19	—	Neg	—	Neg	—	Neg	—	Neg
27	—	Neg	—	Neg	—	Neg	—	Neg

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