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January 2003

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Baczwaski, Mike and Mandigo, Roger W., "Case Ready and Enhanced Pork - How Do Ingredients Make Them Work?" (2003).
Nebraska Swine Reports. 51.

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that is focused on their individual unit's needs. To do so they would need to work together to spread the cost over sufficient production. In doing so, they would not have to become expert at extracting value from intangible assets, nor would they be required to acquire all the data to make decisions. Together they could gain many of the competitive advantages now being enjoyed by a limited number of producers.

Producers do need to be able to trust and rely on the advisor. The focus needs to be on their unit and the best solutions for their operation. One method to accomplish that would be to create a business entity that hired the specialist needed. This would tend to minimize conflict of interest, avoid time spent on marketing the consulting business and allow the specialist to concentrate on providing high quality service.

Producers identify the highest priority needs and acquire persons with expertise to provide them with service. Items such as customer relations, price risk management, environmental regulatory compliance, zoning regulations and comprehensive nutrient management planning are issues of such complexity and such magnitudes of change that producers would benefit from advice specific to their operation.

Conclusion

Reducing the diversity of type and size of producer threatens the flexibility of the pork production industry. When challenged by new or unusual circumstances to meet societal goals production systems must meet objectives in environment and animal husbandry practices. Pork production must also provide the producers and employees with a livelihood that is satisfactory and that encourages future participation. Increasing the competitive advantage of a larger number of individual producers is important to the future of the industry.

¹Allen Prosch is the Pork Central Coordinator at the University of Nebraska Lincoln. References are available by request from the author.

Case Ready and Enhanced Pork — How Do Ingredients Make Them Work?

Mike Baczwaski
Roger Mandigo¹

Summary and Implications

Case ready pork products have grown at a tremendous rate since the early, large scale introductions of the mid 1990s. Estimates exceed 9 billion pieces in the near future, up from 500 million in 1997 and 1.2 billion in 2000. Estimates are that between 70-80% of the fresh pork at the supermarkets is now utilizing two technologies in the case-ready status. These two technologies include enhancement and marination. Enhancement is the application of a solution of water, salt and sodium phosphates, usually approximately a 12% solution. Marination expands the solution with flavor and texture profiles involving additional ingredients. The major value-added meat processors of case ready pork products are fresh-meat processors and retailer co-packers and the list continues to grow rapidly. Justification for pork producers, meat processors and consumers are many. These advantages include: better distribution of products or in-stock at retail and less out-of-stock on a 24 hour basis, labor availability at the retail level, less shrink, greater cost savings, and most importantly increased food safety, consumer satisfaction, consistency, tenderness and juiciness.

Introduction

There are several technologies that producers of case ready meats can utilize to improve product consistency and extend shelf life. Consistency is a

goal that all producers strive for regardless of the industry segment. Case-ready pork allows consumers to experience more consistent fresh pork in regards to color, texture, and eating quality. Case-ready meat allows a shelf life of two to five weeks following addition of an enhancement solution and fabrication to retail cuts. This is compared to a five to 12 day shelf life seen with traditional pork cuts fabricated at the retail store and packaged with the conventional shrink wrapped fresh meat packaging. Extending case-ready meats shelf-life allows for improved processing at large, efficient, central fabrication plants close to the source of the pork. With case-ready concepts, only consumer products are shipped through distribution centers for filling of the needs of the local stores. Fat and bone removed have utilization and value maximized at a central location. Extended shelf life may be accomplished with modified atmospheres containing gases such as carbon dioxide, nitrogen and oxygen in different combinations. Marinated or enhanced products can be vacuum packaged to extend refrigerated product sales life. Cases-ready pork also reduces in-store meat cutting, preparation, and packaging which also has a beneficial effect on food safety due to reduced handling and improved temperature control.

Case-Ready Benefits

Case-ready pork will reduce the amount of out-of-stock merchandise in the retail case and increase availability of complete lines of products. Product management and inventory control is

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much more efficient without in-store meat cutting and packaging. There are new thrusts for case-ready pork that include enhanced or marinated products.

Enhancements and Marinades

Enhancement can be defined as fresh pork that is injected with a solution of water, salt, sodium phosphates and a potentially large range of natural flavors such as rosemary extract and lemon juice. The pork is usually pumped to 8-12% of original weight. A marinade typically contains the same ingredients as the enhancement solution plus flavor components such as caramel colorings and top dressings with whole and/or cracked spices and other flavors. Thus, there are a number of non-meat ingredients that have increased the opportunity for fresh and processed pork in the retail marketplace.

Functionality of Ingredients

The functionality of the non-meat ingredient varies. Non-meat ingredients contribute to product flavor and appearance. Ingredient functionality includes the role in water holding capacity, binding through salt bridges, swelling by phosphates, and impact on overall juiciness and texture properties on the finished product. While increasing yields with the use of non-meat ingredients is economically important to the processor, optimizing their functional impact on tenderness, juiciness, texture and flavor is the most important factor.

Water

The biggest non-meat ingredient used in case-ready pork is water. Water quality, with respect to hardness and possible contaminants, influences potential benefits of the ingredient. Hard water reduces the ability of certain non-meat ingredients to dissolve and reduces the solubility of phosphates, salt and other large molecular weight ingredients. Without properly dissolving in water, phosphates and other

ingredients will precipitate and not go into solution. If these ingredients precipitate out, poor binding in meat proteins will occur, resulting in poor water retention. Contaminates in water, such as iron and copper, increase oxidation. Oxidation of color by lipid and protein oxidation causes a negative effect on flavor and appearance. High chlorine levels in water have an oxidative effect on finished product by increasing lipid rancidity and loss of color stability. Water retention can be effectively controlled through adjusting pH. The isoelectric point (pI) of meat is the point at which the net ionic charge is equal to zero. The pI for fresh post-mortem pork generally occurs at pH 5.3. At the pI, there are no free charges and the fibers are attracted to one another, resulting in minimal space between the fibers. Altering pH with the use of an enhancement solution or a marinade allows charges to cause repulsion of the fibers and attract free water. To accomplish this alteration of pH, alkaline phosphates are generally used. The use of phosphates increases water retention in pork during processing, distribution and final cooking or reheating.

Salt

Salt is a major non-meat component of any marinade or enhancement solution. Salt is needed for the solubilization of pork myofibrillar proteins. Through this process it binds small pieces to one another while allowing for subtle solubilization of proteins within the muscle. Salt can also create a negative effect by causing a rubber-like texture when excessive protein solubilization has taken place. In addition, subjecting pork to too much mechanical action in the presence of high salt and phosphate levels can be detrimental to desired texture. Typically, sodium chloride is the processor's salt of choice but in the cases where excess sodium content may cause problems, alternatives can be used. Potassium salts can be used but they tend to produce bitter or metallic aftertastes. In the case where there is a masking

flavor such as with marination, these potassium salts work well.

Bulking and Water Binding Ingredients

Other non-meat ingredients that are common in case-ready meats include the broad category of hydrocolloid gums. These gums include carageenan, konjac flour, xanthan, and gellan gums. Their function is to increase water holding capacity and aid in retaining water throughout the cooking process. Gums are primarily used in pork products that are low-fat or fat-free.

Lactates and acetates are antimicrobial agents that extend shelf life. Lactates, usually sodium or potassium, are ingredients that are derived from corn or beet sugar. Lactates act as a bacteriostat by interfering with bacterial metabolism and increasing the lag phase of growth. Specifically, lactates inhibit growth of *Listeria monocytogenes*, *Staphylococcus*, *Salmonella* and *Clostridium botulinum*. By doing this, lactates decrease microbial growth therefore increasing shelf life. Research has shown that with the addition of lactate, fresh sausage shelf life can be increased from 30 to 70% and roast pork shelf life can be increased 50 to 100%. The addition of lactate in pork products acts to protect against refrigeration challenges of transportation and retail storage and handling. In case ready pork products, temperature abuse comes in the form of retail refrigeration inconsistencies, consumer abuse after the product is purchased prior to home refrigeration and increased temperatures of home refrigeration units.

Sodium diacetate, a salt of acetic acid, is a biocide that reduces the initial microbial load, but has the potential for unwanted flavors and odors. Commonly a combination of lactate and diacetate allows for lower levels in the product while obtaining a combination of both bactericidal and bacteriostatic actions.



Reducing Agents

Reducing agents play a key role in case-ready meats. Such ingredients are sodium erythorbate and sodium ascorbate. While these ingredients are important in flavor, improving shelf life and keeping quality, the most important role of reducing agents is to reduce the tendency of fresh meat color to darken and turn more brown.

Traditionally, food processors have used synthetic antioxidants developed

from fats and oils such as BHA and BHT. Since it is required to declare these ingredients on the product label, they are not often used in enhanced pork products. Instead, the use of natural antioxidants in the form of herbs, spice extracts and fruit pastes have become widely adapted. Lemon juice is also being used to offset flavors of the antioxidant due to its ability to mask off flavors as well as its potential antioxidant characteristics.

The popularity of case-ready pork

products is increasing and utilizes the technologies of enhancement solutions and the more involved marinades. Benefits include product availability, convenience, consistency, improved retail meat management and the ever present need for increased food safety.

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Fresh vs. Frozen Bellies for Bacon

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Summary and Implications

The use of frozen pork bellies is a common practice in the bacon manufacturing industry. Frozen bellies permit the leveling of supply with sliced bacon needs, seasonal variations and the increasing value recovery from the belly. Freezing provides an excellent means of storing bellies for more efficient use at later times. Concerns that quality does not improve with freezing and storage and a greater understanding of the impact of freezing bellies on bacon quality are very important. Bellies in this study were frozen for at least 15 days prior to defrosting and the start of processing. Results suggest that the use of fresh or frozen bellies in the manufacture of bacon would lead to similar yields. Processing yields including percent pump, smokehouse yield, slicing and total bacon yield were very similar. Genetic line and sex of the pig impacted quantity measures including the processing yields of bacon. Longer storage times could have added to quality differences and concerns. Short-term frozen storage of bellies has minimal impact on sliced bacon quality and performance attributes.

Introduction

Curing meat has been an effective process for centuries and was used long before refrigeration provided for more than a seasonal means of preservation. The Greek and Roman civilizations were advanced in methods of meat preservation such as salting and pickling. In addition to preservation, curing and smoking adds unique flavors, textures, variety and convenience with new products. This study is a part of the National Pork Producers Council research effort on Lean Growth Modeling to improve the quantity and quality of pork. Through the years the emphasis of increased lean, reduced fat and leaner consumer products has been the impetus for more research of bacon. Freezing of raw bellies, a long practiced process, leads to potential concerns about loss of quality and quantity of sliced bacon. Freezing provides an excellent means of storing meat for long periods of time, but, the quality of meat could decrease. Ice crystals are formed within the food products during freezing. Damage could occur to the tissue, including changes in the water holding capacity, texture, and surface color.

During thawing, undesirable phenomena such as exudate loss, evaporation loss and deterioration of fat and protein occur. The effect of freezing

and thawing on bellies on subsequent processing of the bacon has not been reported extensively in the literature. Besides industry processing practices there are other production factors that influence bacon characteristics. Today pigs are bred and fed to be leaner. Consumers prefer leaner pork today than ever before, and thus the industry is turning to raising leaner, heavier muscled pigs to meet these demands. Lean-to-fat ratio is a major decision factor in a shopper's selection of bacon. However, with these leaner pigs, bacon processing characteristics such as smokehouse yield and total bacon yield are often inversely related to carcass characteristics desired by others including producers, packers and consumers. The goal of this work is to understand the quality and quantity of sliced bacon as impacted by certain live hog factors and processing fresh and frozen bellies.

Procedures

A total of 578 bellies were randomly assigned to two treatments; fresh or frozen. The project included pigs from six genetic lines: Chester White, Berkshire, Duroc, Landrace, Poland China and Yorkshire (Table 1). Gilts and barrows were included in the study. After slaughter, the belly was removed

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