MEAT PRODUCTS: FRESH AND RESTRUCTURED

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In 1986, USA per capita consumption on an edible weight basis of beef, pork, veal and lamb amounted to 54 kilograms. Poultry and fish consumption amounted to 30 kilograms. In total, these items accounted for 27% of the food and beverage dollar expenditures in grocery stores. However, these facts do not explain total impact of consumption patterns since 40% of the food dollar in the USA is spent at non-retail outlets such as restaurants, hotels and institutions (Powers et al. 1984; Molpus 1987). The general trend over the past years has been for beef consumption to decline slightly; pork, veal and lamb consumption to remain relatively constant; and for poultry and fish consumption to increase. Part of the reason for the changing pattern of consumption of animal food products is that consumers are concerned about themselves and the food they eat. Modern consumers are seeking foods that they perceive to be nutritious, healthful, tasty and convenient. Consumers are concerned about reducing their intake of salt, sugar and fat, and thus total dietary caloric intake in order to increase their physical fitness and health.

Part of the reason for this concern is that more than half the population of the United States is over 35 years of age.

Concern about self is coupled with a changing household. More than 50% of adult women in the U.S. work away from home; more than 50% of the households have microwave ovens; 17% of the households are single person households and 50% of the households have two or fewer people. In addition, 20-30% of the grocery shoppers in the supermarkets are men.

The changing consumer demands that the animal industry develop products to meet their perceived needs. Consumers will not accept products that do not meet their needs and expectations at a reasonable price. From an industry viewpoint, these foods need to be produced with automated systems, be uniform in portion size and composition, provide a product that has an appropriate perceived value to permit profitable manufacture and sale and be readily marketable through present or future marketing channels.

Product form and availability will play an important role in determining the markets into which new products can make a successful entry. The food service industry will continue to demand frozen products for convenience and shelf-life. On the other hand, retail consumers have demonstrated a preference for fresh refrigerated products as indicated by the large proportion of meat sold in this form. The fastest growing area for marketing food products in the USA is the take-away or carry-out market where food items are purchased at supermarket delicatessens, convenience stores or fast food outlets. Many of these operations have limited cooking facilities and therefore are looking for products that are fully or partially precooked. However, some supermarkets are installing complete restaurants on the premises and sell take-away foods for consumption at homes. This trend to purchase fully prepared food and consume it at home is referred to as "cocooning".

Restructured Meats

Restructured meat products have been studied for a number of years and are currently reviewed in the publication by Pearson and Dutson (1987); Advances in Meat Research, Volume 3: Restructured Meat and Poultry Products. Chapters in this volume contain many valuable references about the economics and technology of producing restructured meats.

Raw Material

The ideal material for manufacture of restructured meat products is uniformly colored muscle tissue that is high in water binding capacity and low in connective tissue and fat. At present this material must be separated manually from other carcass parts and is relatively costly. Major factors in determining the availability of muscle for restructuring will be cost of production of lean tissue and competitive demand for quality muscle tissue for roasts, steaks, stews and sausage. Sausage processors are sometimes able to pay a premium for skeletal muscle to be diluted by lower cost fat, connective tissue and non-meat extenders. However, as consumers demand leaner and lower salt products, there may be reduced markets for fatty sausages and ground beef and increased markets for lean restructured meat products.

Restructuring Processes

Most of the restructured meat manufactured today is produced by sausage technology which uses salt, phosphates and mechanical action to extract the salt soluble proteins (Schmidt and Trout 1982). This material is then formed and frozen. The formed product is cooked from the frozen state and the extracted salt soluble proteins form a heat set gel matrix that binds the product. The major markets for these types of products are roasts and steaks utilized by the food service industry for sandwiches. The product may be precooked at a central location and sold frozen or refrigerated, or may be distributed raw frozen and cooked at the site of consumer purchase. This technology does not permit restructured meat products to be presented to the consumer in the raw refrigerated state as are intact muscle cuts.

A number of innovative methods for restructuring meat without the use of salt and phosphate have been developed in the past five years. One of the methods utilizes the separation of muscle tissue into fine strips so that the material can be mixed and formed by aligning the strips for cooking from the frozen state. Another method developed in The Netherlands utilizes concentrated blood plasma and fibrinogen to bind pieces of meat together in the raw state (Paardekooper 1987). Both of these systems are undergoing further development.

Our research in the Department of Animal Sciences at Colorado State University has concentrated on developing a system for binding restructured meat which utilizes sodium alginate. These efforts have resulted in the development of the algin/calcium gelation mechanism for binding meat. Numerous experiments and trials have been conducted to develop, test and

improve the mechanism for binding meat (Means and Schmidt 1986; Means et al. 1987). Non-meat ingredients utilized in these tests include sodium alginate (0.2 to 1%; Manugel DMB, Kelco division of Merck and Co. Inc.); calcium carbonate (0.02 to 0.25%; Gamma Sperse 80, Georgia Marble); and an encapsulated calcium lactate/lactic acid or another acidifier such as glucono-delta-lactone. During the development of this system, which is referred to as SMR, various proteins, gums and hydrocolloids were tested. Other variables tested have included levels of non-meat ingredients and combinations; meat source and particle size; pH; sequence and time of mixing; handling and storage after mixing and before slicing; and storage conditions.

Manufacture of SMR Meat Products

As a typical example of an ideal product, carefully selected trimmings are ground through a kidney plate with openings 2 centimeters by 4 centimeters. The material may be from any species but the greatest success has been with beef. The meat is placed in a paddle mixer and the non-meat ingredients are sifted into the mixer in sequence. Sodium alginate and calcium carbonate at the 0.5% level are added and mixed into the product for 5 minutes. Thereafter, the encapsulated calcium lactate/lactic acid is sifted into the product and mixed an additional 2 minutes. The mixture is extruded in the shape of a beef rib eye and wrapped and placed in a chiller or freezer for at least 24 hours. The structured rib eye logs are then sliced in the refrigerated or frozen state and packaged for distribution.

Studies have shown that the cohesion, flavour, juiciness and aroma of algin/calcium structured steak were not significantly lower than salt phosphate steaks. There was no contribution of off flavour or odour to the meat product. Colour intensity and discoloration scores of meat with the algin/calcium binder were similar to those of ground meat. As expected, the salt/phosphate treated meat discolored and resulted in unacceptable colour scores. If high levels of alginate are utilized, a slippery mouthfeel is noted in the product. This is reduced by balancing the levels of sodium alginate and acidifier in the formulation. Excess level of the acidifier will result in a metallic or sour taste to the product.

The rate of microbial growth during storage at 4oC was the slowest in salt phosphate products. This delay in microbial growth is attributed to the antimicrobial effects of sodium chloride. Rate of microbial growth was similar among products with the algin/calcium binder and ground meat. These data indicate that alginate did not enhance total microbial growth in PVC overwrapped beef stored at 4oC compared to microbial growth in ground beef without additives.

Subjective evaluations of spoilage indicated that ground beef and product restructured with algin/calcium exceeded the marginally spoiled score of 3 after 9 days of storage at 4oC, while in the presence of salt and phosphate the product was marginally spoiled after 11 days of storage.

Implications

The process of binding meat with the algin/calcium gelation mechanism was awarded a patent (Schmidt and Means 1986) and is approved for commercial use in the United States (USDA 1986a). Thus, the algin/calcium gelation mechanism can be used to produce structured beef steaks which bind not only in the cooked state, but also in the raw, refrigerated state. Detrimental effects of added salt on oxidative rancidity rates and discoloration of refrigerated and frozen restructured products are greatly reduced. In addition it gives consumers at the retail and food service level the option of handling the product in the refrigerated state and decreasing the amount of time needed to cook the product prior to consumption.

Other Carbohydrates

A number of carbohydrates are used to enhance the water binding capacity and cohesion in restructured meat products. These carbohydrates may be used in products restructured with salt and phosphate or intact muscle cuts which usually also have salt and phosphate injected. Carrageenan, a natural gum, can be combined with salt soluble protein's to keep juices and broth within the product and is widely used in production of turkey breast products. It tends to improve tenderness and juiciness of products and enhances sliceability and reduces purge in the package.

The use of starches and modified starches to enhance the water binding capacity and cohesion of meat patties has gained considerable popularity- Usually these materials are used in combination with a certain level of salt and phosphate and with the application of batter and breading to the outside of the product. In addition, since the carbohydrates tend to reduce the species flavour of the meat, spices and hydrolyzed proteins are often used in combination with the carbohydrate to enhance the flavour of the product. The balancing of meat flavour, water binding capacity, cohesion and added flavour is a complex technological area and must be done for each product developed. There is some interest in producing reduced calorie products and therefore a desire to reduce the amount of batter and breading and deep fat frying utilized. This is partially overcome by using a glaze to apply the spice mix to restructured patties and strips.

Proteins

A number of proteins are added to fresh meat products to enhance water binding capacity and flavour. These proteins may be from plants, blood or milk and they may be modified in certain ways to enhance their flavour. Hydrolyzed whey, milk, soy and other vegetable proteins are often added as flavoring agents and water binders. In addition soy protein concentrate and soy isolate may be utilized to bind water and fat in restructured meat products. This material may be suspended and injected into large meat pieces or added as a slurry or as hydrated textured particles to patties.

Surface Treatments

The most popular surface treatment for restructured beef roasts is to apply a surface rub of caramel coloring and spices after the product has been cooked in a bag. The roast may then be rebagged and surface pasteurized by immersing the rebagged product into 80-85oC water for a short period of time. This method is relatively labour intensive and costly from the standpoint of packaging.

Future research may allow the application of a colour and spice rub to the outside of restructured roasts prior to bagging and cooking. Other surface treatments include batter and breading and flash frying to give the product a golden brown colour or coextrusion of a fat and meat emulsion onto the outside of the product to give steaks and/or roasts an appearance of a fat cover (Matthews 1986).

A petition has been granted in the U.S.A. to apply a mixture of reducing agents including sodium ascorbate to prolong the bright colour of fresh meat in a vacuum package (USDA 1986b). This method is presently being market tested and the implication for nonvisible spoilage is being examined.

A successful system for shelf-life extension has been the utilization of moisture and oxygen impermeable packages on raw meat and then cooking the material in the package. With the proper application of salt, phosphate, other additives and mechanical energy it is possible to produce restructured meat for cooking in a package without significant purge in the package. This produces a product which has a very long shelf-life at refrigerated temperatures. This system is widely used to produce hams, roast beef and turkey breast items for the delicatessen trade. As I mentioned previously, if the product must be repackaged the use of post-pasteurization of the surface of the product and extreme sanitary conditions during repackaging will help to extend the shelf-life of the product.

Shelf-life and flavour characteristics of whole muscle meat and poultry products are enhanced with the addition of sodium lactate in the formulations. Sodium lactate is compatible with pickling solutions and is used for its flavour enhancement, preserving properties, natural occurrence in many foods and liquid form. It is especially used in turkey quarter breasts and ground turkey in that it may extend shelflife by four to thirty days. It does contribute a mild saline taste to the product and may cause some graying of the product. In the U.S.A. a current limitation for its use is 2% of actual sodium lactate in the finished product.

Conclusions

Recent research and development has resulted in products and additives to provide the following characteristics to fresh and restructured meat products: (1) enhanced water binding ability, (2) increased shelf-life, (3) more stable colour, (4) decreased caloric content, (5) reduced cooking times, (6) microwavability, (7) decreased costs.

The success of these efforts will depend on industry and consumer acceptance of the finished products and the labeling of these products. Consumers want accurately labeled products that provide a food item of an appropriate perceived value. The value perception is based on appearance, taste, convenience, and nutrition.

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