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Review Paper

PROCESSED MEAT PRODUCTS: HEALTH ISSUES AND ATTEMPTS TOWARD HEALTHIER FOOD

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One of the challenges for the food industry is producing products with high nutritional value and desirable sensory properties. Meat is a food item containing large quantities of available bio-compounds and consumers and has a great passion for its taste. However, several technological problems and health issues have been reported for this category, i.e., meat processed and thus, manufacturers are looking for finding solutions in order to tackle to problems. The example of these attempts are changes in livestock feed and formulations such as reducing the amount of fat and cholesterol, using functional compounds with antioxidant and anti-microbial properties and removing harmful compounds like nitrite. Using protein compounds of plant origin is also another way to respond to the needs of consumers to produce effective products with high nutritional value in physiological systems. This paper tries to provide examples of researches on functional/modified meat products so as to make the reader aware of the progress made and the challenges facing these products.

Keywords: Meat products, Health, Formulation, Nutritional value

INTRODUCTION

Popularity and acceptance of healthy foods has originated from increased expectation levels of health conscious consumer. Healthful nutritional characteristics of the product are of the fundamental factors in adoption of product by today's consumers. Thus, industry sector is looking for developing and production of products, which have specific health and nutritional benefits. In this regard, one of the areas where various researches have been done to increase the nutritional value of products is meat products. Meat is a product with high nutritional value, containing large quantities of available bio-compounds and consumers have a great passion for its flavorful taste. However, in terms of food security, in the area of production, processing of meat products has more sensitivity compared to other food products (Amani *et al.*, 2015). Despite massive processed meat consumption, it has

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always been criticized by medical nutrition specialists. Many studies have shown adverse effects on human health including colon, breast, and prostate cancers, growth hormone abuse, cardiovascular disease, preventive antibiotic residues, diabetes and classical swine fever (Verbeke *et al.*, 2001; Azadbakht and Esmaillzadeh, 2009; and Mcafee *et al.*, 2010). Mentioned diseases can be accorded due to high amount saturated fatty acids (40-50%) in meat fat such as myristic and palmitic acids, which play a vital role in increasing blood levels of LDL cholesterol. Furthermore, during meat frying, the oxidation of cholesterol and other fatty acids may occur which can give rise carcinogenic compounds like aldehydes, esters, alcohols and short-chain carboxylic acids (Bender, 1992; and Esterbauer, 1993). In addition, incorporation of nitrite has created several major problems in terms of consumer health. Thus far, different approaches have been utilized in order to solve the problems like eliminating or reducing fat, replacing nitrite by healthier ingredients, using meat alternatives, etc. This review paper evaluates these approaches and provides the available solutions for these challenges.

DECREASE OF FAT AND CHANGE IN LIPID PROFILE

Change in formulation of meat products with the aim of reducing the amount of fat is one of the most important challenges that meat industry faces in producing functional products. In many studies, reducing the amount of fat in meat products led to undesirable changes in texture of meat and increases the loss during cooking. In addition, changes in the profile of fatty acids can cause reduction in oxidative stability of the product, which result in a unfavorable taste. However, the use of vegetable fats and other substitute substances of fat in the formulation and also change in livestock feeding pattern, can reduce the amount of fat and change the lipid profile and can be regarded as effective solutions in production of functional meat products.

Olive oil is one of the most important unsaturated oils, which has health benefits including reducing risk of cardiovascular diseases and cancer has been proven by many studies. Muguerza *et al.* (2001) carried out a study of Spanish sausage production where lard was replaced with olive oil (0 to 100%). While increasing the content of linoleic acid derivatives, cholesterol level also dropped. In addition, no adverse effects were seen in the sensory parameters. In a similar study, Ansorena and Astiasarán (2004) reported that the addition of olive oil to sausage was more efficient in prevention of oxidation of fat than preservation in vacuum, and increased the content of unsaturated fatty acids in the products. In a study conducted by Ýylmaz (2002), the use of sunflower oil in low-fat frankfurters increased the content of unsaturated fatty acids and no unfavorable change was made. Replacement of lard fat with linseed oil in production of dry fermented sausages, besides, a significant increase in the ratio of unsaturated to saturated fatty acids (PUFA: SFA), has increased the amount of alpha-linolenic acid. However, in some studies, the use of vegetable oils has led to undesirable taste or undesirable characteristics in the tissue (Fernandez-Ginez *et al.*, 2005). Use of inter-estered vegetable oil can be a good solution to overcome this problem. Javidipour *et al.* (2005) used inter-estered oils combined with plant oils: palm, cotton and olive to replace the (at 60 to 100%) the cow fat. The content of oleic and linoleic

acid, and the ratio of unsaturated fatty acids to saturated ones (PUFA: SFA) significantly increased. In addition, the organoleptic characteristics of taste and tissue of products showed no change. Cardoso (2008) and colleagues studied the use of fiber (chicory root) in formulation of low-fat smoked fish. These fibers while improving the strength of the gel and stiffness properties of products did not affect tissue traits and color. In the study by Grigelmo-Miguel *et al.* (1999), the addition of fruit fiber (peach) at 17 and 29 percent levels (frankfurter) reduced the pH. In both used levels, no change in the cooking quality or organoleptic properties was observed. In the study conducted by Mendoza *et al.* (2001) providing low-fat fermentative sausage by inulin replacement in formulation led to softer tissue and increased the tenderness and made reduction of the amount of fat in the formulation (50%) possible.

ENRICHED LIVESTOCK FEED WITH FUNCTIONAL ELEMENTS

One approach for modification of meat and meat products is changes in animal feed using different elements. Selenium is one of the important elements and plays many physiological functions in human body. Selenium deficiency in the diet can lead to a weakened immune system and increased risk of cancer. Therefore, World Health Organization (WHO) is seeking for advanced methods to increase the amount of selenium in the diet, and in recent years, fortifying animal feed with selenium in order to produce functional meat products (rich in selenium) has been of great interest. In a study conducted by Juniper *et al.* (2008) the use of 5% selenium in the diet of cattle for 112 days resulted in increased concentrations of selenium up to 0.66 ppm in the tissue of livestock. In a similar study, enriching pig diet with selenium (at 5% level) led to a significant increase in the concentration of selenium in animal tissues (Zhang *et al.*, 2010). The presence of Conjugated Linoleic Acid (CLA) in livestock feed, in addition to improving the quality of meat, can increase its level in various tissues and change the profile of fatty acid. Therefore, the use of this compound in cattle feed can be an appropriate way to increase the nutritional value of meat products. Du *et al.* (2003) enriched the chicken feed with CLA for a duration of 12 week. While reducing the amount of oxidation and improving the color of raw meat of poultry, the amount of hexanal and pentanal in cooked meat also reduced. In the research conducted by Ivan *et al.* (2001) adding safflower oil for 168 days in sheep feed, enhanced the concentration of conjugated linoleic acid in the muscles of the diaphragm (55%). Enriching animal diet with antioxidant properties compounds such as vitamin E animals besides limiting the oxidation of protein and fat, can improve the quality of fresh meat as well as meat products (Zhang *et al.*, 2010). The study of Harris *et al.* (2001) showed that the presence of vitamins with injected calcium chloride improved the proteolysis and so crispness speed was increased. In addition, the effect of vitamin (in the feed) in reducing plasma levels of meat has been proven by researchers. Vitamin E prevents the phospholipase A_2 activity and causes the stability of reticulum of sarcoplasmic membrane (thereby maintain the structure of the membrane lipids). By keeping sarcoplasma structure, less calcium penetrates into it. Low concentration of calcium also leads to slowing the decline in pH and as the result of this interaction, protein denaturation also reduces and as a result of this meat water-holding capacity increases (Chen *et al.*, 2010).

REDUCING THE AMOUNT OF SALT AND SODIUM

Using salt to increase the shelf life of meat products is inevitable. So, when the amount of salt is less than usual in the formulation, the product shelf life is reduced and the need to add other preservatives substances is necessary. Technologically, salt influences the solubility of myofibrils meat proteins (actin and myosin) and water absorption of formulation is affected by the amount of salt (Choi *et al.*, 2011). In addition, salt is one of the essential components in meat products to produce desirable taste. Therefore, such compounds must be used as the substitute of salt in meat products that in addition to increasing the nutritional value, technologically have positive effect on the production and maintenance processes of the products.

Replacing sodium chloride by potassium chloride can reduce salt intake is in the formulation of meat products. However, one of the problems with the use of potassium chloride in manufacturing is the production of an undesirable bitter taste (Weiss *et al.*, 2010). Ruusunen *et al.* (2003) studied reducing the amount of salt in the formulations of frankfurter. The results showed that in case of lack of phosphate and reduction of amount of salt to below 5.1%, the need to add auxiliary components (to improve water-holding capacity and the quality of cooking) is essential. In this regard, the researchers studied the quality characteristics of low-salt sausage. In the formulation of product above, sodium citrate, carboxymethyl cellulose and carrageenan were used. With the use of above compounds in the formulation, the amount of salt reduced to 4.1% reduction but cooking quality improved and salt flavor of products rose as well. Changes in particle size of the salt crystals can lead to quick and more resolving of salt in the mouth. As a result, at lower levels of used salt a similar taste is created (Angus, 2007; and Weiss *et al.*, 2010). Another method can be application of ultrasound. It has been reported that ultrasound waves can increase the solubility of proteins in low concentrations of salt (Weiss *et al.*, 2010).

REDUCTION OF NITRITE

One of the major components in the formulation of meat products is nitrites. Besides improving the color and flavor (reduction of oxidation), one of the fundamental roles of nitrite is inhibiting the growth of some spoilage and toxic microorganisms (*Clostridium botulinum*). Despite the technological benefits of nitrite, one of the main challenges in meat products industry is finding ways to reduce nitrites consumption. Because the reaction between nitrites and second, third and fourth type amino, leads to the formation of nitrosamine which has a high potential to cause cancer of the digestive tract in the consumers (Sebranek and Bacus, 2007). One way to reduce the direct use of nitrite in meat products formulation is the use of chemicals that are naturally high nitrate content. This method is used in the production of new types of processed products (organic) and the resulting products had similar organoleptic properties (color, flavor) and shelf life with nitrite processed products using compounds like water spinach, celery (Sebranek and Bacus, 2007), unrefined sea salt and carrots (Weiss *et al.*, 2010). Sebranek and Bacus (2007) stated that natural flavorings or spices, and celery juice or celery juice concentrate can be regarded as ingredients, and because these are plant/ vegetable products, the potential contribution of nitrate from these sources is very important. Celery juice and celery powder appear to be highly

compatible with processed meat products because of very little vegetable pigment and a mild flavor profile similar to raw celery that does not detract greatly from finished product flavor. Fischer *et al.* (2005) also suggested adding nitrite regenerative starters and a mixture of spice containing enough amount of nitrate as a way to reduce the amount of nitrite in the formulation of the product because this final product has similar color and flavor as products processed with nitrite. Compounds with antimicrobial and antioxidant properties such as spices and essential oil have also been considered as a replacement for nitrite. The main objective of adding these compounds to the formulation is to create flavor but some spice also have antimicrobial and antioxidant properties.

REDUCING OXIDATION

One of the major problems in the maintenance of meat products is oxidation of lipids and protein. Oxidation reactions lead to the formation of compounds of low molecular weight (radical) that in addition to causing bad taste and weakening the organoleptic characteristics of the product have a negative impact on consumer health (Kamani *et al.*, 2017). Thus, the enrichment of meat products with antioxidant components can help produce new functional types of meat products containing natural preservatives. In a study conducted by Sebrank *et al.* (2004) adding 2500 ppm rosemary extract to formulations of sausage while reducing oxidation in cold and frozen storage conditions also improved product color. In a similar study, rosemary extract was used to increase the shelf life of meat products. The extract led to significant decrease of fat oxidation, prevention of color loss and microbial activity (Zhang *et al.*, 2010). Tang *et al.* (2006) also examined the effect of tea *Katkyn* on the stability of color and lipid oxidation of beef. In both conditions, modified atmosphere packaging and normal packing, oxidation rate of the treated samples was less than control samples. In the study of Menon and Garg (2001) it was shown that the use of clove oil (1, 2%) in the formulation of frankfurter, during storage at temperatures of 5 and 15 degrees, stopped *Listeria monocytogenes* growth. Ntzimani *et al.* (2010) simultaneously used: Lysosome, rosemary argan essential oil in chicken meat which at 4 °C storage, the above combination was effective in stopping the growth of gram-positive, gram-negative bacteria and to some extent yeast.

THE USE OF PLANT PROTEIN IN THE FORMULATION

Use of protein compounds of plant and animal origin is one way to respond to the needs of consumers for products with high nutritional value and effective in physiological systems. In recent years, utilizing herbal protein sources and other ingredients in meat product formulations has increased. There are herbal proteins having a high biological value, for instance soy protein, the biological value of which is about 65% of that of meat. In choosing these types of functional compounds for use in the formulation of meat products, in addition to increasing the nutritional value, technological aspects such as increasing water-holding capacity, helping to form and stability of emulsion, and so on should also be considered (Fernandez-Ginez *et al.*, 2005). In a study conducted by Porcella *et al.* (2001) adding 5.2% isolated soy protein to *choriza* (Argentine sausages) was examined. Within 14 days of storing, the latex poured out of the product decreased. Also, no changes were observed in

aroma, taste, microbial oxidation rate and stability. In a similar study, soy protein (hydrolyzed) was used in frankfurter formulations. The results showed a significant reduction in the microbial population and thus increased in shelf life of products at 25 degrees Celsius (Weiss *et al.*, 2010). Xiong *et al.* (2008) studied the use of wheat gluten (hydrolyzed) in isolated myofibrils model proteins. Gelatinisation process during the heating and characteristics of formation of emulsion were improved. The results showed a significant reduction of microbial transglutaminase enzyme activity. In a similar study adding wheat proteins to frankfurter formulation increased water-holding capacity, cooking quality as well as improved sensory properties of tissue (adhesions). Ho *et al.* (1997) studied the use of tofu in frankfurter with the purpose of eliminating bean flavor and bad mouth feeling caused by consumption of soy flour. The product while having less fat, had better tissue and organoleptic properties than control samples. Therefore, it is necessary to evaluate widely different formulations of various herbal ingredients for achieving a high-quality and healthy meat product.

CONCLUSION

With increasing consumer awareness about the nutritional content as well as the interest of consumer to get information about the health benefits of food, one of the challenges for the food industry is producing products with high nutritional value and at the same time with desirable sensory properties and appearance. So manufacturers of meat products, because of the need to find suitable markets for their products have turned to solutions such as change in livestock feed or formulation (using functional compounds, removal and reduction of harmful compounds). In addition, the need to expand the research to achieve the best process conditions and maximum quality in the industry of functional products seems necessary.

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