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REVIEW ARTICLE

Development in sausage production and practices-A review

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Abstract

In this review development of sausage production practices and effects of incorporation of the different non-meat ingredient on meat products specially meat sausages were discussed. The beneficial effects of added ingredients *viz.* vegetable protein, whey protein, herbs, fibers and spices in meat products especially meat sausages were discused along with quality of meat products. Further, the addition of non-meat ingredients not only improve the quality of the meat products, but also reduce the cost and have beneficial health effects on consumers.

Keyword: Sausage, meat products, processing, non-meat ingredient, whey protein, vegetable protein.

Introduction

Increasing consumer demand for quality meat products results in the development of meat products by incorporating health enhancing ingredients. The long standing positive consumer perception that meat and meat products are the best sources of minerals, vitamins and complete proteins (complete proteins are those proteins contains all of the amino acids that our body needs to function properly) (Verbeke *et al.*, 2010). Selection of meat for sausage production is important in achieving good quality products. All the formulas of sausage production are based on meat and also all additives used in sausage production must be based on weight rather than percentage.

Consumer demand healthier meat products that are low in fat, salt, cholesterol, nitrates and calories in general and contain in addition health-promoting bioactive components such as carotenoids, unsaturated fatty acids, sterols and fibres on the other hand; furthermore, consumer accept these level meat products with altered formulations to taste, look and smell the same way as they are traditionally formulated and processed counterparts. At the same time competition is forcing the meat processing industry to use the increasingly expensive raw material i.e. meat more efficiently and produce products at lower costs (Jochen *et al.*, 2010).

The non-meat ingredients are used in meat products to improve the quality and reduce the cost of the products. These ingredients of very wide sources such as dairy, eggs, plants and microbial including probiotics are incorporated in these meat products (Xiong, 2012; Yadav *et al.*, 2013). These additives able to increase nutritional value, consumer acceptability and benefits to human healths. Table 1 showed the some sausage incorporated with different non-meat ingredient.

Sausage Production: Ingredients and Raw Materials

For thousands of years people have prepared meat products similar to today's sausage. Whoever spoke glowingly of sausage in the Odyssey, saying it was a favorite food of the Greeks. Roman festive occasions were considered incomplete without it. Sausage is a food product resulting from the assemblage of proper ingredient in the right proportion coupled with a structured design and controlled process. The quality of the product is always a reflection of the status of the raw materials and the process. If the process has been carefully designed and developed then the raw materials have to standard to achieve the expected level of quality. Also every raw material for sausage should making measure to the requirement of the quality of the sausage. Every raw material should given specification to details of all important criteria and service that affect the quality of the product. It should define all physical, chemical and microbiological requirements.

Fresh and high quality meat such as lamb, beef, pork, mutton and poultry also cuts from head and leftover cuts may be used. Other ingredients such as salt (addition to taste, extract some proteins from meat, enhances flavor, reduce microbiological spoilage and

increases water holding), water ice (assist the process of mixing and help salt to solubilize meat proteins), curing agents (inhibit microbial growth, provide pink color and enhance flavor), spices (add flavor to the product) and binder (promote fat and moisture retention) and extender (reduce formulation costs).

Steps in Production of Meat Sausage

Raw meat: Raw material should be high quality and subjected to microbial analysis. All ingredients should be properly weighted according to each specific recipe prior to mixing. The meat is genrally fresh or frozen. The lean meat should be well trimmed to a level of less than 10 percent of nontrimmable fat and connective tissue, the trimmed lean meat thus being practically free from sinews and gristle and entirely free from ligament, bone and cartilage particles. The selection of meat should be such that the meat should have a good water binding capacity. About 20% of fat is needed for good texture, taste and flavor. Hard and soft fats can be used. Pork fat, beef fat, mutton fat, chicken fat or even vegetable oils can be utilized. Beef and lamb fat have a very strong flavor which can be masked by a careful choice of spices. Buffalo meat is one of the best sources for quality meat sausages and ready to eat meat products (Kandeepan *et al.,* 2013; Abdolghafour and Saghir, 2014). Buffalo meat has been used for processing of products like sausages (Sachindra *et al*., 2005), loaves (Suresh *et al.,* 2004), burgers (Modi *et al.,* 2003), patties (Suman and Sharma, 2003) and nuggets (Thomas *et al*., 2006).

Meat grinding: The grinding of meat and fat ingredients has largely been practiced for many years and is still done today, mainly by small processors, particularly in the manufacture of specialty products. The fist-size chunks of lean meats are first ground by running them through a 3-6 mm grinder plate while fat trimmings or fatty tissues are reduced through a 6-9 mm grinder plate. The tripe and the filler meats are preferably ground twice: first, through a 3-4 mm and then through a finer grinder plate. Grinding through a coarser plate increases the capacity of the machine and heats the meat plate. Particularly in bull meat, grinding through a finer plate is considered to give a product with better binding and emulsifying properties. The curing salts are then added and the batch is mixed in a mechanical mixer to ensure that the ingredients are well dispersed. The curing process may take place either overnight in a chiller at 1-4°C or after final chopping in the cutter with other ingredients and stuffing, i.e. prior to or during the smoking. During many emulsion-type sausage procedures, a precomminution in the grinder is followed by chopping because it contributes to a better and more uniform size reduction in the cutter. In many cases comminution is not too finely done (Pearson, 1977).

Mincing: After grinding, the meat is minced in to a very fine particle size for easy protein extraction. Proteins have the function of binding the water surrounding fat droplets and keeping them dispersed. Preparation of sausage emulsion is basically in two phases. First, the lean meat, either previously ground or not, is placed on the cutter and chopped. This is done by the simultaneous addition of all the curing salts (kitchen salt, nitrite), phosphate and/or citrate for the total batch and one-third of the total amount of finely crushed ice or water. Increased salt concentration in the water phase of the mixture will result in a greater extraction of the meat protein and is of paramount importance in forming a stable emulsion.

The time of mincing, the lean meat should be chopped for a sufficient period, normally not less than 6-8 minutes. After this time, fat trimmings and other fat meats, then spices and the remaining two-thirds of the total water are added. Chopping is then continued until the batch is thoroughly chopped, however the temperature of the meat emulsion should not be reaches more than 18°C (second phase). In the course of this time, all water is taken up by the disintegrated and homogenized meats. If sodium ascorbate is used, it is also added to the very end of the chopping operation. Preparation procedures which provide for one-phase simultaneous meat and fat cutter treatment are increasingly popular. The polyphosphate and curing ingredients should be dissolved in a small quantity of warm water before being added early enough to enable the effect of polyphosphate on actomyosin and the action of salt and nitrite on water binding properties and color of the meat. With the high salt content and the longest cutting process, more salt soluble proteins are extracted and the binding quality of the finished product is improved. If hot boned meat is used, the addition of phosphates is not necessary.

Filling: Before filling into casings, oxygen should be excluded from the mixture (by vacuum-filling devices) and the temperature of the mix should not exceed 2°C. Natural casing (made from the intestines of slaughter animals) as well as casings made from modified collagen or cellulose are most frequently used. Four undried products, synthetic casings are also used. Evacuation of air from the product enhances color stability and the visual effect of the sausages. It also reduces fat oxidation and bacterial action and prevents proteolysis. A longer shelf life of sausages is therefore achieved by vacuum filling (Essien, 2003).

Casings: Casings, also known as skins, used in sausage manufacturing to achieve their primary significance in portioning. They are broadly divided into two types, namely natural and artificial. Intestines of pigs or sheep are used in making natural casings. Most products made of natural casings come out with a curve after filling and cooking. Artificial casings are now made with collagen, cellulose and plastic materials to suit a wide range of applications. Through a series of mechanical and chemical actions, collagen is extracted from the connective tissue of animals and used for manufacturing casings. Apart from providing the required sausage shape, casings also increase product shelf life by providing high moisture and oxygen resistant properties with a seal strength and density. Casings therefore contribute in minimizing product weight loss during cooking (Essien, 2003).

Cooking: There are many methods of cooking: by immersing in the cooking vat, hot showering that is conducted in a smokehouse equipped with shower nozzles, hot showering in separate hot water spray cabinets to which sausages are moved immediately after smoking, cooking by dry heat by raising the smokehouse temperature and giving only a final brief hot water shower, cooking in tight boxes into which live steam is injected, etc. However, the cooking schedules vary markedly. If water sprays are used the temperature is about 80-82°C. The temperature of water in cooking vats may be about 73-76°C. A final internal sausage temperature of 65°C is considered as minimum but a temperature of 68°C is an optimum end-point temperature providing a sufficient shelf life of the product and desired organoleptic characteristics. This usually requires about 15-20 minutes. The right cooking schedule should be developed by carefully studying the yield and quality of the sausage. After cooking in vats, sausages are hot showered to remove any adhering grease.

Cooling and packaging: The sausage should showered or soaked in water till reach an internal temperature of 38-40°F, then remove the casing and cooled to 4°F for packaging. The main purpose of packaging is to prevent meat and meat products from microbial contamination, physical and chemical changes. Packaging materials for sausages whether primary or secondary should be good enough to offer an acceptable visual and structural presentation of the product to the customer. Vacuum packaging is used on saveloys, frankfurters and cooked sliced sausages to prolong shelf life, and there is an increasing popularity of its use in cooked, chilled and frozen products. Vacuum packaging of sliced sausages is ideal for the sandwich and meal sectors if the packs are passed through a sterilizing or sanitizing unit before use within the process (Essien, 2003). Packaging meat and meat products with appropriate plastic film and laminates plays significant role in retention of the quality and extension of shelf life during refrigerated storage. Vacuum packed preblended buffalo meat and meat products to better refrigerated storage stability (Sahoo *et al.*, 1997).

Classification of Sausage

They are four categories of sausage. Fresh sausage, Cooked sausage, Semi-dry and dry sausage, and specialty meats. Table 2 shows the classification and type of sausage.

Fresh sausages

Fresh sausages are made from fresh meats which are, as a rule, neither cured, smoked, fermented nor cooked. Fresh sausages must be kept under refrigeration prior to eating. They are heated by the consumer himself before serving.

Fermented sausage

Fermented sausages are made from cured or uncured, fermented and often smoked meats but they are not heat processed, they are divided into semi-dry and dry sausages.

Smoked precooked

Smoked precooked sausages are mostly cured, non fermented products; their shelf life is increased by heating due to partial reduction of their moisture content; they are usually finally cooked before consumption.

Emulsion-type sausages

Emulsion-type sausages comprise ready-to-eat products made from comminuted and well-homogenized cured meats, fatty tissue, water and seasonings, usually smoked and slightly cooked. In Europe, these sausages are known as “scalded” because they are only scalded (pasteurized) and not fully cooked.

Cooked sausages

Cooked sausages are ready-to-serve products, basically made from previously cooked fresh or exceptionally cured raw materials, subjected to final cooking after stuffing, with or without additional smoking. A subgroup of these sausages consists of cooked or baked specialties that are not stuffed into casings but moulded and, therefore, not always considered as sausages.

Table 1: Sausage incorporated with different nonmeat ingredient

Meat products	Incorporation	Result of incorporation	References
Chorizo (Argentina sausage	Soy protein isolate	Decreased drip loss during refrigerated stora without changing flour, aroma, juicine characteristics, oxidation, microbial stability	Porcell *et al.* (2001)
Frankfurter and f frankfurter analoge	Soy prot hydrolysaters	Reduced bacterial count, extent shelf l storage 25°C	Vallego-cordoba *et* (1987)
Pork sausage patti Frankfurter	Tofu powder	Lower fat, high protein and moisture conte but in frankfurter lower moisture	Ho *et al.* (1999)
Frankfurter type sausage	Whey protein	Better color, lower chewiness elasticity a higher brittleness	Yetmin *et al.* (2001)
Poultry raw and cooked me	Pre-heated wh protein	Increased WHC, improved rheologi properties, reduced cooking loss	Hongs-prabha and Barl (1999)
Chicken sausage	Whey prot concentrate	Fat content marked effect lightness and redne textural resilience	Ander *et al.* (2006)
Smoked sausage poultry me	Wheat flour (wh protein)	Increased hardness and decreased springiness	Li *et al.* (1998)
Frankfurter sausage	Wheat protein flour	Increased WHC, decreased cooking lo improved viscosity, hesiveness, better stability	Gnanasambnadam and a Zayas (1992)
Frankfurters	Peach dietry fiber	Increased viscosity, decreased pH with influcing cooking loss, protein and collag content and sensory evaluation	Grigelmo-Miguel *et* (1999).
Low fat chicken sausage	Out bran	Decreased moisture content, increased sh stress	Chang and Carpen (1997)
Spine dry fermented sausag	Orange fiber	Decreased residual nitrite, increased amount micrococcus during dry – curing changed p water activity, nitrite residue	Fernandez-lopez *et* (2008)
Cooked turkey products	Rosemary extract	Retarding lipid oxidation, preventing color l by decreased L value and increased a va during refrigerator	Yu *et al.* (2002)
Fresh chicken breast	Oregano oil	Reduced growth of microorganism, introduc strong un favorable	Burt (2004), Chouliara *al.* (2007)

Table 2: Classification and type of sausage (FAO, 1985)

Raw Sausage		Heat Processed Sausage		
Fresh Sausage	Fermented Sausage	Smoked Processed Sausag	Emulsion Sausage	Cooked Sausage
Fresh pork sausa Fresh beef sausa Curry beef, Mut sausage, Sausa burger, Merguez	Semi-dry sausa Dry sausage, Sumr sausage, Air dr sausage, Pepperc Salami	Smoked pork sausa Precooked pork sausa Smoked beef sausa Precooked beef sausa Smoked precooked sausage	Frankfurter, Bolog Mortadella, Chicken Sausa	Liver sausage, Blood He cheeses, Meat loaves

Effects of Incorporation of Dairy Ingredient on Quality of Sausage

Milk proteins are good moisture binder when used in meat processing, although they are a lower emulsifying capacity on a soluble protein basis (Mittal and Usborn, 1985; Zorba *et al.*, 1995). Additions of dairy ingredients have been used as good binders in comminuted meat products to improve texture and sensory properties and minimize cooking loss (Hung and Zayas, 1992). Addition of dairy ingredients significantly increased water holding capacity and emulsion stability and also added dairy ingredients has lower cooking loss (Meltem and Eylem, 2004). Skim milk powder is widely used as a neutral filler with good water binding effect in comminuted meat products, but lactose may cause discoloration of meat products because of maillard reactions with proteins (Ellekjaer *et al.*, 1996). Dairy proteins have been incorporated as water and fat binders and have the potential to modify the textural characteristics of low fat comminuted meat products (Comer *et al.*, 1986). Additions of milk protein as dry ingredients has effects on the texture of comminuted meat products and resulting the change from springy at lower protein concentrations to cakey and dry at higher concentrations (Comer *et al.*, 1988; Baard *et al.*, 1992).

Whey protein showed excellent nutritional and functional properties in low fat meat products (Perez-Gago and Kroch, 2001). Whey proteins improved emulsion stability, provided better color properties and resulted in lower chewiness and elasticity, but higher brittleness and hardness in frankfurter type sausages (Yetmin *et al.,* 2001). Yetmin *et al.* (2001) assert emulsion stability rate was significantly ($p<0.05$) increased by addition of the liquid whey to the formulation, a slight increase in ash content and pH value. Pre-heated whey protein isolate formed gel at low temperature in the presence of added salt (Hongsprabhas and Barbut, 1997). When preheated whey protein was used in poultry raw and cooked meat batter results in higher water holding capacity and improves the rheological properties and reduce cooking loose (Hongsprabhas and Barbut, 1999). Addition of whey protein did not affect the fat and protein content of meatballs, while addition of whey powder was beneficial in improving cooking characteristics at each fat level (Meltem, 2006). Ander (2006) reported that when the gums and whey protein concentrate applied in chicken sausage within the range, weight losses were low (2-4%) and fat content showed a marked effect on lightness and redness and textural parameter resilience. Further, Ander (2006) described that the increasing gums and WPC, decreased sausage hardness while increasing WPC or gum concentrate a more cohesive and less granular matrix was obtained in chicken sausage. The addition of Beta-lactoglubin fractions significantly reduced the cook loss, reduced water holding capacity, while increased hardness and decreased springiness with the lowest mineral level in frankfurters sausage (Hayes *et al.,* 2005). The growth of aerobic bacteria and *Listeria monocytogenes* were inhibited and moisture loss was decreased by 31.3% in sausages with whey protein coating (Shon and Chin, 2008).

Effect of Incorporation of Soy Protein on Quality of Sausage

Soy proteins are commonly used in processed meat products for their fuctional properties and low cost compared to lean meat (Chin *et al.,* 1999). The addition of soy protein as non-meat ingredients in processed meat products may be the possible solution to the recent consumer demands for low fat and low cholesterol meat products (Yadav *et al.,* 2013). Incorporation of 2% soy protein isolate level increased moisture content and cooking yield, while decrease purge loss of the light pork sausage and were less red and more yellow by addition of 1.5% level of SPI (Akesowan 2008; Adisak, 2008). Ahmad *et al*. (2010) claimed incorporation of soy protein brought a considerable change in physic-chemical, microbiological, sensory and textural characteristics of law fat emulsion sausage. Soy protein has been incorporated in processed meat products for improving the water binding capacity and fat binding ability, enhancement of the emulsion stability and increasing yield (Chin *et al.,* 2000). Chin *et al.* (1999) reported soy protein isolate resulted in a softer texture of low fat bologna and did not affect other chemical parameter. Feng *et al*. (2002) described heat and enzyme hydrolyzed soy proteins effected texture properties differently, the 1st improving hardness and 2nd reducing hardness, cohesiveness and breaking strength. Muguerza *et al*. (2003) described the addition of soy oil did not modify the percentage of water or protein and the pH in fermented sausages, but with the addition of pre-emulsified soy oil cholesterol hardly decreased and oxidation was not modified**.** Saturated and monosaturated fatty acids decreased and polyunsaturated increased due the significant increase in linoleic and α-linolenic acids. Cholesterol percent was significantly ($p<0.05$) lowered by addition of soy protein in chevon patties and higher amount of added soy protein in the chevon patties results in lower cholesterol content (Yadav *et al.,* 2013)

With the addition of soy protein to Argentina sausage there was no decrease in drip loss and any changes in flavor, aroma, juiciness characteristic, oxidation and microbiological stability during 14 days of refrigerated storage (Porcell *et al.,* 2001). In frankfurters and fish frankfurter analogs, incorporated soy protein hydrolysates reduce a bacterial count and extracted their shelf life stored at 25°C without influencing the flavor and texture properties of the products (Vallejo-Cardossba *et al.,* 1987). Soy flour produced some beany flavor and soy protein concentrates and isolate provide some undesirable palatability in soy added meat products (Rakosky 1970; Smith *et al.,* 1973). Wilson and Sebranek (1997) described tofu powder added to lean meat had lower moisture content, but their overall acceptability and texture was better than control. Soy isolate is a promising source of soluble protein (Sofos and Allen, 1977; Hand *et al.,* 1987). In cooked sausage used soy protein replacement of fat were successfully improved binding properties and had no detrimental effect of sensory characteristics (Serdarroglu and Ozumer, 2003). Das *et al.* (2008) described addition of soy protein did not make significant effect on shelf life of goat meat nuggets in frozen storage, while pH, moisture, fat percentage, protein content and water holding capacity were significantly ($p<0.05$) lower in nuggets with 15% soy protein. Also Das *et al.* (2008) reported lower force required for compressing or shearing the goat meat as hardness, springiness,

gumminess and chewiness decreased in soy paste incorporated nuggets.

Ahmad *et al*. (2010) reported that the soy protein isolate incorporation increased Hunter L and b values but decreased a value of instrumented hardness. It was concluded that incorporation of soy protein isolate slightly improved texture, juiciness and color of emulsion sausage. Soy proteins one of non meat proteins are widely used as meat binders because of their several functionalities such as water holding, binding and emulsifying properties (Arrese *et al.,* 1991). They have been incorporated into comminuted meat to improve physical and chemical properties of processed meat products such as frankfurters and ground meat patties (Alvarez *et al.,* 1990). Soy protein addition into sausage results in better binding and texture of sausage (Ahn *et al.,* 1999).

Effect of Incorporation of Potato Starches on Quality of Sausage

Potato starches have been used a long time in meat processing during the preparation of sausage and other meat products (Ruban *et al.,* 2008). The sausages prepared with potato flour had a darker color, the lowest folding score and softer texture (Muthia, 2010). Addition of starch will increase the acceptability and quality of meat products (Hughes *et al.,* 1997; Ahamed *et al.,* 2007; Nisar *et al.,* 2009). Murphy (2000) reported that in comminuted meat products potato starches increases the cooking yield, improved texture and shelf life. Claus and Hunt (1991) reported that modified starches are also used to maintain juiciness and tenderness of low fat meat products. The effect of hydrolyzed potato protein (HPP) on meat emulsion, increased fat proportion, lightness, hue angle and decreased redness, yellowness, chroma, hardness and fracture and further suggested that HPP had antioxidant and emulsifying properties in meat emulsion manufacturing (Nieto *et al.,* 2009).

Addition of Fat Replacing Functional Ingredients

Biswas (2007) reported that the increasing addition of chicken fat skin in the chicken sausage results in decrease in emulsion stability and emulsion capacity, while extract release volume and cooking loss were increased. Addition of animal fat with red palm fat and fiber improved physical quality of chicken sausage products (Alina, 2012). Bediako (2014) suggested substantial reduction in saturated fatty acid by replacing pork back fat with incorporating healthy oils in UK style sausages achieved without any effects in eating quality or shelf life of sausages. The pre-emulsified fish oil added Spanish mortadella, a slight increase in hardness and the cutting observed high level of fish oil independently of the fat content (Caceres, 2008).

In increasing of phosphate level caused alleviatable effects in increased hardness in emulsion sausage made by pre-rigor meat, but opposite effects made with frozen meat (Peng, 2009). The addition of natural phenolic- rich plant extract in the production of bologna type sausages found to protect against some types of oxidation in the sausages but not against thiol modifications (Jongberg, 2013). Lipid oxidation effectively inhibited by the addition of green tea extract or rosemary extract, and correlated positively with the protective effects against protein carbohydrate formation (Jongberg, 2013). Also reported appraise of protein thiols and protein polymerization showed that the green tea extract increase thiol loss and the plant extracts were unable to prevent the protein cross link formation of the myosin heavy chain. Tannic acid 0.02%, 0.04% and Ehanolic Kiam Wood Extract (EKWE) 0.08% were effective in postponing the lipid oxidation by lowering the TBARS formation and decreasing the development of fishy odor,. However addition of EKWE at the level of 0.04% was not efficient in preventing the lipid oxidation in the fish emulsion sausages (Maqsood, 2012). The addition of tannic acid at the level of 0.04% maintained the textural properties to a high extent after 20 days storage at 4°C (Maqsood, 2012).

Incorporation of Egg White

The addition of 1% egg white powder improved quality of enrobed buffalo meat cutlets, while a 3% level effect on the sensory attributes and lower shrinkage (Ahamed, 2007). In duck sausage using flours combined with egg white powder significant increase ($p<0.05$) in protein content, folding test, cooking yield, water holding capacity, lightness, moisture and fat retention, however ash and carbohydrate content decreased compared to control sample (Muthia, 2012). Also there were no significant difference in hardness and cohesiveness attributes of all the samples but significant differences occurred in springiness, chewiness and gumminess attributes (Muthia, 2012).

Incorporation of Sago Flour

The addition of sago flour resulted higher folding score, greater elasticity and increased acceptability of sausage due to higher scores for texture and juiciness (Muthia, 2012). The addition of poly dextrose and oat bran was significant decreased in cooking loss of the sausages compare to the control sample (Akesown, 2013). The addition of barley fiber

which has the highest content of soluble ß- glucan (22.3%), lead to the same high process and frying losses as the addition of rye bran and lowest firmness in sausages, however barley fiber is not good ingredient in sausage in high content of ß- glucum and a large soluble fraction (Petersson, 2014). The rye bran was added in frankfurter type sausage and meatballs resulted in sausages meat protein network governs the texture and water holding properties, whiles the meat ball had a more particulate structure, with high frying losses and harder texture. Whereas the addition of untreated rye bran to sausages was harmful, causing a remarkable increase in frying loss (Peterson, 2014). Enzymatic treatment of the rye brans didn't improve the WHC or the texture of the sausage to the rye bran only been soaked in water (Peterson, 2014).

Incorporation of Vegetable Protein

Wheat protein: Wheat proteins are a high additive due to their ability to form of viscoelastic mass of gluten through the interaction with water (Pritchar and Borck, 1994). Gluten produced from wheat flour can be used as binder of sausage type meat products (Jansin-hydrolyzed *et al.,* 1994). Chymotrypsin-hydrolyzed wheat gluten resulted improve thermal gelation and emulsifying properties of myofibrillar protein isolate and lower microbial tansglutaminase activity (Xiong *et al.,* 2008). Li *et al.* (1998) qouted the addition of 3% and 6% of wheat proteins to smoked sausage of poultry meat product will increase hardness and decrease springiness.

Fiber: Dietary fiber is defined as the remnant of the edible part of plants and analogous carbohydrates that are resistant to digestion and absorption in human small intestine (Prosky, 1999). Addition of 17% and 29% of peach dietary fiber suspensions to frankfurter increased viscosity and decreased pH without influencing cooking loss, protein content, collagen contents, and sensory evaluation of sausages (Gringelmo-Miguel *et al.,* 1999). Garcia *et al.* (2002) reported the addition of high level of cereal and fruit fibers increased hardness and cohesiveness and decreased sensory and textural properties in low fat and dry fermented sausage. The addition of 1% and 2% of orange fiber to Spanish type dry fermented sausage increased amount of micrococcus and deceased the residual of nitrite during fermentation (Fernandez *et al*., 2008).

Herbs and Spices: Compounds from herbs and spices contain many phytochemicals, which are a potential source of natural antioxidants including phenolic diterpenes, flavonoids, phenolic acid and tannins (Dawidowicz *et al*., 2006; Kumar *et al.,* 2014). Herb and spice compounds have antioxidant, anti-inflammatory and anticancer activity. Among the all spices, cloves have strongest antioxidant capacity followed by rose petals, cinnamon, nutmeg and other spices (Al-Jalay *et al.,* 1987). The antimicrobial ability of spices is mainly due to phenolic compounds. Allicin is the main ingredient of garlic that has antimicrobial activity against both gram-positive and negative bacteria. The addition of 1% and 3% garlic juice decreased peroxide value, TBARS (thiobarbituric acid reactive substance) value, residual nitrite and microbiological counts in emulsion sausage during cold storage (Park and Kim, 2009). Catechins is a predominant group of polyphenols present in green tea leaves composed of four compounds epicatechin, epicatechin gallate, epigallocatechin and epigallocatechin gallet (Zhong *et al.,* 2009). The addition of green tea catchins at the level of 300 ppm reduced the TBARS values of beef, duck, ostrich, pork and chicken during 10 days refrigerated storage and also providing two to four time anti oxidative abilities then α-tocopherol depend on different animal spices meats (Tang *et al.,* 2001). Choi *et al*. (2003) reported the addition of green tea powder in pork sausage resulted in lower TBARS and decreased voltaic basic nitrogen contents compared sample prepared with nitrate alone. Clove oil at 0.5% and 1% level inhabited the growth of *L. monocytogenes* in minced muttons. At the level of 1% number of *L. Monocytogenes* decreased by 1-3 log cfu/g in mutton (Mennon and Carg, 2001). Clove was able to prevent discoloration of raw pork during the storage at the room temperature, as well as lipid oxidation among spices and herb extract (Shan *et al*., 2009). Rosemary extract contains high level of phenolic compounds and its great antioxidant activity. Addition of rosemary extract to pork sausage at the level 2500 ppm was equally effectives as butylated hydroxy anisole (BHA)/butylated hydroxy toluene (BHT). Also resomary extract equally effectives in maintaining low thiobarbituric acid-reactive substances (TBARS) value in raw and pre cooked sausage during refrigerated and frozen storage, also addition of rosemary extract improved the color and freshness of pork sausage (Sebranek *et al*., 2005).

Conclusion

The non-meat ingredients are generally added in meat products to improve the quality attributes and functional properties. It was concluded based on literature that non-meat ingredients reduced the cost, improved the quality attributes and consumer acceptability of meat products.

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