Nutritional Modification in Meat Food for the Protection of Human Health

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Abstract

Meat is a highly nutritious food and a source of good-quality proteins containing essential amino acids. The basic limitation of the meat is that it is devoid of dietary fibres. The diet free from dietary fibres may cause constipation problem which ultimately results in several metabolic disorders. Henceforth, it becomes essential to provide dietary fibres as well as minimize the fat in preparation of meat-based food. Vegetable and fruit wastes can provide supplement with good dietary fibres in meat food. There are variety of meat available in the market, viz. poultry, beef, sheep, lambs and veal. The nutritional modification of meat implies the processing of meat and meat products in such a way as to incorporate the functional value in the meat and meat products. Since the people are suffering with so many health problems related to high fat and high salt-rich meat products, it is the need of today to make low-fat and low-salt meat products to avoid the problems of atherosclerosis, arteriosclerosis, blood pressure, etc. Now a days, people have become aware enough about their health, hence the processors should make such meat products that carry nutritional adequacy and modified fatty acid profile. This chapter covers the processing of meat to make beneficial effects of human health by proper modification.

Keywords

Amino acids · Dietary fibres · Meat · Atherosclerosis

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4.1 Introduction

Meat has always been the highest choice amongst diet for the human. Meat has high-quality protein in combination with several vitamins and minerals and therefore most suitable for human consumption. Sensory properties of meat are highly appreciated, particularly the presence of myofibrillar protein which contributes to springiness, a unique texture character. The consumption of red meat has been limited to less than 500 g cooked red meat per week because of negative impact of meat consumption upon health (Grasso et al. 2014). In developed countries, wherein food of all types is abundant and cheap, the possible adverse effects of large amounts of fat from animal foods (described hereafter), the ongoing production of hygiene laws in slaughterhouses and the eventual processing of hormones are concerned.

A correlation between the consumption of processed red meat and the risk of colorectal cancer was identified by the World Cancer Research Fund in 2007. Though not given much clarification on the fact, the presumption was that excess fat, protein and iron and heat-processing compound (heterocyclic amines) were the cancer precursors. The other harmful agents in meat and meat products are microbial agents, pesticide residue, food additives like sodium chloride, nitrates and substances produced during meat processing. In meat products, trace amounts of chemical, pesticide and farm residues can be contained. As a product of the animal's reaction to chemical agents used in houses, pasturelands and fields, toxins, for example, could be administered directly to cattle containing insect or intestinal parasites, but may also be used in agriculture. Although there are not clear indications of the danger to the customer posed by these smaller amounts, they are considered a risk. This is why a large number of chemicals that can be found in meat are checked in compliance with universal regulations (Codex 1991A). Several epidémiologic research have shown a link to cancer in different areas such as the pancreas, colon, breast, prostate gland and endometrium between animal protein and cancer susceptibility. A review of 11 cases of colon cancer trials, three of stomach cancer and one of breast cancer have found that available information remains uncertain as to whether removing meat from the stomach would minimize the cancer risk (Phillips and Snowdon 1983). Cholesterol and carcinogenic compounds produced by certain lipid-processing processes in meat and meat products are hazardous to humans. Many lipid oxidation processes might be at least partially responsible for lipid negative effects. Depending on its concentration, circulation or accumulation in the human body, cholesterol may be desired or not in diet. In many other cases, food carrying high amount of cholesterol is limited because of the correlation of cholesterol-rich diet with coronary heart disease. Meat and meat products are among these foodstuffs (especially red meat). Coronary heart disease and saturated fatty acids have been a major cause of illnesses and mortality in areas of the industrialized world. Roughly 25% of saturated fatty acid is provided with animal fat in the diet, and meat intake itself is responsible over several diseases. Atherosclerosis indicates that the coronary arteries are impaired by accumulation of complex fatty mixes in the valves resulting in the occurrence of heart diseases. Thrombosis is a process in which blood clot formation occurs which blocks the narrowed arteries, it

is fatal. However, if thrombosis is not fatal but reduces blood flow to heart muscle leads to the shortage of oxygen and it can lead to the sufficient damage, it is known as myocardial infection. There are several factors which may lead to coronary heart diseases including family history of CHD, smoking, lack of exercise, various type of stress and saturated fatty acid (Palmitic acid) in the diet. There are three types of lipoprotein in blood: low-density lipoprotein (LDL) where 46% of molecules is cholesterol; high-density lipoprotein (HDL) which has 20% cholesterol and very-low-density lipoprotein (VLDL) which have 8% cholesterol. Meat and its products are rich source of beneficial compounds: high-quality proteins, zinc, high bioavailable iron, magnesium and selenium. There are several considerations for reduction of cholesterol level in meat and meat products: short-path molecular distillation; lecithin treatment; extraction by saponin, using cholesterol oxidase; supercritical carbon dioxide extraction. Some of these methods are non-selective, expensive and adequately researched. Application of cholesterol-lowering compound, like soy protein and phytosterols, is better suited method (Cohn et al. 2010).

Pesticide residues and food additives are commonly occurring in meat and believe to cause serious hazards. These two classes of compound however do not generally constitute serious problem as long as the processor is adding them in a balancing manner to meat products. Protein quality of the meat is dependent upon the availability of essential amino acids; most of the essential amino acids are present in meat. Eight of the 20 food amino acids are essential for adults and ten for children.

Dietary protein quality can be determined in several ways (FAD/WHO 1991), but generally, according to specifications, it is the percentage of the amino acids present in the product or diet. This was presented on a percentage basis in prior literature, but with the approval of the S.I. nomenclature system, it is expressed as a ratio. A ratio of 1.0 (100%) thus implies that the amino acids present in the dietary proteins are to the exact level required to meet human needs; a ratio of 05 implies that only half of the essential amino acids required are present in one (or more) of them. The protein content will be zero when an essential amino acid is totally absent.

Also, the intake of red meat is linked with increased incidence of diabetes and cardiovascular diseases. It is worth mentioning the use of animal fat in diets and their connection to heart conditions and associated circulatory disorders. Red meat has high level of cholesterol, which played a role in blocking coronary arteries of patients having cardiac diseases. It has already been proposed to reduce the circulatory cholesterol in the blood of high-risk heart patients by using unsaturated fatty acids in the form of vegetable oil. Some new studies have demonstrated that the occurrence of heart disease and animal fat content in diet is obviously not interrelated. This is confirmed by the fact that even when there is total absence of cholesterol in the diet, cholesterol is accumulated in the body (Pearson and Gillette 1997). There are many other factors for cardiovascular disorders, such as heredity, hypertension, alcohol, the consumption of sugar and lack of exercises. The meat food has important components of animal tissues, i.e. cholesterol which occurs either free (unesterified) or combined with a fatty acid. Common lean meat of pork, beef and lamb contains 70–75 mg cholesterol per 100 g, 90% being in the free form. Whereas liver and brain contain 300 and 200 mg per 100 g cholesterol, respectively.

In 1982, a report on "Diet Nutrition and Cancer" was published by the National Academy of Science which proposed involvement of dietary fat in human cancer. The same study has indicated that meat preservation by smoking and salt can also lead to rising cancer incidences.

4.2 Remedies and Reformulation of Meat Products

Modification and reformulation may be done in meat food to overcome the problems of cancer, coronary diseases, obesity and heart diseases. It is suggested that meat products with lower content of fat, cholesterol, NaCl and nitrites should be taken in formulation. The animal fat may be replaced by vegetable oils like canola oil, safflower oil and olive oil which provide health benefits to human. Many approaches for reducing the salt contents in meat products were documented as sodium consumption has negative impact and causes high blood pressure (Aburto et al. 2013), for example salt substitutes (KCl, $MgCl_2$, $CaCl_2$), application of flavour enhancer (yeast extract or monosodium glutamate) and the practising of new processing technologies (power ultrasound and high-pressure pulsing).

Nitrates and nitrites have several functions in meat product (de Oliveira et al. 2012; Bedale et al. 2016): Lipid oxidation gives specific colours to the product and provide antimicrobial activities. The reduction of nitrites leads to the addition of artificial antioxidants, colourants, or preservatives, e.g. polyphosphates are used for increasing the water-holding capacity resulting in good texture and poor cooking loss. Again their involvement in chronic diseases, cardiovascular diseases or obesity, phosphates tend to be substituted by carrageenan, citrate, or protein of different origins (milk and soybean) (Tapola et al. 2004; Alvarado and McKee 2007). The reduction of fat, particularly animal, will reduce the chances of obesity and cardiovascular disease. The replacement of animal fat by vegetable oil with enough unsaturated fatty acids will bring the health benefit in the meat products. The aroma perceived in case of substitution of fat mimic systems of great significance. Most of the aroma compounds are fat-soluble and therefore help in the vaporization of these compounds assisted by high temperature. However, if the fat mimic substance is used to reduce the fat level of meat product, it provides double benefit: (1) it avoids the risk of cardiovascular disease due to saturated fat, (2) it helps to release aroma compound which are easily vaporized and perceived strong. The reducing or replacing of fat from meat system in processed meat brings many changes in the product. It provides mouth feel which can be in terms of viscosity, body, fullness, lubricity, creaminess, juiciness, smoothness. Flavour is the most important factor among all the sensory attributes. Nutritional requirements are met to the consumer in meat as meat has balanced amount of good-quality protein, vitamins (particularly from B group) and important minerals like iron, zinc, magnesium and selenium. Both fat and water are carriers of fat-soluble and water-soluble vitamins. Fat plays a very pivotal role in bringing perception of flavour to the humans, fat brings mouth feel, richness, acts as precursor and also play a role of flavour masking. Fat act as precursor of flavour in combination with protein (amino

acids and other components upon heating). Though the aroma components are volatile but the fat and fatty acid associated with them hidden up to certain range of temperature. When heating or cooking crosses the limit of temperature, the fat melts and this gives a sudden burst of flavour. This can be exemplified with the release of butter flavour. Judicious use of fat (low fat) and salt can be imparted for flavour development of meat product. Reduced fat system has comparatively less fat and more water. Because many volatile aroma molecules are more soluble in oil than in water, the aroma can be regarded as powerful, harsh and imbalanced. This may be probably due to increase in vapour pressure in proportion to fat removal. More volatile aroma substances are released and enhanced as the vapour pressure increases. On the other side, salt is water-soluble, with the increase in water content salt loses its savour and needs to be adjusted to provide a similar salt profile to a product. This is particularly essential because salt improves flavour and also gives a salty taste for health-conscious people as they seek low-sodium product. The problem of formulating low-fat meat product is compounded with low-salt product. While fat and water are solvent of flavour component, protein and carbohydrate absorb flavour. However, protein hydrolysates can be utilized as potentiators to increase flavour and minimize the amount of salt required to balance the flavour in low fat meat product. As potentiators, it can be used to increase the flavour and reduce the amount of salt needed to balance the taste in a low-fat meat product. Overall effect of these components will not bring any adverse effect on physico-chemical, texture and sensory characteristic of meat product. Other flavour enhancers such as monosodium glutamate, guanidine 5 monophosphate and inositol 5 monophosphate favour the reduction of the salt content and improve flavour in low-fat meat system. Fat mimic system comprise of thickening agent, soluble bulking agent and micro particulate. Thickening agents like starches, gum and hemicelluloses give lubricity and are swellable. Soluble bulking agent like polydextrose, polyols and low viscous hydrocolloids play role in controlling absorption. Microparticulates having diameter of less than 0.3 μm are not regarded as particulates but serve as ball bearings smoothing out the flow properties of the fat replacement system. They are water-insoluble, examples are microparticulated proteins, microcrystalline cellulose. Once employed as a fat-mimetic device, these ingredients can mimic several of the textured features of fat in low-fat foods. Many fermentable gums are produced possessing different features which can be useful for low-fat meat processing.

Hydrocolloids are thickening and bulking agents made from microcrystalline cellulose. They are long chain polymers mainly composed of carbohydrates. Many are soluble and swellable in the aqueous environment and give smooth and creamy features that resemble fat. They provide thick gel in aqueous system and possess stabilizing, emulsifying, whipping and encapsulating characteristics.

4.3 Alginates

Alginates which are extracted from a class of brown sea weed has gelling properties. They form irreversible gels in cold water in the presence of calcium ions. The characteristic of cold-water gel formation is distinct from the gums extracted from red sea weed. Their potential to develop cold gel on exposure to calcium carbonate has enabled them to form restructured meat. The irreversible gel-forming properties make them suitable and efficient in low-fat meat products that will be reheated.

Carrageenan: It is extracted from red seaweed. There are three types of carrageenan: Kappa carrageenan forms strong gel that can undergo syneresis, whereas iota carrageenan forms fragile elastic gel but not subjected to syneresis, both form thermally reversible gel. For controlling syneresis, both kappa and iota carrageenan are usually mixed. Third type, Lambda carrageenan does not form gel and therefore it has no application in meat product. Kappa carrageenan has been used in sectioned and formed meat, e.g. in turkey breast product. Due to US regulatory approval, it needed an additional binding agent to offset the low salt level 0.05–1.0%, i.e. common in turkey breast (Pearson and Gillette 1997). Because of its cold solubility and freeze–thaw durability, Iota carrageenan is suggested to be used in low-fat beef patties. Added salt is incorporated in fat to ensure that the solubilization of iota carrageenan is not compromised. In emulsion-type meat products, carrageenan is used with salts and phosphates to extract the myofibrillar protein prior to adding the carrageenan. To thicken the pickle and hold carrageen suspended before being injected, Xanthan gum may be applied to the Kappa Carrageenan. Xanthan gum solutions liquefies and viscosity falls rapidly when the pump's shear effect is encountered. They are most suitably brought in combination as dry mix with soluble dispersing agents such as dextrose. Carrageenan interacts synergistically with starches and other carbohydrate substances like konjac flour. They have excellency in low meat product and can be employed in fairly low concentrations (0.1–0.5%). Carrageenans interact with proteins, bind the water, enhance slicibility, improve sensitivity and release aroma elements easily. They solubilize when meat products are heated and form gels during cooling between 50 and 60 °C.

4.4 Starches

The properties of meat products are dependent on the origin of added starches. Waxy corn starch in which amylopectin (branched chain) is in greater quantity has natural tendency to more fat-like feel than corn starch which has 74% amylose (linear chained). Waxy corn granules absorb water and swell quicker, giving a higher viscosity, but are more retrograde than dent corn starch. The starches of potato and tapioca are extremely bland with a smooth mouth feel, their gelatinisation temperature is lower.

There are several hydrocolloids and fat mimetic system that help as thickening agents, soluble bulking agents which maintain the texture, viscosity and stability of the meat products. They help to reduce total fat in the meat products.

Maltodextrins are formed by cleavage of amylose and amylopectin. They do not possess intact starch granules. In general, for low-fat meat products, maltodextrins with dextrose equivalents below 20 are used. They are cost-effective and easy to use and help to improve in holding water. Maltodextrins also play role in microbial inhibition by reducing the activity of water. They are limited to 3% in sausage products with standards of identity. There are many other types of hydrocolloids, viz. guar gum, locust bean gum, gallon gum and xanthan gum, which are used as a hydrochloride and form a gel when combined with each other. This property has been utilized in processed meat like bologna salami and pepperoni. It provides stability, impart smooth structure and assist in extrusion and stuffing. Several other types of hydrocolloids are konjac flour, cellulose and cellulose derivatives, which are distinctly used to improve the elasticity, strength of gel and increase in the concentration of the product. Such gels can be used in the processed meat to imitate the feel of ground fat. Cellulose derivatives are carboxymethyl cellulose (CMC), methyl cellulose (MC), carboxylethyl cellulose (CEC), hydroxypropylmethyl cellulose (HPMC) and microcrystalline cellulose (MCC). These cellulose derivatives found in most plants have water-binding capacity and therefore impart different characteristics to meat products. They form gel upon heating but not on cooling. This property enhances their potential to be used in meat products. They remain firm when they are heated as well as when cold. They cultivate suitability to microwave application for use in fat food. As they create an oil absorption barrier, which delay the loss of natural moisture. They provide better adhesion properties for breading having microparticulate structure impart some fat mouth feel to meat products. Methyl cellulose (at 0.15%) helps to improve binding strength and increased water-holding capacity in meat formulations.

Some protein products help to provide the water binding properties and act as a good hydrocolloid which can bind the great deal of water and soften the processed meat product, among them are gelatin, milk proteins and serum proteins. In cold water, swelling of gelatin occurs while in hot water it dissolves, gel formation occurs at 20 °C. This gel melts at 30 °C and thus will release flavour and can improve taste as the temperature of mouth is higher than 30 °C. Similarly milk protein albumin binds water, form gel and acts as a good emulsifier likewise serum albumin and fibrinogen excellent gelling protein and provides adhesive properties to meat products.

Some plant proteins also have peculiar properties of hydration and help to stabilize emulsion-type meat products. Soy concentrates (70%), soy flour (50%) and soy isolates (90%) are the three forms of soy products. The isolates are actually fat and carbohydrate-free and therefore they are most suitable to be used in low-fat meat products. The consumer has well accepted soy protein as ingredient. The isolates are also free from beany flavour and they are made very bland. Hydration of soy protein isolate is recommended with water in the ratio of 1:4. Combination of soy protein isolate in meat products provides good texture and imparts firmness.

Functional meat products play important role in providing health benefit and protect meat products from creating adverse effects on human health. The following methods are being suggested for meat products to make them functional:

(a) Reduced fat content in meat brings down fat and cholesterol content, improves fatty acid profile, reduces the risk of some common diseases such as obesity and hypercholesterolemia. (b) Improved dietary fibre in meat products enhances binding properties, cooking yield and textural profile, decreases caloric values, reduces the risk of gastrointestinal disorder, coronary heart disease, diabetes, obesity. (c) Products developed from lesser amount of sodium inhibit the risk of hypertension, reduce the risk of other diseases such as kidney stone, renal failure and cardiovascular disease. (d) Meat products enriched with natural antioxidants improve shelf life and lower TBARS (Thiobarbituric acid reactive substances) values.

The fibre is being the most important constituents of the food which is absent in meat. Another shortcoming in the products is the presence of saturated fat. Addition of fibre and several other functional ingredients will enhance the functional and nutritional value of the meat products.

Incorporation of dietary fibre: The plant-based derivatives like vegetables, fruits, herbs, nuts and spices are primarily used these days for the production of healthier and modified meat products having enhanced shelf life. The incorporation of dietary fibres and antioxidants is the major approach in new meat products development. The integration of fibres is in demand due to their technical use and their health benefits (Fisinin et al. 2009). The risk of obesity, colon cancer, cardiovascular disease and various other diseases was decreased with diets with a high proportion of dietary fibres (National Cancer Institute US Department of Health and Human Services 1984). Functional ingredients as fibre content in meat products are shown in Table 4.1. Several dietary fibres are being used as a possible fat replacement in meat products for the assessment of good health results (Mansour and Khalil 1997).

Fat oxidation in meat and meat products poses a severe problem of shelf unstability in meat. Meat fat contains good portion of phospholipids in its fat content. Meat is also a source of iron. Both phospholipids and iron are promoter of rancidity. Salt also promote rancidity. In all meat products, salt is often a constituent and therefore there are fair chances of the product getting rancid if all three factors prevail. The phenomenon of rancidity in case of meat and meat products often is indicated by warmed over flavour (WOF). Thus oxidation in meat due to the above factors lead to loss of quality particularly sensory and nutritional quality. Sensory qualities like taste, colour and texture are severely affected due to the fat oxidation. Free radicals produced by oxidation lead to the chain reaction associated with oxygen integration, and lipids, proteins, pigments and vitamins are the main targets in meat products (Johnson and Decker 2015). Antioxidants are used to prevent oxidation in meat products and preserve sensory attributes. Some of the antioxidants used in meat products are polyphosphates, butylated hydroxytoluene (BHT), sodium ascorbate and tocopherol acetate. Natural antioxidants are most preferred due to their nutritional advantage and also preventing the risk of oxidation. In the last two decades the natural antioxidants in meat products appear to be good substitute to reduce the consumption of synthetic additives since they are widely accepted by the people of the society. As these antioxidants are non-toxic and providing the functional properties beneficial to human health. Many

Table 4.1 Effects on various properties of meat products incorporate with different fibre sources

S. No.	Ingredients (functional) incorporated	Product as carrier	Results shown by the product developed
1	Pumpkin	Chicken sausages	Product showed fibre enrichment
2	Husk obtained from psyllium	Chicken patties	Reduction in fat cholesterol level coupled with dietary fibre enhancement
3	Rice bran in combination with flax seed oil	Beef patties	Reduction in both saturated fatty acid and total lipid
4	Lemon fibre combined with carrot fibre	Beef hamburger	Resulted in diminishing fat and cholesterol level
5	Flour of green banana mixed with soybean hulls	Chicken nuggets	Colour and texture improvement in addition to dietary fibre increment
6	Guava flour	Meat (sheep) nuggets	Boosting antioxidants level and dietary fibre
7	Fenugreek leaves flour with Psyllium husk	Meat (goat) patties	Boosting antioxidants level and dietary fibre
8	Rice flour with added gluten	Patties (beef)	Texture fairly improved
9	Tomato paste with added flax seed	Patties (beef)	Both fatty acid profile and nutrients were improved
10	Carrots with oats combination	Meat (chicken) cutlet	Higher moisture, lower free fatty acid
11	Flour (finger millet)	Patties (chicken)	Moisture retainment plus cooking yield enhancement

of synthetic antioxidants, viz. BHA and TBHQ, has been noted to show carcinogenic effect on human being, therefore many countries like Europe and USA has banned these antioxidants. The current industrial trend has shifted towards natural antioxidants such as sodium ascorbate, ascorbic acid, tocopherol acetate and various plant materials which are rich in radical scavenging polyphenols (Shahidi et al. 1992). In humans the antioxidants defence system includes enzymes (e.g. superoxide dismutase, catalase and glutathione peroxidase), copper- and iron-binding extracellular proteins (e.g. celluloplasmin, hactoglobin, albumin transferrin and lactoferrin), antioxidant vitamins (e.g. Vitamin C, vitamin E and beta carotene) and other cellular compounds (glutathione, quinone, uric acid and bilirubin) (Krinsky 1992). Furthermore, several exogenous phenolic compounds obtained from foodstuffs such as spices and herbs used in processed meat add to a pool of antioxidants (Jiang and Xiong 2015). Plant kingdom has been recognized as the most abundant source of antioxidants, e.g. being the spices, herbs and essential oils are rich in antioxidant. Sometimes they are used to improve the organoleptic or sensory characteristics of the meat product. Several fruits and vegetables are good source of antioxidants and other phytochemicals. Many plant leaves like tea leaves are excellent examples of plant antioxidants. Nature also has produced a series of

multi-purpose short peptides, which can neutralize free radicals and chelate pro-oxidative metal ions. The later resulted in the preparation of natural antioxidant peptide by enzymatic protein hydrolysis.

One basic feature of such phenolics is the ability to break free radical chain reactions by hydrogen and electrons donation (Shahidi et al. 1992). Particularly rosemary extract, licorice extract, clove oil and black pepper are used as flavouring agents in processed meats. Most of the phenolic constituents are found in spices and herbs (e.g. gallic acid and caffeic acid). Rosemary extract is among the most approved and widely utilized natural antioxidants in the meat industry. Its antioxidant property is linked with the occurrence of various phenolic diterpenes, like carnosol, carnosic acid, rosmariquinone, rosmaridiphenol and rosmanol (Aruoma et al. 1992). Green tea extracts are used as nutraceutical supplements as natural antioxidants, antibacterial agents and antivirals. These extracts possess antimutagenic and anticarcinogenic activities (Yang and Landau 2000). The functional ingredients found in food material help to prevent several non-communicable diseases such as incorporation of fibre in meat product. Sources of fibre may be some fruits, vegetables, rice bran, flax seed, etc. Six examples are being cited regarding the discussion: (1) pumpkin rich in fibre had been incorporated in chicken sausage gives fibre-enriched product (Calvo et al. 2008). (2) Psyllium husk was added in chicken burger patties to enhance dietary fibre content and reduce cholesterol content (Savadkoohi et al. 2014). (3) Flax seed and rice bran were incorporated in beef burger patties to bring down the level of total lipid and saturated fatty acids (Johnson 1998). (4) Carrot and lemon fibre were added in beef and hamburger to reduce the fat and cholesterol content (Rodriguez-Amaya 2016). (5) Green banana and soybean flour were incorporated in chicken nuggets to improve dietary fibre and boost instrumental texture and colour characteristics (Sesso et al. 2003). (6) Guava was added in sheep meat nuggets to improve the antioxidants and dietary fibre. Antioxidants have been used in different types of meat products. These ingredients have functionality and had been obtained from different natural plant materials, e.g. in raw chicken meat, aqueous state of curry leaves and fenugreek leaves was used to improve the antioxidant activity of meat product (Chowdhury et al. 2001); clove powder was incorporated in chicken patties to impart antimicrobial property to the meat products; similarly, pomegranate rind powder was used in chicken patties to improve the antioxidant potential of the meat product; Guava, a good source of fibre and antioxidant, has been incorporated in sheep meat nugget to improve antioxidant property and provide dietary fibre. Natural antioxidants used to inhibit oxidation in processed meat products are given in Table 4.2.

Meat is though not essential part of diet, it attracts good population of society. Its consumption for better nutritional potential has been suggested by nutritionist as it contains good-quality protein, vitamins particularly B complex, and minerals like potassium, phosphorous, iron, zinc, magnesium and selenium. However, the diet of meat product has problems associated with excessive intake of saturated fatty acids, risk of food poisoning and several non-communicable diseases such as coronary heart disease (CHD) and blood pressure (BP). This has been created due to saturated

Table 4.2 Oxidation inhibition in meat products using different antioxidant (natural) sources

Antioxidant source	Prominent bioactive compound	Other bioactive compounds	Mechanism of antioxidant action	Meat products incorporated	References
Extracts of spices and herbs	Phenolic acids	Gallic, rosemarinic, casonic and caffeic acid	Through radical scavenging as well as metal chelation	Precooked pork and sausages	Jiang et al. (2013), Kong et al. (2010)
Extracts of fruits and leaves	Flavonoid, vitamin A,D, E,K	Procyanidins, quercetin, catechin	Radical scavenging only	Cooked patties (burger), pork patties (raw and cooked)	Ganhão et al. (2010), Jo et al. (2003)
Extracts of nuts and cereals	Tocopherols	Tocopherols (α-, β-, γ- and δ-)	Through radical scavenging	Steak (restructured), frankfurters	Cofrades et al. (2004), Jiménez-Colmenero et al. (2010)
Essential oils	Polyphenols	Eugenol, terpenoids	Through radical scavenging	Meat patties (Turkey), burgers (beef)	Loizzo et al. (2015), Sharafati-Chaleshtori et al. (2015)
Protein hydrolysates with peptides	Short chain peptides	Carnosine, Tyr-Phe-Glu, Tyr-Ser-Thr-Ala	Through radical scavenging coupled with metal chelation	Beef (cooked), patties (meat), meat emulsions, frankfurters	Cheng et al. (2014)

fatty acids, smoking, various type of stresses and certain disease associated together with a number of dietary factors.

Meat is highly regarded in the majority of countries and societies. Usually different forms of meat form the basis for celebrative and festive occasions and is seen as a food of high nutritional value from the traditional and also from the scientific perspective. A large number of people who are vegetarians and meat is not their essential diet, but to make the diet adequate they include the animal products so that a good diet is ensured. An energy-appropriate diet is almost always sufficient in protein, in both quality and quantity. The protein requirement of adult is 7–8% of total energy intake, and since most cereals contain 8–12% protein. Hence if the diet comprises of entirely cereal, the sufficient nutrients will be available to satisfy energy need and protein need at the same time. On special occasion the little high protein is required, e.g. pregnant women and nursing mother needs high protein requirements. In some of the diseases people either suffering from infection or intestinal parasites. In the relevant diseases the protein catabolism is enhanced. During stress conditions like fever, broken bone, burns and other traumas, there is considerable loss of protein, therefore it must be compensated by adequate nutritional diet.

Meat is a good source of all B-complex vitamins viz. thiamine, riboflavin, niacin, biotin, cyanocobalamin, pantothenic acid and folacin. Some organs (offals) contain good amount of Vitamins A, E and K which are absent in lean meat.

Amount of iron present in the food provides a source but its chemical form and presence of another ingredient decide about the absorption in the human body. Various physiological factors also decide to promote or inhibit the absorption of iron present in meat as haem iron, it is properly absorbed about 15–35%, while there is a poor absorption of iron from the plant food falling in the range of 1–10%.

4.5 Conclusion

Meat and meat products have excellent nutritional value and therefore are highly consumed by the large population of the world. There are certain limitations in using meat as red meat contains cholesterol which is harmful to the human health. Meat does not contain dietary fibre and therefore it may cause several cardiovascular diseases even colon cancer, due to constipation created by meat diet. The dietary fibre plays important role in improving digestibility, providing bulk in the intestine and help in movement of digestive matter in intestinal tract. Certain non-meat ingredients viz. vegetable protein dietary fibre, cereals by products, legumes, fruits, and lactic acid bacteria provide functionality to the meat. These ingredients provide health benefit by mediating specific physiological functions. Reformation and nutritional modification are achieved by the addition of dietary fibre, hydrocolloids and fat-mimicking substances. These constituents prevent gastrointestinal disorder, coronary heart disease, diabetes and obesity.

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