Journal of
Advanced Veterinary Research
Volume 2 (2012) 314-324

Review Article

Functional Meat and Meat Products: An Overview

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(Recieved 27 November 2011/ Accepted 28 September 2012)

Abstract

A food can be regarded as functional if it is satisfactorily demonstrated to beneficially affect one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved health or well-being and/or to a reduction in the risk of disease. They are very important for health and are classified on various basis such as Supplementation of functional ingredients in diets of animals which includes Conjugated linoleic acid, Vitamin E, Omega-3 (ω3) fatty acids and Selenium; enrichment of functional ingredients in meat and meat products which includes functional foods from plant sources such as Soy proteins, Wheat proteins, Fibers, Broccoli and other Cruciferous Vegetables, Citrus Fruits, Tomatoes, Flaxseed, Herbs and spices as well as functional foods from animal sources such as Fish and Dairy Products like Whey protein and Probiotics and finally production of functional components during processing which includes Curing, Fermentation, Production of antibacterial compounds like Bacteriocin and Enzyme hydrolysis of proteins. Current status of functional meat products in world and India, safety issues and future prospects has been discussed.

Keywords: Conjugated linoleic acid; Vitamin E; Omega-3 (ω3) fatty acids; Selenium; Flaxseed; Probiotics

Introduction

In recent years, the consumer demands for healthier meat and meat products with reduced level of fat, cholesterol, decreased contents of sodium chloride and nitrite, improved composition of fatty acid profile and incorporated health enhancing ingredients are rapidly increasing worldwide (Zhang *et al.*, 2010). The term functional foods was first introduced in Japan in the mid-1980s and refers to processed foods containing ingredients that aid specific bodily functions in addition to being nutritious. To date, Japan is the only country that has formulated a specific regulatory approval process for functional foods. Known as Foods for Specified Health Use (FOSHU), these foods are eligible to bear a seal of approval from the Japanese Ministry of Health and Welfare (Arai, 1996). Currently, 100 products are licensed as FOSHU foods in Japan.

Although there is no exact definition of what a functional food is and many consider that it is a concept still under development, among the most widely accepted definition from a European point of view is that mentioned by Robertfroid (Pascal; Collet-Ribbing, 1998), namely that “a food may be considered functional if it contains a component (be it nutrient or not) with a selective effect on one or various functions of the organism, whose positive effects justify that it can be regarded as functional (physiological) or even healthy.” A food can be regarded as functional if it is satisfactorily demonstrated to beneficially affect 1 or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved health or well-being and/or to a reduction in the risk of disease. A functional food must remain food and it must demonstrate its effects in amounts that can normally be expected to be consumed in the diet: it is not a pill or a capsule, but part of the normal food pattern (Dipplock *et al.*, 1999). For example Vitamin E-induced inactivation of phospholipase A2 prevented calcium leakage into sarcoplasm and resulted in lower sarcoplasmic calcium concentration (Chen *et al.*, 2010).

The Institute of Medicine's Food and Nutrition Board (IOM/FNB, 1994) defined functional foods as "any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains." Thus, there is no precise and universally

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ISSN: 2090-6277/2090-6269, www.advetresearch.com

accepted definition of these foods. Consequently, it has been suggested to understand the term "a functional food" as a new idea, rather than a defined product (Dipplock *et al*. 1999; Roberfroid, 2000). Accordingly, an ideal functional food is considered to be: (1) A conventional or everyday food; (2) Consumed as a part of the conventional diet; (3) Composed of naturally occurring components; (4) Enhancing target function(s) beyond its nutritive value; (5) Reducing the risk of disease, and (6) Having sound, scientifically-based and verified claims.

In a more practical way, a functional food is defined as: (1) A natural food in which one of the components (nutrient or non-nutrient) has naturally been enhanced through special growing conditions; (2) A food to which a component has been added to provide benefits (e.g. the addition of selected probiotic bacteria to improve gut health); (3) A food from which a component has been removed (e.g. the reduction of saturated fatty acids); (4) A food in which the nature of one or more components has been modified (e.g. protein hydrolysates in infant formulas); (5) A food in which the bioavailability of one or more components has been increased, and (6) any combination of the above possibilities.

Importance of functional foods

1. Functional foods that contain plant sterol/stanol having cholesterol lowering ability are highly effective and should be integrated into older people's diets. Nuts in particular are rich in phenols, flavonoids, isoflavonoids, phytosterols and phytic acid, and have been linked to reductions in plasma lipids and protection against cardiovascular disease.
2. Functional foods that contain phytosterols are associated with a reduction in serum cholesterol levels and of cardiovascular risk. This could be of great importance in developed societies in which cardiovascular disease is the main cause of death.
3. Functional foods that contain fibre, as well as vitamins, minerals, flavonoids and terpenes provide protection against oxidative processes.
4. The polyunsaturated fatty acids found in fish (eicosapentaenoic and docosahexaenoic acids) effectively regulate haemostatic factors, and provide protection against cardiac arrhythmias, cancer and hypertension. So functional foods that contain them also play a vital role in the maintenance of neural functions and the prevention of certain psychiatric disorders.
5. Functional foods that contain olive oil may have health benefits, including the reduction of coronary heart disease risk, the prevention of several types of cancers and the modification of the immune and inflammatory responses.It also appears to have a role in bone mineralisation (thus reducing the risk of osteoporosis). Olive oil is known for its high levels of monounsaturated fatty acids and it is a good source of phytochemicals, such as polyphenolic compounds, squalene and a-tocopherol. This food therefore has several components that contribute to its overall protective effect. Phenolic compounds have been shown to inhibit LDL oxidation in vitro and ex vivo.
6. Probiotic functional foods tend to help in avoiding diarrhea caused by antibiotics. The dairy products such as cheese and yoghurt, are better tolerated by lactose intolerant individuals. In addition, lactic acid bacteria confer benefits, including improvements in gastrointestinal health and of the immune response.
7. Functional foods that contain garlic, onions, herbs and spices are used as condiments and may increase the nutritional value of food. Some also contain large quantities of flavonoids (fennel, chives, etc.) or allicin (raw garlic and onion); the latter may have cardiovascular benefits and help improve cognitive function. (Ortega, 2006).

Functional alterations in meat and meat products

The nutritional strategies to improve the quality of food products of animal origin are a relatively new approach that has emerged at the interface of animal nutrition, food science and human nutrition. This approach has been effectively used to alter animal product composition to be more consistent with human dietary guidelines. Equally, it has been used to enhance health-related, i.e. functional properties of foods of animal origin. Both meat and its associated products can be modified by adding ingredients considered beneficial for health or by eliminating or reducing components that are considered harmful. In this way, a various foods can be obtained which can be considered “healthy.”

Classification

At present numerous functional food components from plants (i.e. phytochemicals) as well as animals (i.e. zoochemicals) are under investigation for their potential role in disease prevention and health promotion. Ingredients of functional meat and meat products may be classified as:

Supplementation of functional ingredients in diets of animals-

Conjugated linoleic acid

Conjugated linoleic acid (CLA) is a collective term describing a mixture of positional and geometric isomers of linoleic acid, which are involved with double bonds at positions 7 and 9, 8 and 10, 9 and 11, 10 and 12, and 11 and 13 in the fatty acid chain. Numerous physiological and biological properties have been attributed to CLA including antioxidant and antiobesity, anticarcinogenic and antiatherosclerotic and antidiabetogenic and protection of immune system and, and contribution to bone formation and CLA can be produced with very limited amount by gastric bacterial biohydrogenation in pig resulting in low amount of CLA in pork (Dugan *et al*., 2004).

Vitamin E

Vitamin E supplementation in animal diet and meat products can improve the quality of fresh meat and meat products by limiting protein and lipid oxidation. Vitamin E supplementation can improve meat color and reduce lipid oxidation in pork, beef and lamb. For fresh meat quality, vitamin E is possibly involved in regulating the conversion of muscle to meat by inhibiting protein oxidation. In poultry, dietary vitamin E inhibited the development of PSE conditions induced by heat stress resulting in improved meat quality (Olivo *et al*., 2001). Vitamin E-induced inactivation of phospholipase A_2 prevented calcium leakage into sarcoplasm and resulted in lower sarcoplasmic calcium concentration. Lower calcium concentration in sarcoplasm is associated with slower rate of pH decline and lower levels of protein denaturation, and thus cause increased water holding capacity (Chen *et al*., 2010).

Omega-3 (ω3) fatty acids

Long chain ω3 polyunsaturated fatty acids (PUFA) are recognized as essential constituents for normal growth and development in animal. This group of fatty acids includes eicosapentaenoic acid (EPA, 20:5), docosapentaenoic acid (DPA, 22:5) and docosahexaenoic acid (DHA, 22:6). Omega-3 fatty acids are involved in gene expression (as second messengers) and cyclic adenosine monophosphate signal transduction pathways to regulate the transcription of specific genes and Omega-3 fatty acids such as DHA can also contribute to the development of infant brain and liver and play important roles in the prevention and treatment of various kinds of diseases. Regular consumption of ω3 fatty acid-enriched pork can decrease the content of serum triglycerides and increase the production of serum thromboxane, and thus can reduce cardiovascular diseases. Omega-3 fatty acids are possibly involved in regulating chronic inflammatory disorders by decreasing the production of inflammatory eicosanoids, cytokines and reactive oxygen species, and inhibiting the expression of adhesion molecules (Calder, 2006). The development of central nervous system and neurological disorders were shown to be associated with ω3 long chain PUFA (Assisi *et al*., 2006), and dietary supplementation with fish oils reduced blood pressure and inhibited hypertension. The primary source for long chain ω3 PUFA is fish and other seafoods.

Selenium

Selenium is an essential trace mineral for human and animal because it is involved in regulating various physiological functions as an integral part of selenoproteins. In mammals, the glutathione peroxidase and thioredoxin reductase are the most abundant selenium-containing proteins which play key roles in redox regulation via removing and decomposing hydrogen peroxide and lipid hydroperoxides (Ursini *et al*., 1997). In human, selenium deficiency is associated with decreased immune function resulting in increased susceptibility to cancer and cardiovascular diseases and muscular dystrophy, diabetes, and arthritis cataracts, stroke, macular degeneration and other diseases.

Enrichment of functional ingredients in meat and meat products

Functional Foods from Plant Sources

Soy proteins

Soy proteins are widely used in meat products in the forms of soy flour, and soy protein concentrate and isolate to improve water and fat binding ability, enhance emulsion stability, improve nutritional content, and increase yields (Chin *et al*., 2000). Soy protein isolates are very hydrophilic and thus can be incorporated into meat products to reduce cooking loss.

Wheat proteins

Wheat proteins could be a great additive due to their ability to form viscoelastic mass of gluten through the interaction with water (Pritchard and Brock, 1994). Gluten produced from wheat flour can be used as a binder or extender in sausage products (Janssen *et al*., 1994). Chymotrypsin-hydrolyzed wheat gluten resulted in lower microbial transglutaminase activity and improved thermal gelation and emulsifying properties of myofibrillar protein isolates (Xiong *et al*., 2008).

Fibers

Dietary fiber is one of the ingredients to provide meat products with low-fat and high fibers. Dietary fiber is defined as the remnant of edible part of plants and analogous carbohydrates that are resistant to digestion and absorption in human small intestine (Prosky, 1999). Increased intake of dietary fibers has been recommended due to their effects in reducing the risk of colon cancer, diabetes, obesity and cardiovascular diseases in human (Eastwood, 1992).

Broccoli and other Cruciferous Vegetables.

Epidemiological evidence has associated the frequent consumption of cruciferous vegetables with decreased cancer risk. A particular isothiocyanate has been isolated from broccoli, known as sulforaphane has been shown to be the principal inducer of a particular type of Phase II enzyme, quinone reductase.

Citrus Fruits

Several epidemiological studies have shown that citrus fruits are protective against a variety of human cancers. Although oranges, lemons, limes, and grapefruits are a principal source of such important nutrients as vitamin C, folate, and fiber, Elegbede *et al*. (1993) have suggested that another component is responsible for the anticancer activity. Citrus fruits are particularly high in a class of phytochemicals known as the limonoids (Hasegawa and Miyake, 1996).

Tomatoes

Lycopene, the primary carotenoid found in this fruit (Gerster, 1997), and its role in cancer risk reduction (Weisburger, 1998). Lycopene is the most abundant carotenoid in the prostate gland (Clinton *et al*., 1996). Other cancers whose risks have been inversely associated with serum or tissue levels of lycopene include breast, digestive tract, cervix, bladder, and skin (Clinton, 1998) and possibly lung (Li *et al*., 1997).

Flaxseed.

The flaxseed oil contains the most (57%) of the omega-3 fatty acid, a-linolenic acid. Consumption of flaxseed has also been shown to reduce total and LDL cholesterol (Bierenbaum *et al*., 1993), as well as platelet aggregation (Allman *et al*., 1995).

Herbs and spices

Compounds from herbs and spices contain many phytochemicals which are potential sources of natural antioxidants including phenolic diterpenes, flavonoids, tannins and phenolic acids. These compounds have antioxidant, anti-inflammatory and anticancer activities. In food systems, they can improve flavor, retard lipid oxidation-induced food deteriorations, inhibit the growth of microorganisms, and play roles in decreasing the risk of some diseases.

Rosemary extracts

Rosemary extract contains high levels of phenolic compounds leading to its great antioxidant activity. Phenolic compounds are capable of regenerating endogenous tocopherol in the phospholipid bilayer of lipoprotein (Rice-Evans *et al.*, 1996). Sebranek *et al*. (2004) reported that rosemary extracts added to pork sausages at 2500 ppm level was equal to or more effective than BHA/BHT in delaying TBARS values in raw and precooked sausage during refrigerated and frozen storage. In addition, addition of rosemary extracts improved the color and freshness of pork sausages added a water-soluble rosemary extract in cooked turkey products and found that it was effective in retarding lipid oxidation and preventing color loss.

Green tea

Catechins is a predominant group of polyphenols present in green tea leaves composed of four compounds epicatechin, epicatechin gallate, epigallocatechin, and epigallocatechin gallate (Zhong *et al*., 2009). These tea compounds promote health by preventing lipid oxidation and providing antibacterial, anticarcinogenic and antiviral ability. Tea catechins were reported to reduce the formation of peroxides even more effectively than α-tocopherol and BHA in porcine lard and chicken fat (Chen *et al*., 1998). Tea polyphenols could inhibit the formation of mutagens, which was known to be associated with the breast and colon cancer, during cooking of ground beef hamburger style meat (Weisburger *et al*., 2002).

Clove

Clove (*Eugenia caryophyllus*) is known to have antimicrobial activity for long time due to its active ingredient- eugenol. Clove oil at 0.5% and 1% level inhibited the growth of *L. monocytogenes* in minced mutton. At 1% level, the number of *L. monocytogenes* decreased by 1–3 log cfu/g in the mutton (Menon and Garg, 2001). In ready-to-eat chicken frankfurters, clove oil at 1% and 2% level inhibited the growth of *L. monocytogenes* during storage at 5°C and 15°C (Mytle *et al*., 2006). Clove oil was also effective in inhibiting other food borne pathogens including *C. jejuni, S. Enteritidis, Escherichia coli* and *Staphylococcus aureus* (Smith-Palmer *et al*., 1998). Clove was able to prevent discoloration of raw pork during storage at room temperature and was the strongest antioxidant in retarding lipid oxidation among spice and herb extracts including cinnamon, oregano, pomegranate peel and grape seed (Shan *et al*., 2009).

Garlic

Allicin is known as the main ingredient of garlic that has antimicrobial activity against both gram-positive and gram-negative bacteria. In refrigerated poultry meat, aqueous garlic extract inhibited the growth of microbial contaminants including facultative aerobic, mesophilic, and faecal coliforms on the surface of poultry carcasses (Oliveira *et al*., 2005).

Sage

Sage is the dried leaf of a mint family and is commonly used in pork and pizza sausages. The major antioxidant compounds in sage include carnosol, carnosic acid, rosmadial, rosmanol, epirosmanol and methyl carnosate (Cuvelier *et al*., 1994).

Oregano

Pork and beef added with 3% oregano essential oil showed lower levels of oxidation after 12 days of refrigerated storage (Fasseas *et al*., 2008). Oregano oil could extend the shelf-life of fresh chicken breast meat by reducing the growth of microorganisms during refrigerated storage. However, 1% oregano oil could introduce very strong unfavorable flavor to food products resulting in low sensory quality. Oregano essential oil (0.05%, 0.5% and 1%) could delay the growth of microorganisms and decrease the final counts of spoilage microorganisms under modified atmosphere conditions (Skandamis and Nychas, 2001).

Addition of vegetal oils to meat products

Olive oil is the most monounsaturated vegetable oil. It has a high biological value, and its consumption is related to a decreased risk of heart disease and breast cancer (Pappa *et al*., 2000). Vegetable oils have also been used as partial substitutes of pork backfat in low-fat frankfurters and other types of cooked product giving rise to products with more adequate fatty acid profiles and cholesterol levels than traditional ones (Muguerza *et al*., 2001).

Functional Foods from Animal Sources

Fish

Omega-3 (n-3) fatty acids are an essential class of polyunsaturated fatty acids (PUFAs) derived primarily from fish oil. The cardioprotective effect of fish consumption has been observed in some prospective investigations (Krumhout *et al*., 1985), but not in others (Ascherio *et al*., 1995).

Dairy Products
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There is no doubt that dairy products are functional foods. They are one of the best sources of calcium, an essential nutrient which can prevent osteoporosis and possibly colon cancer. In view of the former, the National Academy of Sciences recently increased recommendations for this nutrient for most age groups.

Whey proteins

Whey proteins showed excellent nutritional and functional properties in low-fat meat products (Perez-Gago and Krochta, 2001). When liquid whey was used in frankfurter-type sausages, it could replace 100% of ice in frankfurter formula (Yetim et al., 2001). Whey proteins improved emulsion stability, provided better color properties, and resulted in lower chewiness and elasticity, but caused higher brittleness and hardness in frankfurter-type sausages (Yetim *et al*., 2001).

Probiotics

In addition to calcium, however, recent research has focused specifically on other components in dairy products, particularly fermented dairy products known as probiotics. Probiotics are defined as "live microbial feed supplements which beneficially affect the host animal by improving its intestinal microbial balance" (Fuller, 1994). Although a variety of health benefits have been attributed to probiotics, their anticarcinogenic, hypocholesterolemic and antagonistic actions against enteric pathogens and other intestinal organisms have received the most attention.

Probiotic bacteria and probiotic products have been reported to have various functions including modulation of intestinal flora; prevention of diarrhea; improvement of constipation; prevention and treatment of food allergies; reduction of cancer risk; lowering plasma cholesterol level; and lowering faecal enzyme activities (Agrawal, 2005; Arihara, 2006).

Production of functional components during processing

Curing

The curing of meat generally involves the use of a mixture of sodium chloride, sugar, nitrate and/or nitrite and often a reductant such as sodium ascorbate or sodium erythorbate. During processing, many biochemical changes such as proteolysis, lipolysis and oxidation can occur in meat products especially in dry-cured meat products, and the degradation of ribonucleotides which play a key role in the typical aromatic volatile compounds development.

Fermentation

The basic starter cultures used in meat industry are selected strains of homofermentative Lactobacilli (Lactic acid bacteria, LAB) and/or Pediococci, and Gram-positive catalase–positive cocci (GCC), non-pathogenic, coagulase-negative staphylococci and/or kocuriae.

Fermentation of meat causes number of physical, biochemical and microbial changes, which eventually result in functional characteristics of the products. Those changes include acidification (carbohydrate catabolism), solubilization and geleation of myofibrilla and srcoplasmic proteins, degradation of proteins and lipids, reduction of nitrate into nitrite, formation of nitrosomyoglobin and dehydration. Lipid oxidation products, free fatty acids, and volatile compounds produced from the process of fermentation are responsible for the aroma of a meat product. Although, lactic acid is the major flavor compound in the fermented meat products, acetic acid also play an important role in fully dried meat products (Mateo & Zumalacárregui, 1996).

Degradation of proteins during the fermentation process is one of the key factors involved in the improvement of functional value of meat products.

Lipolysis produces free fatty acids and has a significant effect on the development of characteristic flavor in fermented meat products (Galgano *et al*., 2003) because the free fatty acids resulted from lipolysis are easily oxidized and produce alcohols, aldehydes, ketones, esters and lactones.

Production of antibacterial compounds

Bacteriocins are the peptides produced by lactic acid bacteria with antibacterial properties. These peptides can reduce or inhibit the growth of other Gram-positive bacteria (Diep and Nes, 2002), and thus they can be used to control the growth of food borne pathogens such as L. monocytogenes in food products (Ennahar *et al*., 1999). Production of bacteriocins during fermentation of meat plays an important role in enhancing the functional value of meat products, but production of other antimicrobial compounds by specific starter cultures can also be used in fermented sausages.

Enzyme hydrolysis of proteins

The bioactive peptides embedded in proteins are usually inactive within the native proteins and supposed to be released during proteolytic enzyme digestion or food processing. There are many kinds of bioactive peptides with antihypertensive (Arihara *et al*., 2004), antioxidant (Elias *et al*., 2008), anticancer (Song *et al.*, 2000), antimicrobial (Minervini *et al*., 2003), opioid (Leppala, 2001), mineral binding (Jiang and Mine, 2000), immunomodulatory (Nelson *et al.*, 2007), cholesterol-lowering (Jeong et al., 2007) and anti-diabetic activities (Jianyun *et al*., 2008). There is a growing interest in potential uses of bioactive molecules in food and health care sectors (McCann *et al*., 2005).

Reducing some ingredients

Sodium chloride control

Due to the role of sodium in the development of hypertension in sodium-sensitive individuals, public health and regulatory authorities have recommended a reduced dietary intake of sodiumchoride. However, intake still exceeds the nutritional recommendations in many countries (Ruusunen, 2003a). The main source of sodium chloride in meat products is salt (NaCl), and its reduction in meat products is an important goal for decreasing overall dietary sodium. Because salt contributes to water and fat binding in meat products, its reduction has an adverse effect on these parameters increasing cooking loss and weakening the texture (Ruusunen, 2003a, 2003b).

Although meat as such is relatively poor in sodium, containing only 50 to 90 mg of sodium per 100 g, the sodium content of meat derivatives is much higher because of the salt content, which may reach 2% in heat-treated products and as much as 6% in uncooked cured products, in which drying (loss of moisture) increases the proportion even further. Estimates taking eating habits into account suggest that approximately 20% to 30% of common salt intake comes from meat and meat derivatives (Jiménez-Colmenero *et al*., 2001).

Reduction of the fat content in meat

Meat is in a major source of fat in the diet, especially of saturated fatty acids (SFA), which have been implicated in diseases associated with modern life, especially in developed countries. The ratio of n- 6: n-3 polyunsaturated fatty acids (PUFA) is also a risk factor in cancers and coronary heart disease, especially the formation of blood clots leading to a heart attack. The selection of breeds and genetic lines within breeds, changes in animal feeding practices, including some feed additives (probiotics, antibiotics, and so forth), and intervention in animal metabolism (anabolic implants, -agonist, growth hormone, etc.) are the main tools used to achieve a reduction in carcass fat content (Chizzolini *et al.*, 1999).

Substitution of nitrite in meat products

Nitrites play an important role in preservation, flavour development and possibly for texture. The main contribution of nitrite to the preservation of meat products is its ability to inhibit *C. botulinum*. It is this characteristic combined with the aesthetic qualities of colour, texture and flavour that contribute to the widespread use of nitrite in meat products. The concern about human foods containing nitroso compound has greatly increased as it has been found that domestic animals fed fish meal preserved with high levels of sodium nitrite were dying of liver failure. N-nitrosodimethylamine, which is one of the several possible types of N-nitrosamine that has been found to be the cause of liver failure. Thus, there have been efforts to find out substitutes for nitrite. The major modification would be to develop a replacement or substitute for nitrite. Combinations of various additives in an attempt to provide the several functions of nitrite have been attempted. Among nitrite substitutes, ascorbate or erythorbate, alpha tocopherol, sorbate, propylene glycol, *Lactobacillus fermentum* strain etc. have been tried.

Current status of functional meat products in world

The largest market for functional foods is USA followed by Europe and Japan. The markets of these three regions constitute 90% of total global sales of functional foods (Benkouider, 2005). The estimations of global markets for functional foods are in the range of 33 billion to 61 billion dollars (Benkouider, 2004).

Present status of functional meat products in India

Although, there were multiple laws and regulations covering the foods in India, but there was no single law that could have significantly regulate the functional foods. In 2006, the Indian government passed Food Safety and Standard Act to integrate and streamline the many regulations covering nutraceuticals, foods and dietary supplements. The Food Safety and Standard Act (FSSA) 2006 addresses nutraceuticals, functional food, dietary supplements and need to regulate these products such that anyone can manufacture, sell or distributes or import these products. These products include novel foods, genetically modified article of food, irradiated food, organic food, and food for special dietary uses, functional food, nutraceuticals and health supplements. FSSA does not differentiate functional food, nutraceutical, dietary supplements and instead classified all these products as food for special dietary application. This allows for functional food and food supplements with therapeutic claims to be alongside food and without declaration of nutraceutical content, clinical trial results, and health studies. Although, Food Safety and Standard Act 2006 define functional food/nutraceuticals legally, still there are further effective regulations; guideline and suitable protocols are required to gain momentum for effective implementation across the nation. Still there is need to clarify and formulate the regulatory framework.

Safety Issues

Although increasing the availability of healthful foods, including functional foods is critical to ensuring a healthier population safety is a critical issue in India and world. The optimal levels of the majority of the biologically active components currently under investigation have yet to be determined. In addition, a number of animal studies show that some of the same phytochemicals (e.g., allyl isothiocyanate) having cancer-preventing properties have been shown to be carcinogenic at high concentrations (Ames *et al*., 1990).

The benefits and risks to individuals and populations as a whole must be weighed carefully when considering the widespread use of physiologically-active functional foods. Soy phytoestrogens may represent a "double-edged sword" because of reports that genistein may actually promote certain types of tumors in animals (Rao *et al*., 1997). Knowledge of toxicity of functional food components is crucial to decrease the risk: benefit ratio.

Future prospects

As the economy develops, meat and meat products is not only utilized to provide necessary nutrients but also expected to have additional functions to prevent diseases and improve mental and well-being of consumers (Roberfroid, 2000; Siró *et al*., 2008). These demands provide great opportunities for meat industry. The strategies to fortify foods with functional compounds to increase micronutrients and limit or eliminate undesirable constituents can be done by dietary supplementation at animal production level, treatments and handling of meat raw materials, and reformulation of meat products.

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