Dietary Fibers as Functional Ingredients in Meat Products

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Received Date: 22.06.2016 Accepted Date: 22.07.2016

Abstract: Dietary fiber (DF) is defined as lignin and the polysaccharide components of plants which are indigestible by enzymes in human gastrointestinal tract. Increased intake of DF has been strongly recommended because of their effects in decreasing the risk of diabetes, colon cancer, obesity and cardiovascular illnesses in human. Functional foods can be defined as foods that are used to prevent and treat certain disorders and illnesses, in addition to their nutritional value by itself. Dietary fiber is one of the components (amino acids, peptides and proteins, vitamins and minerals, antioxidants, oligosaccharides, sugars/alcohols, glucosides, etc.) that have been identified as having potentially useful functional effects for human health. Processed foods and/or fast foods have become cornerstone of normal diets in modern society. Plenty of these processed foods comprising the meat products deficit minimum amounts of DF. DF incorporation in constantly consumed foods (meat, dairy and baked products) could help to accomplish the fiber shortage. DF can also be added into meat products, to reduce the caloric value by fat replacement and to improve the stability and texture of meat products. Various types of dietary fibers (wheat bran, oat bran, rye bran, rice bran, peach dietary fiber, carrot dietary fiber, lemon albedo, sugar beet fiber, brewer's spent grain, etc.) have been examined with other ingredients for the formulation of reduced-fat and/or DF-rich meat products. In the present review, different DF sources and their applications in meat products and effects on quality characteristics have been examined.

Keywords: *Dietary fiber, Functional food, Meat products*

Et Ürünlerinde Fonksiyonel Gıda Bileşeni Olarak Besinsel Lifler

Özet: Besinsel lifler (BL), insanların barsak sistemlerinde enzimler tarafından sindirilemeyen, bitkilerin polisakkarit bileşenleri ve lignin olarak tanımlanır. Yüksek miktarlarda BL alımı, insanlarda kolon kanseri, diyabet, obezite ve kardiyovasküler hastalık riskini düşürücü etkisinden dolayı tavsiye edilmektedir. Fonksiyonel gıdalar, besin değerlerinin yanında, bazı hastalık ve rahatsızlıkların önlenmesi ve iyileştirilmesinde kullanılan gıdalar olarak tanımlanmaktadır. BL'ler insan sağlığına faydalı fonksiyonel etkiler gösteren bileşenlerden (oligosakkaritler, şekerler/alkoller, aminoasitler, peptidler ve proteinler, glukosidler, izoprenler ve vitaminler, mineraller, antioksidanlar vb.) birisidir. İşlenmiş gıdalar ve fast-food, modern toplumun tipik diyetinin esasını oluşturmaktadır. Et ürünleri de dâhil olmak üzere, bu işlenmiş gıdaların çoğu asgari BL içeriğinden yoksundur. Sıklıkla tüketilen gıdalara (et, süt ve fırın ürünleri) BL ilavesinin bu açığın üstesinden gelmeye yardımcı olabileceği düşünülmektedir. Ayrıca BL'ler et ürünlerine, yağla yer değiştirerek kalorisini düşürmek, et ürününün tekstür ve stabilitesini geliştirmek amacıyla da ilave edilmektedir. Değişik BL'ler (buğday kepeği, yulaf kepeği, çavdar kepeği, şeftali besinsel lifi, havuç besinsel lifi, limon albedosu, şeker pancarı lifi, biracılık artığı küspe vb.) tek başlarına veya diğer bileşenlerle beraber düşük yağlı ve/veya BL' ce zengin et ürünlerinde kullanılmışlardır. Bu derlemede, değişik BL kaynakları ve bunların et ürünlerindeki uygulamaları ile kalite özellikleri üzerine etkileri gözden geçirilmiştir.

Anahtar Kelimeler: *Besinsel lifler, Fonksiyonel gıdalar, Et ürünleri*

Introduction

Dietary fiber (DF) can be described as the residual of eatable fragment of plants and alike carbohydrates that are indestructible to assimilation and/or absorption in the small intestine of human (Prosky, 1999). Various works have showed the useful influences of DF consumption against many diseases (McKee and Latner, 2000; WHO/FAO, 2003). These can be summarized as prevention against coronary heart disease and cancer, normalization of blood lipids, regulation of glucose absorption and insulin secretion and prevention of constipation and diverticular disease. DF can also give some functional properties to foods, e.g., increase emulsification or gel formation, oil holding capacity, water holding capacity. Indeed, dietary fiber added into foods can stabilize high fat food and emulsions, modify textural properties, improve shelf-life and avoid synaeresis. Roberfroid (2000) defined the functional foods. According to the definition, functional food must include an ingredient with an influence on diverse functions of the organism whose favorable effects can be confirmed as functional. On the other hand, many scientific results present the interrelation in between the consumption of functional foods and their functional effects (Jiménez-Colmenero et al., 2001). Epidemiological studies have showed the relationships between diets that lack in DF and increment in the count of chronical illnesses (WHO/FAO, 2003). Obesity, colon cancer and cardiovascular heart diseases are the examples for such diseases.

Meat products are certainly main source of food proteins with high biological value in various countries. Meat is also a perfect source of some soluble vitamins and minerals, essential fats, and all these components have specific function to our body (Biswas et al., 2011). However, most of the meat products are lack in complex carbohydrates like DF. Nowadays, supplementation of DF in meat products have acquiring higher prestige. Sufficiency of the dietary fiber supplementation in foods is rising due to the plenty of effectual properties (Akoh, 1998; Jiménez-Colmenero, 1996). These can be given as water retention, ability to decrease cooking loss, lubrication, neutral flavor and texture modification. So, DF can be used as the constituent to produce meat products that contain low amount of fat and high amount of dietary fibers.

Dietary Fibers as Functional Ingredients: Dietary fiber is not a new area and the definition of DF arises from Hipsley (1953). It has also different range of definitions. One broadly accepted definition from the American Association of Cereal Chemists states: "Dietary fiber is the remnants of the edible parts of plats or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine. Dietary fibers promote beneficial physiological effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation" (AACC, 2001). So, dietary fiber as a category of ingredients comprises mainly of oligo and polysaccharides (e.g., cellulose, pectic materials, hemicelluloses, inulin), lignin and some other components such as waxes, polyphenols, saponins, phytates, resistant protein, cutin (Elleuch et al., 2011). Resistant starch (RS) can be classified into five different types (RS1-5). RS is consisted of different fractions: physically inaccessible, retrograded, chemically modified fragments, starch complexes with other related components, etc. Dietary fiber is generally divided into two main parts. These are namely, soluble and insoluble fibers (Anderson et al., 1994). Fruits, vegetables, oats and beans have high amounts of soluble fibers. On the other hand, whole grains are good examples for the source of insoluble DF (Wisker et al., 1985). On the contrary, insoluble fibers like cellulose and lignins have negligible influence on the viscosity of intestinal substances, also speed up the transit time in small bowel and show remarkable laxative impact than soluble fiber. Fundamentally, the soluble fibers such as pectins, gums cause gluey dilutions that retard gastric emptying and/or absorption from the small intestine and tend to decrease blood cholesterol level (Verma and Banerjee, 2010). Since the mid-1970s, interest in the importance of DF in health has conducted many of the investigations (Abdul-Hamid and Luan, 2000; Puupponen-Pimìa et al., 2002). In accordance to the results, it received significant public attention. Considering the American Dietetic Association, the valid recommended DF intakes for adult persons range from 25 to 30g/day and the insoluble to soluble fiber ratio should be 3:1. Dietary fiber is an essential component broadly consumed nowadays while manufacturing alimentary foods because of its importance in public health benefits (Puupponen-Pimìa et al., 2002).

Functional foods can be described as in addition to behaving as nutrients might positively influence certain biological functions, evolving our health and also declining the hazard of certain illnesses (Diplock et al., 1999). Colon cancer, cardiovascular diseases, constipation, diverticulosis, irritable colon and diabetes are the main examples of the illnesses that can be protected by consuming sufficient amount of DF (Rodrîges et al., 2006). There are 3 fundamentals for a food to be called as a functional (Goldberg, 1994): (1) It must be a food (no tablets, capsules or powder etc) obtained from naturally should regulate specific reactions such as preventing and treating specific illnesses, enhancing biological defense mechanisms, controlling certain psychological and physiological situations (Jiménez-Colmenero et al., 2001). Twelve groups of compounds have been determined as possesing useful influences on some aspects of the wellness (Goldberg, 1994): DF, sugars, oligo-saccharides, proteins, peptides and amino acids, alcohols, isoprenes and vitamins, glucosides, lacticacid bacteria, choline, UFA, minerals and antioxidants (Jiménez-Colmenero et al., 2001). In these respects, DF can be considered as a functional ingredient in many of the foods including meat products.

Dietary Fiber Applications to Meat Products: Nowadays, modern consumers have progressively go importance to their wellness, and suppose the foods to be beyond tasty, attractive, and also safe and healthy. Products of meat are known as valuable sources for essential amino acids, fats, certain vitamin and minerals and some minor sustenance (Biesalski, 2005). Recently, healthier meat products have been gaining the consumer demands (Zhang et al., 2010). Low amount of cholesterol and fat, well balanced composition of fatty acids, lower levels of both sodium chloride and nitrite in meat products have spreading all through the world. Most products have generally higher amount of protein and fat however, deficit in DF (Sanchez- Zapata et al., 2010) and the supplementation of DF into the meat products in accordance with health issue have been underlined

many times. Relevance of dietary fiber addition in meat products is rising due to its functional properties like emulsion stability, water retention, texture modification, lubrication and neutral flavor (Mehta et al., 2015). Numerous dietary fiber sources such as wheat bran, oat bran, sugar beet, rice bran, soy, brewer's spent grain, pea, etc. have been added in the recipes of certain meat products like patties, meatballs, and sausages for improvement of nutritious daily regime. DF is a possible choice as fat substitutes in manufacturing of varying meat products. A wide list of various DF resources used in the recipe of different meat products are given in Table 1.

Table1. Various DF sources used for the formulation of DF-rich meat products.

Type of DF	Type of meat product	References
Wheat bran	Meatballs	Yılmaz (2005)
	Beefburgers	Mansour and Khalil (1997)
	Chicken patties	Talukdar and Sharma (2010)
	Beef patties	Saricoban et al. (2009)
Oat bran	Meatballs	Yılmaz and Daglıoğlu (2003)
	Frankfurters	Chang and Carpenter (1997)
Rye bran	Meatballs	Yılmaz (2004)
Rice bran	Pork meatball	Huang et al. (2005)
Peach dietary fiber	Frankfurters	Grigelmo-Miguel et al. (1999)
Carrot dietary fiber	Sobrassada	Eim et al. (2008, 2013)
	Pork sausages	Grossi et al. (2011)
Lemon albedo	Sausages	Fernandez-Gines et al. (2004); Aleson-Carbonell et al. (2004)
Sugar beet fiber	Frankfurters	Ozboy-Ozbas et al. (2003); Vural et al. (2004a)
	Turkish type salami	Vural et al. (2004b); Javidipour et al. (2005)
Brewer's spent grain	Frankfurters	Özvural et al. (2009)
	Chicken sausages	Choi et al. (2014)

Wheat bran is a good source of insoluble DF. The supplementation of wheat bran into the meatballs at the addition levels of 5, 10, 15 and 20% were investigated by Yılmaz (2005). Results indicated that total trans fatty acids decreased and, on the other hand, the ratio of total unsaturated fatty acids to total saturated fatty acids was found in increment for the meatballs supplemented with wheat bran than in control meatballs. The wheat bran incorporated meatballs were found lighter and yellower than the control samples. While increasing the wheat bran level from 5% to 20%, moisture and fat contents of the meatballs decreased and ash and protein contents increased but, Saricoban et al. (2009) investigated that supplementation of wheat bran declined protein and inclined fat content of cooked beef patties. Undigested dietary fibers from wheat bran can be introduced to replace some of the fat in beefburgers, decreased the levels of cholesterol and improving their cooking yield, texture and diameter (Mansour and Khalil, 1997). Talukdar and Sharma (2010) added both oat bran and wheat bran into the chicken meat patties at the levels of 5-15%. Oat bran seems to be a proper fat substitute in ground beef and pork sausage products (Keeton, 1994). Because of oat bran's ability to gain water and compete particle definition in ground meat in terms of texture and color. It has been utilized as a fat substitute in meatballs. Results showed that oat bran containing meatballs had lower degree of total fat, and trans fatty acids than control (Yılmaz and Daglıoğlu, 2003). Meatballs including the 20% of oat bran gave the highest ash and protein contents, and yellowness and lightness. The lowest moisture content as well as redness value was also obtained. No significant difference was obtained for sensorial properties of the meatballs. Chang and Carpenter (1997) utilized oat bran to reduce the fat content in frankfurters. As the oat bran content increased, the higher amount of water was gained from frankfurters. It is also reported that the contents of moisture and carbohydrate increased as the addition level of oat bran and water increased.

In another research, Yılmaz (2004) investigated the addition of rye bran at the addition levels of 5 to 20% as a fat replacer in the meatball recipes. Fatty acid composition, some physico-chemical and also sensory properties of rye bran including meatballs were determined. Incorporation of rye bran to the meatballs increased their nutritive properties. Rye bran including samples was found yellower and lighter than control. In another research study, Huang et al. (2005) investigated the addition of rice bran in Kung-wan, an emulsified pork meatball. They reported that as the addition level of rice bran increased, fat and protein contents and white index values of meatballs decreased. Meatball samples including rice bran less than 10% gaved insignificant difference

according to the sensory attributes such as texture, taste and overall acceptability values from the ones including no rice bran. Peach fiber incorporation as a fat replacer might be a good way to produce DF rich and fat content lower products (Gregg et al., 1993; Verma and Banerjee, 2010). DF of peach showed the higher water holding capacity, and also in low fat ones have retained higher added water. No changes obtained in the textural attributes in lower addition levels of peach fiber. Grigelmo-Miguel et al. (1999) utilized two different peach DF samples to get low level of fat and high level of DF in frankfurters, by adding 17 and 29%, individually. Supplementation of 3% of carrot DF resulted in a dry fermented sausage (*sobrassada*) akin to those prepared with lipolytic process and fermentation, with compression values and also hardness a quietly similar to those of the standard ones (Eim et al., 2008). The usage of carrot DF to *sobrassada* improved the sensory attributes of the samples according to the addition level. In order to develope healthier sausages, the synergistic affect of high pressure and different contents of carrot DF were investigated in pork sausages (Grossi et al., 2011). Some physical characteristics of pork sausages such as working pressure, temperature, and also holding time were studied. The sensory analyses resulted that high pressure treatment well cooperate with carrot DF improving many of the sensorial properties synergistically.

Addition of lemon albedo in non-fermented dry cured sausages was studied (Aleson-Carbonell et al. 2004). Because of its acidic nature, pH of the non-fermented dry cured sausages decreased. Supplementation of lemon albedo in Bologna sausages resulted in changes in hardness and juiciness values (Fernandez-Gines et al., 2004). Decrease in juiciness was lower in bolognas with supplemented cooked albedo than raw albedo. Sugar beet fiber has been introduced in food manufacturing as a dietary fiber source. It has been produced from sugar beet pulp collected from the saccarose extraction process (Michel et al., 1988). At this stage, the sugar beet pulp has been dewatered by pressing. Ozboy-Ozbas et al. (2003) recommended the usage of sugar beet fiber as a fat replacer. However, the sensory analysis of sugar beet fiber supplemented frankfurters gave slightly lower values than control samples. Introduction of sugar beet fiber significantly up the level of total DF and water holding capacity values of frankfurter (Vural et al., 2004a). Similar results were also obtained for the Turkish- type salami samples (Javidipour et al., 2005; Vural et al., 2004b).

One of the main by-products of the brewing is brewer's spent grain. Ozvural et al. (2009) studied the effects of dried and ground brewer's spent grain on DF content and some quality attributes of beef frankfurters. It has been reported that brewer's spent grain can be possibly supplemented to frankfurters to increase their DF content without deleteriously affecting their sensory properties. Effects of replacing pork back fat with brewer's spent grain pre-emulsion for the production of lower fat chicken sausages were investigated by Choi et al. (2014) in terms of physicochemical, textural and sensorial properties. Their results show that brewer's spent grain is effective DF source especially for producing of the low fat meat products. They recommended that 20-25% of brewer's spent grain pre-emulsion was quite appropriate for pork back fat in chicken sausages.

Conclusions

Meat and meat products have been usually underlined as good sources of nutrients such as proteins, fat-soluble vitamins, minerals and some bioactive compounds. Dietary fiber is one of the valued ingredients that could be added in meat products. DF obtained from different plant sources such as fruits and vegetables and some cereal fibers have been used in the food processing. However, the fruit and vegetable originated DF resulted in having better oil binding capacity that is of great significance in emulsioned meat products (Rodriguez et al., 2006). Ionic strength, pH, particle size and chemical structure have been found affecting the possibility about the addition of different DF as ingredients in certain meat products (Mehta et al., 2015). Selection of proper DF rich sources and correct supplementation levels can improve the health images of many of the meat products.

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