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The Application of Dietary Fibre in Food Industry: Structural Features, Effects on Health and Definition, Obtaining and Analysis of Dietary Fibre: A Review

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Abstract It is important for food materials to be delicious as well as nutritious and natural. Rapidly increasing of human population of world, environmental pollution caused by consistently developing technology, insufficient education and problems caused by wrong nutrition are making supplying of natural food is more difficult. Healthy nutrition refers to efficient and balanced nutrition, that is, efficient intake of nutrient elements (lipids, carbohydrates, proteins, vitamins, minerals) for body cells to work smoothly. But, oil content present in the structure of some food materials is a problematic situation for consumers. In order to solve this problem, dietary fibre can be used, which can improve the textural and sensual qualities of products in addition to being functional. An excessive interest has been observed over the last years in fibrous nutrients in developed countries (e.g. USA and various parts of Europe). In the present review, it has been conducted on the food products in which dietary fibres are used, changes taking place in the structures of these nutrients, the importance of the use of dietary fibres.

Keywords: *dietary fibres, laxative, analtical methods, health*

1. Introduction

A nutraceutical food may provide expanded utility beyond its nutritional benefit. These benefits can be both physcial and mental and are commonly attributed to the active components of the food. Today’s functional foods and dietary supplements are typically marketed to large groups of the total population. Scientific evidence confirming the relationship between food and health has promoted the rapid development of a new food market in recent years: the functional food market (Siró, Kápolna, Kápolna and Lugasi, 2008; Viuda-Martos et al., 2010).

Dietary fibre (DF) was originally defined in 1972 by Trowell as ‘that portion of food which is derived from cellular walls of plants which are digested very poorly by human beings’ (De Vries, 2010; EFSA, 2010; Westenbrink et al., 2012). DF has been known and investigated for a very long time (Asp, 2004), from being considered as waste to being described as a ‘universal remedy’ that improves any physiological problem within human organism (Rodríguez et al., 2006).

Dietary fibre cannot be digested by the human digestive enzymes to absorbable components in the upper alimentary tract (Trowell et al., 1976; Ajila and Prasada Rao; 2013). Over the past two-hundred years diet has become increasingly processed, leading to greatly reduced fibre content (Burkitt & Trowell, 1975; Cleave, Campbell, & Painter, 1969; Kendall et al., 2010).

Dietary supplements are typically marketed in the form of a capsule, pill, powder or gel and are not presented for use as a conventional food, meal or diet. Dietary supplements contain one or more dietary ingredients (e.g., vitamins, minerals, amino acids, herbs or other botanicals) and are intended to supplement the diet (U.S. Food and Drug Administration, 1994; van Kreijl et al., 2006; Eussen et al., 2011).

2. Structural Features of Dietary Fibres

Dietary fibre as a class of compounds includes a mixture of plant carbohydrate polymers (Thebaudin, Harrington, & Bourgeois, 1997; Rodríguez et al., 2006; Mongeau, 2003; García Herrera et al., 2010), both oligosaccharides and polysaccharides, e.g., cellulose, hemicelluloses, pectic substances, gums, resistant starch, inulin, that may be associated with lignin and other non-carbohydrate components (e.g., polyphenols, waxes, saponins, cutin, phytates, and resistant protein). Dietary fibre is composed of nondigestible carbohydrate, lignin and other associated substances of plant origin, fibres of animal sources and modified or synthetic nondigestible carbohydrate polymers. Cereals are the principal source of cellulose, lignin and hemicelluloses, whereas fruits and vegetables are the primary sources of pectin, gums and mucilage (Normand, Ory, & Mod, 1987; Elleuch et al., 2011). Each polysaccharide is characterised by its sugar residues and by the nature of the bond between them (Table 1) (Elleuch et al., 2011). Resistant starch and resistant protein withstand digestion in the small intestine. Resistant starch is composed of four groups (RS1: physical inaccessible starch, RS2: ungelatinised starch granules, RS3: retrograded starch and RS4: chemically modified starch) (Fuentes- Zaragoza, Riquelme-Navarrete, Sánchez-Zapata, & Pérez-Álvarez, 2010).

Table 1. Chemical composition of dietary fibres

Fibres	Main chain	Branch units	References
Cellulose	β-(1,4) glucose		Olson et al. (1987)
β-glucans	β-(1,4) glucose and β-(1,3) glucose		Johansson et al. (2000)
Hemicelluloses			Olson et al. (1987)
Xylans	β–D-(1,4) xylose		
Arabinoxylans	β–D-(1,4) xylose	Arabinose	
Mannas	β–D-(1,4) mannose		
Glucomanns	β–D-(1,4) mannose and β-D-(1,4) glucose		
Galactoglumannans	β–D-(1,4) mannose and β-D-(1,4) glucose	Galactose	
Galactomannas	β–D-(1,4) mannose	α -D-galactose	
Xyloglucans	β-D-(1,4) glucose	α -D-xylose	
Pectin			
Homogalacturonan	α-(1,4)-D-galacturonic acid (some of the carboxyl groups are methyl esterified		Ridley, O'Neill and Mohnen (2001)
Rhamnogalacturonan-I	(1-4) galacturonic acid, (1,2) rhamnose and 1-,2-,4-rhamnose	Galactose, arabinose, xylose, rhamnose, galacturonic acid	Oechslin, Lutz, and Amado (2003)
Rhamnogalacturonan-II	α-(1,4) galacturonic acid	Unusual sugar such as; apiose, aceric acid, fucose	Vidal, Doco, Williams, and Albersheim (2000)
Arabinanes	α-(1,5)-L-arabinofuranose	α-arabinose	
Galactanes	β-(1,4)-D-galactopyranose		
Arabinogalactanes-I	β-(1,4)-D-galactopyranose	α-arabinose	
Arabinogalactanes-II	β-(1,3)- and β-(1,6)-D-galactopyranose	α-arabinose	
Xylogalacturonan	α-(1,4) galacturonic acid	Xylose	Le Goff, Renard, Bonnin, and Thibault (2001)
Inulin	β-(1,2)-D-fructosyl-fructose		Blecker et al. (2001)
Gum			
Carrageenan	Sulfato-galactose		
Alginate	β-(1,4)-D-mannuronic acid or α-(1,4)-L-guluronic acid		
e.g.1:seed gum from *Abutilon indicum*	β–(1,4)-D-mannose	D-(1,6) galactose	Sing, Mishra, Khare, Khare and Gupta (1997)
e.g.2:seed gum from *Lesquerella fendleri*	Rhamnose, arabinose, xylose, Mannose, galactose, glucose, galacturonic acid		Abbott, Wu, Carlson, Slodki, and Kleiman (1994)
Oligofructose (enzymatic hydrolysis of inulin)	β–(1,2)-D-fructosyl-fructose		
Polydextrose (synthetic)	D-Glucose		
Resistant maltodextrins (heat and enzymatic treatment of starch)	α-(1,4)-D-Glucose	α-(1,6)-D-Glucose	
Lignin	Polyphenols: Syringyl alcohol (s), Guaiacyl alcohol (G) and p-coumaryl alcohol (H)		Sun, Tomkinson, and Bolton (1999)
Chitosan	β–(1,4)-linked D-glucosamine and N-acetyl-D-glucosamine		Borderis et al. (2005)

The chemical nature of fibres is complex; dietary fibres are constituted of a mixture of chemical entities. The choice of analytic method to investigate fibres depends on the composition of each particular fibre (Elleuch et al., 2011).

Larrauri (1999) described the "perfect fibre" as having the following characteristics:

- It must not contain any components that are nutritionally offensive.
- To maximise its use, it must be of high concentrate in a small quantity.
- It should have no taste and no negative odour, colour or texture effects.
- It should contain a balance between soluble and insoluble fibre with an acceptable presence of bioactive compounds.
- Its addition must not affect the food it is being added to, but it must also have a long shelf life.
- It should work harmoniously with food processing.
- It should have a positive consumer image.
- It should contain the expected physiological effects.
- It should be in an adequate price (Kunzek, Müller, Vetter, & Godeck, 2002; Larrauri, 1999; O'Shea et al., 2012; Pomeranz 1991; Saura-Calixto and Larrauri 1996).

3. The Classified of Dietary Fibres Compunds

Dietary fibres are as soluble or insoluble, based on whether they form a solution when mixed with water (soluble), or not (insoluble) (Periago, Ros, López, Martinez, & Rincón, 1993; Ajila and Prasada Rao; 2013). Fiber includes: insoluble fiber (lignin, cellulose and hemicelluloses) and soluble fiber (pectins, β-glucans, galactomanan gums, and a large range of nondigestible oligosaccharides including inulin) (García Herrera et al., 2010; Rodríguez et al., 2006; Alvarez and Peña-Valdivia, 2009; Ramirez-Santiago et al., 2010; La Course, 2008;

Jalili ve ark., 2001; Dülger and Sahan, 2011). Each category has different physiological effects (Schneeman, 1987; Ajila and Prasada Rao; 2013). The insoluble part is related to both water absorption and intestinal regulation, whereas the soluble fraction is associated with the reduction of cholesterol in blood and the decrease of glucose absorption by the small intestine. Although soluble fibre is less common in foods than insoluble fibre, it is believed to have important effects in the digestive and absorptive processes (Dreher, 2001; Peressini and Sensidoni, 2009). It is well known that dietary fibre fractions behave in a different way. Soluble dietary fibre presents a potential prebiotic character (Gibson & Roberfroid, 1995; Fuller & Gibson, 1997). The varietes and sources of dieteray fibres is given in Table 2 (Jalili ve ark., 2001; Dülger and Sahan, 2011).

Table 2. Types and and sources of dietary fibres

Dietary fibres	**Features**	**Sources**
Soluble Fibers		
Pectin	It is been galacturonic acid, rhamnose, arabinose, the high content of galactose, intermediate laminate and on the primary wall	Whole grains, apple, legumes, cabbage, root vegetables
Gum	Generally are composed monomers of hexose and pentose	Oatmeal, haricot bean, legumes
Mucilages	Compounds which is synthesized in plants that it is contain of glycoprotein	Food additives
Insoluble fibres		
Cellulose	It is the main component of cell walls which consisting of glucose monomers	Whole grains, bran, peas, root vegetables, beans family of cruciferous, apple
Hemicelluloses	Primary and secondary the cell walls	Bran, whole grains
Lignin	It is been consist of aromatic alcohols and the components of other cell wall	Vegetables, flour
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4. Definition, Obtaining and Analysis of Dietary Ffibre

The reported method is that from Weende, developed in the Experimental Station of Weende, Gottinguer, Germany, which consists of a sequential extraction with diluted acid and alcali solutions, and was adopted by the 'Association of Official Analytical Chemists' (AOAC) for determining fibre until the 1960s. Later on it was proposed the isolation of fibre by digestion of the samples with trichloroacetic, acetic and nitric acids that did not solubilize cellulose but only lignin (Van Kamer, 1949; Rodríguez et al., 2006).

According to Hong et al., (2012) generally, there are three methods to gain dietary fiber: Chemical method, physical method and microbial fermentation. Removal of starch and protein can be more complete using chemical method, but the poor selectivity, side-effects and difficultly controlled extraction conditions greatly limit its use (Wang et al., 2004; Du et al., 2005). What are worse, hemicelluloses and soluble dietary fiber which plays an important role in physiological function is soluble in alcaline solution. Thus, this method can cause the undesired decrease of overall physiological activity (Zhang et al., 2011). Physical method, such as extrusion cooking, does not cause degradation of the polymer structure or some other deep damage. Therefore, the side chain group can be preserved almost intact, which enables the cation exchange capacity not to be impacted (Ma et al., 2005; Liu et al., 2005; Jacobs and Delcour, 1998). Recently, microbial fermentation of dietary fiber has been widely recognized and accepted due to the high selectivity, mild and easily controlled reaction conditions (Liu, 2008). It has also the advantages of not destroying the structure of natural fiber and no loss of important physiologically functional SDF and hemicelluloses. However, the microbial fermentation itself is still in its infancy stage and microbial fermentation of DF may produce toxic substances, thus affecting its safety (Li, 2003).

Several are very specific and precise for the identification and quantification of the different DF components. Many consist of the use of highly purified enzymes that selectively release oligo- and polysaccharides that constitute DF; of special interest are those enzymes that hydrolyze fructans, galactans, mannans, arabinans and β-glucans (Kamp, Asp, Miller, & Schaafsma, 2004; Rodríguez et al., 2006). Insoluble dietary fibre (IDF) residues obtained after enzymatic treatment and centrifugation were treated with 12 M sulphuric acid (30°C, 1h) and then hydrolysed with 1 M sulphuric acid (100°C, 1.5h). NS plus UA in the hydrolysates were determined following the same procedure as in SDF analysis (Mateos-Aparicio et al., 2010).

The method was based on the enzymatic removal of protein from the material and the separation into soluble and insoluble fractions by centrifugation (Figure 1) (Mańas, 1992; Grigelmo-Miguel et al., 1999a).

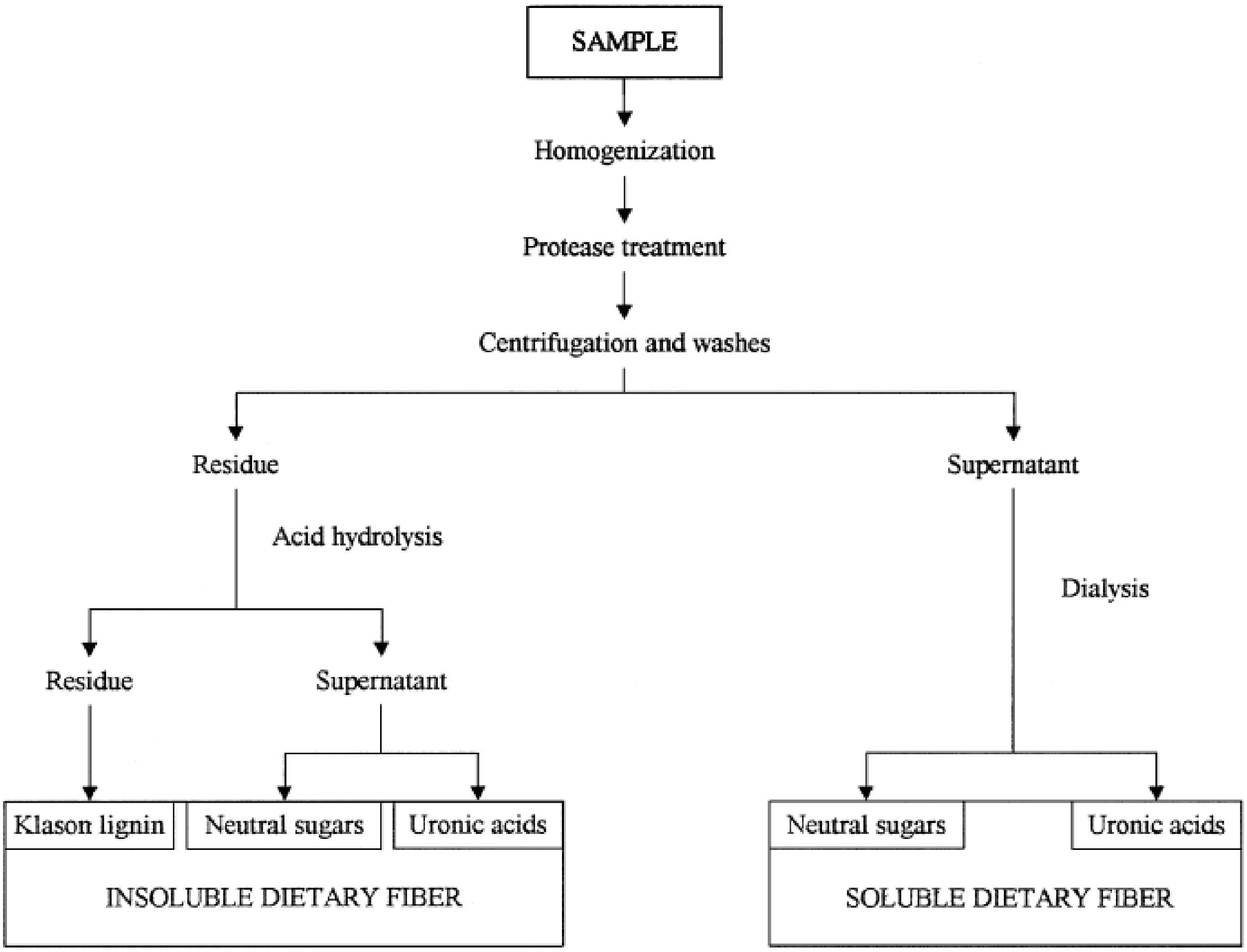

Figure 1. Flow diagram for dietary fibre analysis procedure

5. Dietary Fibres Effects on Health

In 400 BC Hippocrates already mentioned the beneficial effects of DF, more recently its utility has been questioned, so while Kellogg (1923) promoted its positive action, McCance and Lawrence (1929) considered DF to be a non-digestible portion of plant foods that irritated the intestine. Since the mid-1970s, interest in the role of dietary fibres in health and nutrition has prompted a wide range of research and received considerable public attention (Abdul-Hamid & Luan, 2000; Elleuch et al., 2011). Lately, Cleave (1956) related certain diseases with 'deficiency of fibre syndrome' and Walker (1947) proposed that DF determined in great extension the digestive tract function (Rodríguez et al., 2006).

In recent years, much research has focused on characterizing the physiological effects resulting from human consumption of a wide variety of dietary fiber sources. These effects include modulation of blood lipid profiles, decreased post-prandial blood glucose response, laxation (Hong et al., 2012) and a number of other effects (Bourquin et al., 1996). Over the years, dietary fibre has received much positive attention with regard to its potential as a pharmafood, due to its ability to reduce cholesterol (Andreasen, Landbo, Christensen, Hansen, & Meyer, 2001; Anderson et al., 2009; Cui, Nie, & Roberts, 2011; Estruch et al., 2009; Ajila and Prasada Rao; 2013; Thebaudin et al., 1997; Tungland & Meyer, 2002; Marlett et al., 2002), diabetes and coronary heart disease, prevention and treatment of obesity (Schweizer & W€ursch, 1986; Topping, 1991; Davidson & McDdonald, 1998; Schneeman, 1998; Terry et al., 2001;Wang, Rosell, & de Barber, 2002; Ferguson & Harris, 2003; Peters et al., 2003; Bingham et al., 2003; Nawirska and Monika Kwaśniewska, 2005; Mann & Cummings, 2009; Elleuch et al., 2011; Mendeloff, 1987; Tinker, Schneeman, Davis, Gallaher and Waggoner, 1991; Anderson, Smith and Guftason, 1994; Cassidy, Bingham and Cummings, 1994; Grigelmo-Miguel et al., 1999a; Viertanen and Aro, 1994; Ascherio and Willet, 1995; Kimm, 1995; Kim, 2000) and ease constipation (Telrandhe et al., 2012; O'Shea et al., 2012; Rodriguez et al., 2006; EFSA, 2010; Hauner et al., 2012). Nowadays, research show that the ingestion of suitable quantities of food fiber produces many beneficial effects on the digestive tract, such as the regulation of the intestinal function, improvement of the tolerance to glucose in diabetics (Oestmann, Rossi, Larsson, Brighenti and Björck, 2006; Pins et al., 2002; Ajila and Prasada Rao; 2013) or prevention of chronic diseases as colon cancer (Mongeau, 2003; Pérez Jiménez et al., 2008; García Herrera et al., 2010) and anti-carcinogenic effects (Scharlau et al., 2009; Ajila and Prasada Rao; 2013). Foods rich in fibre contain a broad spectrum of compounds that may prevent different types of cancer. Also, several fibres have demonstrated, in vitro, and in vivo, their capacity for adsorbing carcinogenic agents, so it is recommended to consume plant foods with lignified or suberized cell walls that are the most effective for linking hydrophobic carcinogenic agents (Steinmetz & Potter, 1991; Slavin, 2001; Rodríguez et al., 2006).

Fibre as a food ingredient can offer physiological functionalities for each technological property, as shown in Table 3 (Elleuch et al., 2011).

Table 3. Technological and physiological properties of dietary fibre products

Technological property	Physiological functionality
Water holding capacity	Laxative
Water swelling capacity	Reduction of blood cholesterol
Water retention capacity	Reduction of blood glucos
Water solubility	Reduction the risk of chronic disorder e.g. coronary heart disease, diabetes, obesity and some forms of cancer
Oil holding capacity	
Viscosity	
Texturizing	
Stabilizing	
Gel-forming capacity	
Antioxidant capacity	

Recommended adult intakes for total fibre in countries which have developed guidelines range from 21 to 40 g/day, and World Health Organization has recommended that total fibre intake be 25 g/day (WHO/FAO, 2003; Food and Nutrition Board, Institute of Medicine, 2001). However, estimates of actual total dietary fibre consumption range from 14 to 29 g/day, with only a few countries reporting fibre consumption at or above the WHO recommendation, and with most reported values below either national or WHO recommendations (Gray, 2006). Although numerous health organisations suggest increasing the consumption of DF, with spesific recommendations of 30±45 g per day (Bonfeld, 1985; Spiller, 1986; Eastwood, 1987; Schweizer & Würsch, 1991; Grigelmo-Miguel et al., 1999a), daily intake for total fibre for adults has been set at 38 g for men and 25 g for women (Trumbo, Schlicker, Yates, & Poos, 2002; Soukoulis et al., 2006; Duxbury, 2004; Schofield, 2004; Ramirez-Santiago et al., 2010), people in developed countries currently only eat about 11±12 g per day (Saura-Calixto, 1993; Grigelmo-Miguel et al., 1999a). Recommended intakes for fiber are also included for children and teenagers (Table 4). Over the years, dietary fibre has received much positive attention with regard to its potential as a pharmafood, due to its ability to reduce cholesterol, diabetes and coronary heart disease and ease constipation (Telrandhe et al., 2012; O'Shea et al., 2012). In addition, using of too much fiber can prevent as iron, zinc, calcium and magnesium the absorption of minerals by the body exactly. Using of high fiber in a short time may occur gas, bloating, and abdominal cramps. Therefore, gradually increasing used fiber in nutrition will protect us from these side effects. (Anonymous, 2013).

Table 4. Dietary reference intake values for total fiber by life stage

Life stage group	Adequate intake (g/day)	
	Male	Female
1-3 years	19	19
4-8 years	25	25
9-13 years	31	26
14-18 years	38	26
19-30 years	38	25
31-50 years	38	25
51-70 years	30	21
Over 70 years	30	21
Pregnancy		28
Lactation		29

6. Utilization of Dietary Fibres in Food Industry

To be acceptable, a dietary fibre added to a food product must perform in a satisfactory manner as a food ingredient (Jaime et al., 2002; Figuerola et al., 2005). From a functionality perspective, citrus fibre can play a number of roles: (i) it may be used as a tool for improving texture, (ii) as a bulking agent in reduced-sugar applications, (iii) to manage moisture in the replacement of fat, (iv) to add colour, and (v) as natural antioxidant (Viuda-Martos et al., 2010; Ramirez-Santiago et a., 2010). Dietary fibres can provide a multitude of functional properties when they are incorporated in food systems. Thus, fibres addition contributes to the modification and improvement of the texture, sensory characteristics and shelf-life of foods due to their waterbinding capacity, gel-forming ability, fat mimetic, antisticking, anticlumping, texturising and thickening effects (Dello Staffolo, Bertola, Martino, & Bevukaqcua, 2004; Gelroth & Ranhotra, 2001; Thebaudin et al., 1997).

The literature contains many reports about additions of dietary fibre to food products such as baked goods, beverages, confectionery, dairy, frozen dairy, meat, pasta and soups. Most commonly, dietary fibres are incorporated into bakery products to prolong freshness, thanks to their capacity to retain water, thereby reducing economic losses. Fibres can modify bread loaf volume, its springiness, the softness of the bread crumb and the firmness of the loaf (Sangnark & Noomhorm, 2004; Wang, Rosell, & Barber, 2002). In addition, introduction of dietary fibre in meat products has been shown to improve cooking yield, water binding, fat binding, and texture (Cofrades et al., 2000).

In the case of beverages and drinks, the addition of dietary fibre increases their viscosity and stability, soluble fiber being the most used because it is more dispersible in water than insoluble fiber. Some examples of these soluble fibers are those from fractions of grains and multi-fruits (Bollinger, 2001; Rodríguez et al., 2006), pectins (Bjerrum, 1996; Rodríguez et al., 2006), ß-glucans, cellulose beet-root fibre (Nelson, 2001), polidextrose (Mitchell, 2001; Rodríguez et al., 2006), etc.

Dietary fibre and soy protein preparations due to their functional properties are extensively used in many branches of the food industry, including the meat sector (Bilska, Krysztofiak, Sęķ & Uchman, 2002; Hoogenkamp, 2007; Jiménez-Colmenero, Ayo and Carballo, 2005; Makała & Olkiewicz, 2004; Pietrasik & Duda, 2000; Waszkowiak, Górecka, & Janitz, 2001; Waszkowiak and Szymandera-Buszka 2008).

Dietary fibres from different sources have been used to replace wheat flour in the preparation of bakery products. Pomeranz, Shogren, Finney, and Bechtel (1977) used cellulose, wheat bran and oat bran in bread making. Potato peel, a by-product from potato industry, rich in dietary fibre, was used as a source of dietary fibre in bread making (Toma, Orr, D'Appolonia, Dintzis, & Tabekhia, 1979; Sudha et al., 2007). Among foods enriched in fibre, the most known and consumed are breakfast cereal and bakery products such as integral breads and cookies (Cho & Prosky, 1999; Nelson, 2001; Rodríguez et al., 2006), as well as milk and meat derived products.

Enrichment of bakery products has traditionally consisted of the addition of unrefined cereals; however it is starting to use other DF sources, mainly fruits, which present beter nutritional quality, higher amounts of total and soluble fibre, less caloric content, stronger antioxidant capacity and greater grade of fermentability and water retention (Grigelmo-Miguel & Martı´n-Belloso, 1999b; Larrauri et al., 1996; Saura-Calixto, 1998; Rodríguez et al., 2006). The addition of DF to bakery products also improves their nutritional quality since it makes possible to decrease the fat content, by using DF as substitutive of fat without loss of quality (Byrne, 1997; Martin, 1999; Rodríguez et al., 2006). Isolated fibre components such as resistant starch and ß-glucans are also used for increasing fibre content in pastries, breakfast cereal, etc. (Knuckles, Hudson, Chiu, & Sayre, 1997; Rodríguez et al., 2006).

The use of fibres in dairy products is also widespread: e.g., inulin introduces numerous improvements into dairy products. It improves body and mouthfeel in cheese analogues or ice cream, and reduces synaeresis in yoghurt and other fermented milk products (Blecker et al., 2001).

For the elaboration of jams and marmalades, the most common added-fibres are those consisting of pectins with different degree of esterification, which mainly comes from fruits and are a factor in keeping the stability of the final product. (Grigelmo-Miguel & Martı´n-Belloso, 1999b; 2000; Rodríguez et al., 2006). In the case of low-calorie chocolates and derivatives, fibre compounds such as inuline and oligofructose are used as sugar substitutes (Gonze & Van der Schueren, 1997; Rodríguez et al., 2006).

Citrus fibre may be incorporated into a broad range of products. For example meat products (Alesón-Carbonell, Fernandez-Lopez, Perez-Alvarez, & Kuri, 2005; Fernández-López et al., 2007), fish (Sanchez-Zapata et al., 2008; Viuda-Martos et al., 2010) and dairy product (Sendra et al., 2008; Viuda-Martos et al., 2010). Although citrus fibre itself may be invisible in the food products, it is fast becoming one of the most appreciated ingredients in today's market place.

The contents of dietary fiber in some foods are given Table 5 (Jalili et al., 2001; Ekici and Ercoskun, 2007). Servings of commonly consumed grains, fruits, and vegetables contain only 1–3 g of dietary fiber (Marlett & Cheung, 1997). Legumes and high-fiber bread and cereal products supply more dietary fiber, but are not commonly consumed (Slavin, 2003).

Table 5. The contents of dietary fiber in some foods

Food	Fiber (%weight)	Food	Fiber (%weight)
Almonds	3	Nuts	2
Wheat	3	Walnut	2
Lima beans	2	Broccoli	1
oatmeals	2	Carrot	1
Peach	2	Strawberry	1
Whole wheat flour	2	Apple	1
Corn	2	White flour	<1

7. Studies Related to Dietary Fiber

Grigelmo-Miguel et al., (1999a), reported that insoluble and soluble dietary fibre (DF) fractions of peach DF concentrate, obtained by an enzymatic-chemical method, were analysed for neutral sugars, uronic acids and Klason lignin. Total DF constituted 31±36% dry matter (DM) of the concentrate and insoluble DF was its major fraction (20±24% DM). The high proportion of soluble fraction (11±12% DM) in the peach DF concentrate, in comparison with cereal brans, was noticeable. Results suggested that peach DF concentrate may be not only an excellent DF source but an ingredient in the food industry.

Viuda-Martos et al., (2010), reported that the effect of orange dietary fibre (ODF), oregano essential oil (OEO) and the storage conditions (vacuum, air and modified atmosphere) on the shelf-life of bologna sausage were analysed. ODF and OEO samples stored in vacuum packaging showed the lowest aerobic and lactic acid bacteria counts. The sensory evaluation scores were similar for samples with ODF and OEO, and stored either in air or vacuum packaging. Orange dietary fibre and oregano essential oil could find a use in the food industry to improve the shelf-life of meat products.

Soukoulis et al., (2009), reported that the effects of four dietary fibre sources (oat, wheat, apple and inulin) on the rheological and thermal properties of model sucrose polysaccharides solutions and ice cream mixes were investigated. The content of fibre in insoluble compounds increased significantly the viscosity and the shear thinning behaviour of the model solutions and ice creams, due to the increase of total solids and the formation of networks comprised of hydrated cellulose and hemicellulose. The increase of soluble material did not alter significantly the rheology of the samples but limited the freezing point depression and elevated the glass transition temperatures, indicating a potential cryoprotective action. The use of oat and wheat fibre favoured viscosity development due to water-binding, whereas inulin caused a remarkable increase of glass transition temperature (Tg) in model solutions and ice cream mixes, indicating the reduction of water molecule mobility from the bulk aqueous phase to the ice crystals' surface. Apple fibre addition greatly increased viscosity and elevated the Tg values, particularly in the presence of proteins. Results suggested that the potential use of dietary fibres as crystallisation and recrystallisation phenomena controllers in frozen dairy products.

Chantaro et al., (2008), reported that the feasibility study of using carrot peels, as a starting raw material to produce antioxidant dietary fiber powder was investigated. The effects of blanching and hot air drying (60-80 ^{o}C) on the drying kinetics and physicochemical properties of dietary fiber powder were first evaluated. The results showed that blanching had a significant effect on the fiber contents and compositions, water retention and swelling capacities of the fiber powder.

Waszkowiak et al., (2008), reported that use wheat dietary fibre and soy protein isolate as carriers of KI and KIO_3 for fortification of processed meat with iodine. Products from minced pork were prepared with addition of iodised wheat fibre and soy isolate, and iodised table salt for comparison and the effects of thermal processing and storage on changes in iodine content were determined. It was shown that both alternative carriers limited the iodine changes in meat products compared with iodised table salt. However, wheat fibre was more effective in limiting iodine losses during thermal processing and soy protein during storage of the products. The greatest effect of the carriers was found in meat products fortified with the less stable KI.

Fagan et al., (2006), reported that this study was to determine the effects of soluble dietary fibre inclusion on milk coagulation kinetics. Three fibre ingredients gum acacia, inulin or pectin were added to milk prior to addition of rennet. Milk coagulation was monitored using a controlled stress rheometer, NIR transmission sensor and a hot wire sensor. Gel times and coagulum firming rates were determined from the sensor response characteristics. Gel microstructure was examined using confocal scanning laser microscopy. Gum acacia (1-3% (w/w)) significantly decreased gel times and coagulum firming times and these gels had more open casein networks than the control gels. A 2% (w/w) addition of inulin was required to decrease gel time and coagulum firming time and no discernable difference was observed between the inulin enriched and control gels. Pectin (0.2-0.4% (w/w)) significantly reduced gel times. Above 0.2% (w/w), added pectin increased coagulum firming times and resulted in a limited casein network developing.

Ajila and Prasada Rao (2013) in this study, carbohydrate composition and bound phenolics in dietary fibre of mango peels were determined. Total dietary fibre content was in the range of 40.6-72.5%. Galactose, glucose and arabinose were the major neutral sugars in insoluble and soluble dietary fibres. Bound polyphenolic and flavonoid contents were in the range of 8.1-29.5 and 0.101-0.392 mg/g, respectively, and were found to be more in ripe peel than in raw peel. Gallic, protocatechuic and syringic acids were the bound phenolic acids, and kaempferol and quercetin were the major flavonoids of the peels. Ferulic acid was identified only in dietary fibre of Raspuri peels. Thus, the studies indicated the presence of significant amount of bound phenolics in dietary fibre, which adds additional health benefits of antioxidant properties of mango peel, which can be used in functional foods.

Elleuch et al., (2008), the date by-products of two date palm (Phoenix dactylifera L.) cultivars, Deglet-Nour and Allig, from the Degach region (Tunisia), were analysed for their main chemical composition. Studies were also conducted on the physicochemical properties (colour, water and oil-holding capacity and rheological behaviour) of dietary fibre (DF) extracted from date flesh. The following values (on a dry matter basis: DM) were obtained for fleshes of Deglet-Nour and Allig cultivars, respectively: sucrose 52.7% and 13.9%, glucose 13.7% and 29.9%, fructose 12.6% and 29.0%, total dietary fibre 14.4% and 18.4%, protein 2.1% and 3%, ash 2.5% and 2.52%. Insoluble DF, the major fraction of total DF, constituted 9.19-11.7% DM for Deglet- Nour and Allig, respectively. The elaboration of DF concentrates from date fleshes was characterised by an extraction yield of 67%. The chemical composition of these DF concentrates showed high total DF contents (between 88% and 92.4% DM) and low protein and ash contents (8.98-9.12% and 2.0-2.1% DM, respectively). The DF concentrates showed a high water-holding capacity (~15.5 g water/g sample) and oil-holding capacity (~9.7 g oil/g sample) and pseudoplasticity behaviour of their suspensions. Thus, date DF concentrates may not only be an excellent source of DF but an ingredient for the food industry.

Sudha et al., (2007), apple pomace, a by-product of apple juice industry, is a rich source of fibre and polyphenols. Also in view of the antioxidant property of pomace, it would play an important role in prevention of diseases. Apple pomace procured from fruit juice industry, contained 10.8% moisture, 0.5% ash and 51.1% of dietary fibre. Finely ground apple pomace was incorporated in wheat flour at 5%, 10% and 15% levels and studied for rheological characteristics. Water absorption increased significantly from 60.1% to 70.6% with increase in pomace from 0% to 15%. Dough stability decreased and mixing tolerance index increased, indicating weakening of the dough. Resistance to extension values significantly increased from 336 to 742 BU whereas extensibility values decreased from 127 to 51 mm. Amylograph studies showed decrease in peak viscosity and cold paste viscosity from 950 to 730 BU and 1760 to 970 BU respectively. Cakes were prepared from blends of wheat flour containing 0–30% apple pomace. The volume of cakes decreased from 850 to 620 cc with increase in pomace content from 0% to 30%. Cakes prepared from 25% of apple pomace had a dietary fibre content of 14.2% The total phenol content in wheat flour and apple pomace was 1.19 and 7.16 mg/g respectively where as cakes prepared from 0% and 25% apple pomace blends had 2.07 and 3.15 mg/g indicating that apple pomace can serve as a good source of both polyphenols and dietary fibre.

Ramirez-Santiago et al., (2010), Yam soluble fiber (YSF) extracted from Pachyrhizus erosus was added (1 g per 100 mL) to a stirred yogurt (SYYSF). Its syneresis and microstructure properties were evaluated and compared to those of a stirred yogurt (SYC) without added YSF. The SYC yogurt exhibited a more compact casein micelle aggregates network than that of the SYYSF yogurt which was more open, relaxed and covered with fibrous structures attributed to the YSF components. The rheological analysis showed that the SYYSF yogurt had lower storage modulus (G) and loss modulus (G00) values in the linear viscoelastic region than the SYC yogurt, but its flow behavior was characterized by a lower flow index (n), higher consistency index (k), and higher yield stress (s0) than the SYC yogurt. Incorporation of the YSF reduced significantly the syneresis and produced a more acceptable mouthfeel in the SYYSF yogurt in comparison to the SYC yogurt, indicating the viability of the process to obtain a commercial product.

Qi et al., (2011), the aim of this work was that pod as raw materials, study the effect of cellulase on extraction rate of soluble diet fiber (SDF) and insoluble diet fiber (IDF), and optimize the effects of the cellulase that included four sides: the time of cellulase action, the temperature of cellulase action, the pH of the cellulase and the rate of cellulase. As a result of the work maximum yield of SDF (6.72%) was obtained with the time of cellulase action of 72.83 min, the temperature of cellulase action of 57. 37ºC, the pH of the cellulase 8.4 and the rate of cellulase of 0.33%. On the other hand the maximum of IDF (66.51%) was obtained with the time of cellulase action of110.38 min, the temperature of cellulase action of 65ºC, the pH of the cellulase 8.8 and the rate of cellulase of 0.55%.

Grossi et al., (2011), in order to investigate the synergistic cooperation between high pressure treatment (HP) and carrot dietary fibre, two formulations of pork sausages containing different percentage of carrot dietary fibrewere pressurized at 500 and 600 MPa, for 1 second, 3, 6, and 9 min at 40, 50, and 60°C. HP treatments significantly increase Young's Modulus and affect Hencky strain values. We conclude that HP processing and carrot dietary fibre markedly improvedemulsion strength resulting in firmsausages. Colour changeswere investigated and significant increase in L* value and decrease in a* value were found, indicating that HP, temperature, and dietary fibre can affect physico-chemical properties of themeatmatrix altering the intrinsic ability to absorb or reflect light. The sensory evaluation showed that HP treatment synergistically cooperate with carrot dietary fibre improving sensorial attributes like homogeneity, creaminess, fattiness, and firmness as detected by Napping in combination with Ultra-Flash Profile.

8. Conclusion

Consumers have been different expectations to be relevance changing world stiutation and developing technologies. Human had to give more importance to their health and nutritional stiuation with increasing enviromental polution and stress in their life. So, recently it is watched that there has been increasing demand to foods that has low calories, low fat and low cholesterol content and functional foods. Functional foods can be defined as foods that have positif effects on the health. An important development in this regard has been in dietary fiber mixed products. The enrichment of foods with dietary fibres is an effective way to enhance nutritional and physiological aspects and to promote functionality by influencing rheological and thermal properties of the final product. It is needed to work on better understanding both for users and producers of dietary fibre values.

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