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RESEARCH ARTICLE

DIETARY FIBRE AND ITS FUNCTIONALITY: A REVIEW

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ABSTRACT

Dietary fibre has long history, its term originated by Hipsley (1953) who coined dietary fibre as non-digestable constituents making up the plant cell wall Dietary fiber is broadly classified according to its solubility into soluble and insoluble fibers. Microbial and synthetic are rich source of soluble fiber. Cereals, pulses and oilseeds are rich sources of insoluble fiber. Fibre, as a food ingredient, shows various types of techno-functional properties such as emulsification, fat replacement, stabilizer, texturizer and cryoprotectant in wide range of processed food products. The food industry takes advantage of these properties to improve the viscosity, texture, sensory characteristics and shelf-life of its products. The physico-chemical properties of fibre can be manipulated through different processing treatments to improve their functionality and nutrient content in different food products such as baked goods, beverages, dairy, meat and pasta products.

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INTRODUCTION

Dietary fibre has long history, its term originating with Hipsley (1953) who coined dietary fibre as a nondigestable constituents making up the plant cell wall and further its definition has seen several revisions. Botanists define fibre as a part of the plant organs, chemical analysts as a group of chemical compounds, consumer as a substance with beneficial effects on human health and for the dietetic and chemical industries dietary fibre is a subject of marketing (Dhingra *et al*., 2012). The latest definition proposed by Codex Alimentarius defined dietary fibre as carbohydrate polymers with ten or more monomeric units, which are not hydrolysed by the endogenous enzymes in the small intestine of humans and belong to the following categories: edible carbohydrate polymers naturally occurring in the food as consumed; carbohydrate polymers obtained from food raw material by physical, enzymatic, or chemical means; synthetic carbohydrate polymers. The decision on whether to include carbohydrates from 3 to 9 monomeric units should be left to national authorities (Mudgil and Barak, 2013).

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Classification

Several different classification systems have been used to classify the components of dietary fiber: based on their role in the plant, based on the type of polysaccharide, based on their fermentability. However, none is entirely satisfactory, as the limits cannot be absolutely defined. The most widely used classification for dietary fiber has been to differentiate dietary fiber components on their water solubility as depicted in Figure 1(Guo, 2009 and Gray, 2006).

The major food sources of dietary fibre are plant foods such as cereal grains, legumes, vegetables, fruits and seeds, as shown in Table 1. Fibre components also obtained from milling fractions, oilmeals, fruits and vegetables peels.

A variable proportion of dietary fibre will be derived from isolated or synthetic indigestible carbohydrates, incorporated into food products, for example, nondigestible oligosaccharides (fructo-oligosaccharides, galacto-oligosaccharides), resistant maltodextrins and polydextrose (Table 2).

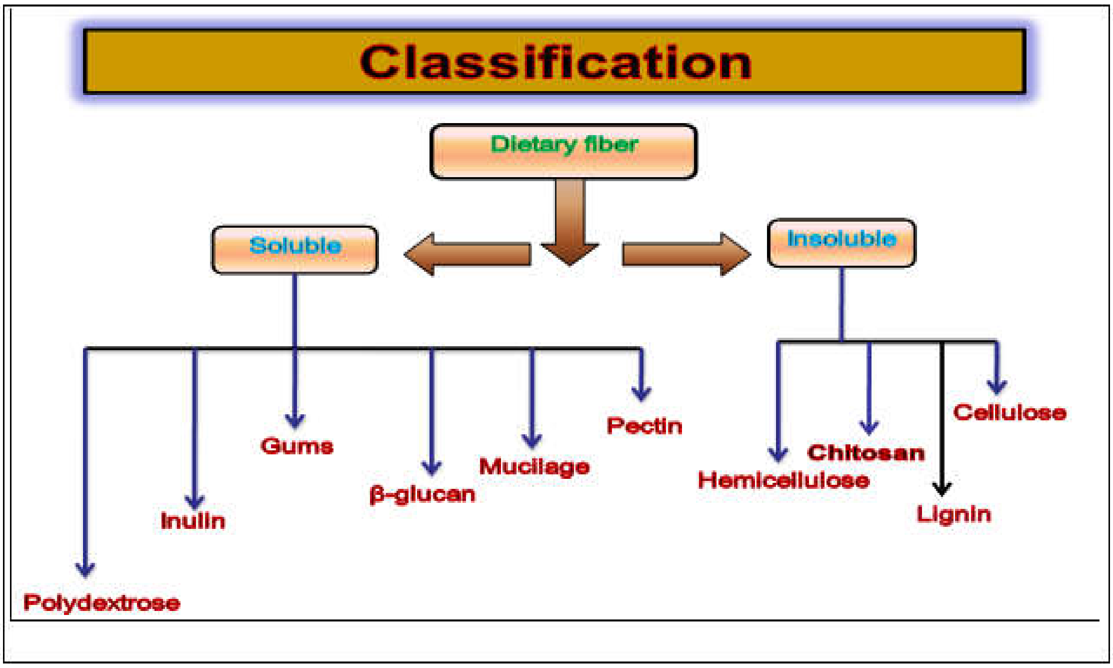

Table 1. Natural sources of various components of dietary fiber

Natural sources of various components of dietary fiber	
Fiber component	Main food source
Cellulose	Vegetales, woody plants, cereal brans
Hemicellulose	Cereal grains
Chitin & Chitosan	Shrimps, lobster, crab
β-glucan	Grains (oats, barley, rye, wheat)
Pectin	Fruits, vegetables
Gums	Legumes, seaweed & micro-organisms
Inulin	Chicory, banana

Table 2. Some synthetic & modified fibers

Some synthetic & modified fibers	
Fructo-oligosaccharides	Transfructosylation of sucrose with a β-fructosidase of *Aspergillus niger*
Oligofructose	Partial enzymatic degradation of native plant inulin
Polydextrose	Thermal polymerisation of glucose with sorbitol and acid
Resistant maltodextrins	Alkaline heat treatment of strach

Table 3. Dietary fibre content of various food source

Dietary fibre contents of various food sources			
Source	Total dietray fibre (g/100g edible portion)	Insoluble dietary fibre (g/100g edible portion)	Soluble dietary fibre (g/100g edible portion)
Grains			
Barley	17.3	-	-
Corn	13.4	-	-
Oats	10.3	6.5	3.8
Rice	1.3	1.0	0.3
Wheat (whole grain)	12.6	10.2	1.1
Wheat bran	42.4	40.3	2.1
Legumes			
Green beans	1.9	1.4	0.5
White beans	17.7	13.4	4.3
Vegetables			
Tomato	1.2	0.8	0.4
Bittergourd	16.6	13.5	3.1
Spinach	2.6	2.1	0.5
Cauliflower	1.8	1.1	0.7
Fruits			
Apple	2.0	1.8	0.2
Grapes	1.2	0.7	0.5
Oranges	1.8	0.7	1.1
Nuts & seeds			
Almonds	11.20	10.10	1.10
Commercial available			
Pectin	90-100	-	90-100
Fibersol-2RMD	90	-	90

Technological property	Physiological functionality
Water holding capacity	Laxative
Water swelling capacity	Reduction of blood cholesterol
Water retention capacity	Reduction of blood glucose
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	

Table 4. Techno-functional properties of dietary Fibre

Factor	Techno-functional properties
Type of fibre	Water holding capacity of soluble fibre is higher than insoluble
	Flaxseed gum in dairy beverages resulted in better sensory & rheological properties
Particle size	Decrease in hydration with decrease in particle size of wheat bran
	Increase with reduction in coconut fibre particle size
Molecular weight	High molecular weight β-glucan difficult to dissolve in water even at low concentration of 0.5%
Nature of chain	Highly branched guar gum & pectin more soluble & viscous

Table 5. Application of dietary Fibre in various food products

Dietary fiber	Source	Functionality	Food application
Cellulose	Cell walls of higher plants	Water holding capacity	Frozen dairy desserts
Oat bran	Outer layer of oat groats	Fat replacement	Fat replacer in ground beef & pork sausage products
Legume fiber	Legume seeds	Water –binding & oil binding capacity	Fat replacer in bakery products
Pectin	Middle lamellae of plant cells	Water binding, emulsifying, gel-forming & thickening	Stabilizer, thickener & emulsifier in beverages; fat replacer in cheese
β - glucan	Oats & barley	Oil binding & water holding capacity, emulsifying	Fat replacement in meat, dairy & bakery products
Xanthan gum	*Xanthomonas campestris*	Stabilizing & texture-modifying capacity, fat replacement	Stabilizer & texture modifier, thickener in beverages & dairy products
Inulin	Banana, chicory, barley, onion	Gel forming capacity; low viscosity, heat & acid stability	Fat replacer in muffin; gel-forming agent & foam stabilizer
Oligosaccharides	Enzymatic hydrolysis of inulin	Water - holding capacity, low viscosity	Improve the flavor, mouthfeel

Dietary fibre content of various food sources

Dietary fibre is naturally present in cereals, vegetables, fruits and nuts. The amount and composition of fibres differ from food to food. Cereals to be one of the main sources of dietary fibre, contributing to about 50% of the fibre intake in western countries, 30–40% dietary fibre may come from vegetables, about 16% from fruits and the remaining 3% from other minor sources (Dhingra *et al*., 2012). Dietary fibre content of various food sources is presented in Table 3.

Technological functionality of dietary fibre

Dietary fibre is complex polysaccharide which show wide range of functionality such as emulsification, fat replacement, gel-forming, cryoprotectant, thickener and stabilizer. These technical functionalities are highly influenced by the physico-chemical properties of dietary fibres, such as water-holding and binding capacity, oil binding capacity, solubility and viscosity which are discussed (Elleuch *et al*., 2011 and Theabaudin *et al*., 1997). These physico-chemical properties are effected by various physical factors such as particle size, nature of chain, molecular weight and type of fibre which are summarized in Table 4:

Application of dietary fibre in food industry

The food industry can take advantage of the physicochemical properties described above to improve the viscosity, texture, sensory characteristics and shelf-life of their products. Fibre-rich byproducts may be incorporated into food products as inexpensive, non-caloric bulking agents for partial replacement of flour, fat or sugar, as enhancers of water and oil retention and to improve emulsion or oxidative stabilities. However the percentage of fibre that may be added is finite, because it can cause undesirable changes to the colour and texture of foods. 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 used fibres in processed food products are listed in Table 5. Most commonly, dietary fibres are incorporated into bakery products to prolong freshness, by 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 and Noomhorm, 2004; Wang, Rosell, and Barber, 2002). As a rule, the incorporation of fibres in bread reduces loaf volume and increases firmness, but the extent of modification depends on the fibre source. Various options can improve the quality of bread with additional fibre, including enzymatic treatment of fibres (Laurikainen *et al*., 1998), the use of different milling fractions, and alkaline hydrogen peroxide treatment of lignocellulosic material (Gould, Jasberg, and Cote, 1989; Jasberg, Gould, and Warner, 1989; Sangnark and Noomhorm, 2003). Bread prepared with smaller sized fibres from sugarcane, was more tender and elastic than with coarser fibres, and most organoleptic characteristics, those related to colour, odour and taste, increased with particle size reduction (Sangnark and Noomhorm, 2003). 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 syneresis in yoghurt and other fermented milk products (Blecker *et al*., 2001). Fibre improves the texture of ice cream, providing a uniformly smooth bulk, desirable resistance to melting, and improves handling properties primarily by hindering crystal growth, as temperature fluctuates during storage (Regand and Goff, 2003). Soukoulis, Lebesi, and Tzia (2009) showed the potential use of dietary fibres (oat, wheat, apple and inulin) as crystallization and recrystallisation controllers in frozen dairy products.

Other applications involve fruit products. Grigelmo-Miguel and Martina-Belloso (1999b) used fibres as an ingredient in jam. They showed that strawberry jam, in which peach dietary fibres replaces industrial pectin, has pseudoplastic behaviour, and the higher the dietary fibre content, the higher the viscosity of the jam. Their evidence from sensory evaluations indicates that jams enriched with high peach fruit dietary fibre were as acceptable as conventional jam. Fibres can also be introduced into meat products, to reduce the caloric content by fat substitution and to improve the texture and stability of meat products. Surplus white and red beeswing, i.e., undigested fibres from wheat bran, can be added to replace some of the fat in beefburgers, reducing levels of cholesterol and improving their cooking yield, diameter and texture (Mansour and Khalil, 1997). Garcia *et al*. (2002) showed that the addition of cereal or fruit fibre, specifically 1.5% orange fibre, to dry fermented sausages gives an organoleptic characteristic similar to the conventional high fat product. Addition of 3% carrot dietary fibre yielded a dry fermented sausage (sobrassada) akin to those prepared with fermentation and lipolytic processes. Fibres can be introduced into fish products. Borderias *et al*. (2005) provide a concise synopsis demonstrating that the addition of soluble fibres such as carrageenans from algae, or guar and xanthan from seeds, to fish products, improves their functionality. It improves water binding, thickening, emulsion capacity and gelling properties of products made with minced fish muscle, especially where the raw material used is of poor functional quality, but it can cause extensive loss of rigidity and elasticity in muscle protein gels (Borderias *et al*., 2005; Yoon and Lee, 1990).

In case of beverages and drinks, the addition of dietary fibre increases their viscosity and stability, soluble fibre being the most used because it is more dispersible in water than insoluble fibre. Some examples of soluble fibres are those from fractions of grains and multi-fruits (Bollinger 2001), pectins (Bjerrum 1996), β-glucans, cellulose beet-root fibre (Nelson 2001). Oat fibre can be incorporated into milk shakes, instant type-breakfast drinks, fruit and vegetable juices, ice tea, sports drinks, cappuccino and wine. Other beverages that can benefit from the addition of fibre include liquid diet beverages- both those created for people with special dietary needs as well as weight loss or mealreplacement beverages (Hegenbart 1995). Larrauri *et al*. (1995) described the manufacture of powdered drink containing dietary fibre from pineapple peel. The product, called FIBRALAX, contained 25% dietary fibre and 66.2% digestible carbohydrates, and provided a mild laxative effect.

Conclusion

Fibre-rich ingredients are available in different forms and from different botanical origins. Different fibres exhibit different structural and chemical compositions, resulting in a range of nutritional and technological properties. Incorporation of fibre can change the consistency, texture, rheological behaviour and sensory attributes of the end products. Addition of fibre in breakfast cereals, bread, cookies, cakes, yogurt, beverages and meat products has been reported with favourable results.

REFERENCES

Bjerrum, K. S. 1996. New applications for pectins. Food Technol 3: 32–34.

Blecker, C., Chevalier, J. P., Van Herck, J. C., Fougnies, C., Deroane, C., and Paquot, M. 2001. Inulin: Its physiochemical properties and technological functionality. *Recent Research Development in Agricultural and Food Chemistry,* 5: 125-131.

Bollinger, H. 2001. Functional drinks with dietary fibre. Fruit Process 12: 252–254.

Borderías, A. J., Sánchez-Alonso, I., and Pérez-Mateos, M. 2005. New application of fibre in foods: Addition to fishery products. *Trends in Food Science* and *Technology,* 16: 458-465.

Dhingra, D., Michael, M., Rajput, H and Patil, R. T. 2012. Dietary fibre in foods: A review. *Journal of Food Science* and *Technology,* 49: 255–266.

Elleuch, M., Bedigian, D., Besbes, S and Blecker, C. 2011. Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: A review. *Food Chemistry,* 124: 411-421.

Garcia, M. L., Dominguez, R., Galvez, M., Gavlez, D., Casas, C., and Selgas, M. D. 2002. Utilisation of cereal and fruit fibres in low fat dry fermented sausage. *Meat Science,* 60: 227–236.

Gould, J. M., Jasberg, B. K., and Cote, G. L. 1989. Structure-function relationships of alkaline

Gray, J. 2006. ILSI Europe concise monograph series: Dietary fibre. Pp: 13-17.

Grigelmo-Miguel, N., and Martina-Belloso, O. 1999b. Influence of fruit dietary 628 fiber addition on physical and sensorial properties of strawberry jams. *Journal of Food Engineering,* 41: 13-21.

Guo, M. 2009. Functional foods: principles and technology. Woodhead Publishing Ltd. Pp: 71-74.

Hegenbart, S. 1995. Using fibres in beverages. *Food Prod Des*., 5 (3): 68–78.

Hipsley, E H 1953. Dietary "Fibre" and pregnancy toxaemia. Br Med J 2:420–422.

Jasberg, B. K., Gould, J. M., and Warner, K. 1989. High-fibre, non calorie flour substitute for baked foods. Effect of alkaline peroxide-treated lignolcellulose on dough properties. *Cereal Chemistry,* 66(3): 209-213.

Larrauri, J. A. 1999. New approaches in the preparation of high dietary fibre powders from fruit by-products. *Trends in Food Science and Technology,* 10: 3–8.

Laurikainen, T., Harkonen, H., Autio, K., and Poutanen, K. 1998. Effects of enzymes in fiber-enriched baking. *Journal of the Science of Food and Agriculture,* 76: 239–249.

Mansour, E. M., and Khalil, A. H. 1997. Characteristics of low-fat beefburger as influenced by various types of wheat fibers. *Food Research International*, 30: 199-205.

Mudgil., D and Barak, S. 2013. Composition, properties and health benefits of indigestible carbohydrate polymers as dietary fiber: A review. *International Journal of Biological Macromolecules,* 61: 1-6.

Nelson, A. L. 2001. High-fibre ingredients: Eagan Press Handbook Series. Eagan Press, St. Paul

peroxide-treated lignocellulose from wheat straw. *Cereal Chemistry,* 66(3): 213-217.

Regand, A and Goff, H. D. 2003. Structure and ice recrystallisation in frozen stabilised ice cream model systems. *Food Hydrocolloids,* 17: 95–102.

Sangnark, A., and Noomhorm, A. 2003. Effect of particle sizes on functional properties of dietary fibre prepared from sugarcane bagasse. *Food Chemistry,* 80: 221–229.

Sangnark, A., and Noomhorm, A. 2004. Chemical, physical and baking properties of dietary fiber prepared from rice straw. *Food Research International,* 37: 66-74.

Soukoulis, C., Lebesi, D and Tzia, C. 2009. Enrichment of ice cream with dietary fibre: Effects on rheological properties, ice crystallisation and glass transition phenomena. *Food Chemistry,* 115: 665–671.

Thebaudin, J.Y., Lefebvre, A.C., Harrington M and Bourgeois, C.M. 1997. Dietary fibres: Nutritional and technological interest. *Trends in Food Science* and *Technology,* 8: 41-48.

Wang, J., Rosell, M. C., and Barber, C. B. 2002. Effect of the addition of different fibers on wheat dough performance and bread quality. *Food Chemistry,* 79: 221-226.

Yoon, K. S., and Lee, C. M. 1990. Cryoprotectant effects in surimi and surimi/mince-based extruded products. *Journal of Food Science,* 55: 1210-1216.

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