Scientific Papers. Series D. Animal Science. Vol. LXVI, No. 2, 2023
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

FUNCTIONALITY AND APPLICATION OF DIETARY FIBER IN FOOD PRODUCTS - REVIEW

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Abstract

Dietary fibers are components of plant material, extremely important in the diet, because they resist enzymatic digestion in the digestive tract, with a role in improving intestinal transit. Dietary fibers are mostly carbohydrates such as cellulose, hemicellulose, pectic substances, gums, and mucilages, but also non-carbohydrate. The presence in the daily diet of whole grains, nuts, vegetables, fruits and seeds positively affects health, because their consumption has been linked to the decrease in the incidence of several diseases. From a technological point of view, dietary fiber is added as a functional food ingredient in food products to provide water-holding capacity, viscosity, gel-forming capacity and fat-binding capacity to food products. These beneficial characteristics of dietary fiber components can enhance the image of products as healthy and functional foods. This article reviews the concept and definition of dietary fibers used in food production and their functional characteristics and health benefits.

Key words*: dietary fiber, food product, functional property, processing.*

INTRODUCTION

Concern for the health and a healthy diet of the population had an extremely distorted trajectory throughout history. But, in the last decades, easier access to information, the increase in the degree of awareness, the increase in income and the standard of living, pandemic periods caused a greater concern regarding lifestyle and health, and the term dietary fiber entered the daily diet of consumers. Knowing the role and benefits of these dietary fibers on the body greatly stimulated the imagination of the industry and the actors working in the field of nutrition, so they are currently "on the wave". The same, Prosky (2000) mentioned that dietary fiber can be considered a functional food when it gives a special function to that food aside from the normal expected function and similarly when the dietary fiber is used as an additive to foods. For example, dietary fiber brings many benefits, e.g., contributes to colonic health, bifidobacterial or lactobacillus stimulation in the gut, coronary artery health, cholesterol reduction, glucose metabolism, etc. (Prosky, 2000). In conclusion, functional foods are ingredients that offer health benefits that extend beyond their nutritional value and the DF fulfills this role in some cases.

According to a study conducted by Grand View Research, the global market size of the dietary fiber market is estimated to grow at a CAGR of 9.2% from 2022 to 2030. The food & beverage segment is anticipated to continue with the growth of consumer awareness of the importance of dietary fiber in the daily diet (grandviewresearch.com).

Dietary fibers (DF) are components of plant material, extremely important in the diet. They are not digested in the small intestine because humans do not produce enzymes capable of hydrolyzing them into constituent monomers (Turner et al., 2011), but are benefice role in improving intestinal transit. DF is considered to be a non-caloric nutrient that does not contribute calories to our diet because it reaches the colon intact. However, in the colon, these are available for fermentation by some bacteria and the released metabolites can be used to meet some of the body's energy requirements (Cronin et al, 2021).

In the last decades, DF has been extremely promoted for its nutritional and functional effects, with DF being used over time precisely for their beneficial role in body health.

However, looking back over time, DF have always been present in people's daily diets and promoted their beneficial effects.

DIETARY FIBER DEFINITION

Since ancient times, DF have been omnipresent in the diet of the population. There is evidence that in a period of ancient Greece, it was known that bran cereals helped prevent constipation, as well as promote well-being and health. In the 1930s, Kellogg confirmed wheat bran's positive effects on patients with constipation and colitis. But, the actual name of fibers was only mentioned in 1953, by Dr. Eben Hipsley in an article on pregnancy toxaemia (Hipsley, 1953). Concern for the effects and functions of DF on health continued, so that in the 70s, the first definition of DF appeared, which sounded like this: "*Dietary fiber consists of the remnants of edible plant cells, polysaccharides, lignin, and associated substances resistant to digestion by the alimentary enzymes of humans*" (Trowell, 1974).

In the course of time, different definitions were given to them. Such as in 2000, the American Association of Cereal Chemists (AACC) defined "*Dietary fiber is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine*" (AACC Report, 2001). In 2002, the panel on the definition of DF constituted by the National Academy of Science defined "*total fiber*" as the combination of "*dietary*" and "*functional" fiber*". DF is the edible, nondigestible component of carbohydrates and lignin naturally found in plant food. Some foods with DF include cereal bran, sweet potatoes, legumes, and onions. Functional fiber refers to those fiber sources that are shown to have similar health benefits as DF, but are isolated or extracted from natural sources (Institute of Medicine, 2005).

At present, not there is a harmonized definition, and there are still debates in different profile groups regarding a clear definition for DF (Jones JM., 2014). The issuance by *Codex Alimentarius* of an international definition of DF in 2009 marked an important step forward for fiber research and nutrition. The CODEX definition has been adopted or reaffirmed by many national authorities, but it did not completely solve the issue of international harmonization, because a footnote to the definition allows national authorities to choose whether or not to include nondigestible polymers that are shorter than 10 sugar units [degree of polymerization (DP)≤10]. Thus, the DP issue could impair international harmonization if some countries decide not to accept these short-chain oligomers as DF.

In Regulation (EU) No 1169/2011 is mentioned that 'fiber' means carbohydrate polymers with three or more monomeric units, which are neither digested nor absorbed in the human small intestine and belong to the following categories:

- edible carbohydrate polymers naturally occurring in the food as consumed,
- edible carbohydrate polymers which have been obtained from food raw material by physical, enzymatic or chemical means and which have a beneficial physiological effect demonstrated by generally accepted scientific evidence,
- edible synthetic carbohydrate polymers that have a beneficial physiological effect demonstrated by generally accepted scientific evidence.

RECOMMENDATION INTAKE

Intake of DF recommendations is not the same in all countries because of different eating habits and lifestyles (Mehta et al., 1992). The European Food Safety Authority recommends an intake of 25 g per day for adults. This recommendation is based on the role of DF in bowel function. However, the benefit of diets, that are rich in foods containing fiber and provide fiber intakes greater than 25 g per day, has also been noted.

On a national level, dietary recommendations vary with most countries generally recommending daily intakes between 25-35 g for adults. According to a list published by Akbar & Shreenath (2022), the current daily recommended DF consumption ranges between 14-20 g for children, 22-30 g for adolescents, and 25-38 g for the elderly.

The EU Regulation (EC) No 1924/2006 on nutrition and health claims regulation helps consumers identify foods containing fiber and their benefits. In accordance with this regulation:

- "*High in fiber*" claims are permitted on foods that contain at least 6 g of fiber per 100g or at least 3g of fiber per 100 kcal;
- "*Source of fiber*" claims are permitted on foods that contain at least 3 g of fiber per 100g or at least 1.5 g per 100 kcal.

OVERVIEW OF DIETARY FIBER CHEMISTRY

DF are composed of indigestible carbohydrates found inherent to and intact in plants. These carbohydrates include the remains of edible plant cells, polysaccharides, cellulose, hemicellulose, lignin, and other compounds that are resistant to digestion by human digestive tract enzymes but can be soluble or partially soluble in the digestive tract e.g., pectin, mucilage, resistant starch, gums, and other related plant substances (Tabel 1). The composition and nature of fiber in the diet will depend on the age, species, and anatomical source of the plant material (Yangilar, 2013).
The classification of DF is based on the solubility of DFs in water (Figure 1) and is divided into two types, each with different characteristics: soluble fibers and insoluble fibers (Ibrahim & Menkovska, 2022).
Soluble fibers, such as β-glucans, inulin, fructo-oligosaccharides, xyloglucans, mucilage, pectin, psyllium and gums, are water-soluble fibers generated from the inner flesh of plants. Soluble fibers also extend the feeling of fullness due to their property in delaying gastric emptying, causing the feeling of fullness, and they can improve digestion and lower blood glucose (Carlson et al., 2018; Nicholson, 2016). They produce a sticky gel in the colon, where bacteria digest them into gases and by-products such as short-chain fatty acids. For example, foods with soluble fiber include oatmeal, chia seeds, nuts, beans, lentils, apples, and blueberries, oats, barley, fruits, peas, beans, other legumes, and most root vegetables.
Insoluble fibers are present naturally in plants such as vegetables, fruits, and whole grains. These nondigestible fibers such as cellulose, hemicellulose, lignin, and resistant starch, are found in whole-wheat bread, brown rice, seeds and skin of fruits and are not soluble in water or gastrointestinal fluids, remaining more or less unchanged as they move through the digestive tract (Lissoni et al., 2020; Ibrahim & Menkovska, 2022).
Insoluble fibers play an important role in controlling weight and improving bowl health by preventing constipation and colon cancer. Foods with insoluble fibers include whole wheat products (especially wheat bran), quinoa, brown rice, legumes, leafy greens like kale, almonds, walnuts, seeds, and fruits with edible skins like pears and apples.

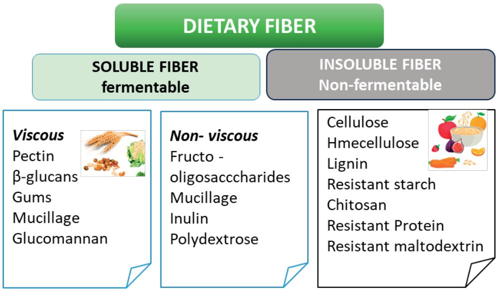

Figure 1. Classification of dietary fibers based on their physicochemical characteristics (Arranz et al., 2012; Ranganathan & Anteyi, 2022)

DF is an essential part of a healthy diet and is essential for keeping the gut healthy and reducing the risk of chronic health conditions.

Table 1. Classification of dietary fiber

Fiber type	Description	Sources	References
Cellulose	The main structural component of the plant cell wall. Insoluble in concentrated alkali; soluble in concentrated acid.	Plant cell walls, especially plants with a rigid structure , in fruits, vegetables (plants), cereals, and various brans.	Dhingra et al, 2012
Hemicellulose	Cell wall polysaccharides contain the backbone of β-1,4 glucosidic linkages. Vary in degree of branching and uronic acid content. Insoluble in water but soluble in dilute alkali.	Cereals, bran, timber, legumes, rice husk, wheat straw	Gírio et al., 2010 Huang et al., 2021 Penfield et al., 1990; Dhingra et al, 2012
Pectic substances	Pectin is an amorphous polysaccharide present in ripe plants and fruits, especially in the primary cell walls and middle lamella of fruits and which varies in methyl ester content. Pectic substances are water-soluble and gel-forming.	In the skin of fruits (apples, plums, peel, quinces and pulp of citrus fruits), vegetables	Nasrollahzadeh et al., 2021 Gawkowska et al., 2018
Mucilages	Synthesized by some specialized secretory cells of the plant and its function is to prevent excessive dehydration of seed endosperm. Mucilage is a water-soluble viscous material characterized by a light color, which is part of the fiber. Food industry use, hydrophilic, stabilizer, emulsifiers, thickening or gelling agents, and viscosity modifiers e.g., guar gum	Leguminous seed plants (guar, locust bean),	Calle et al., 2021 Cakmak et al., 2023 Dhingra et al, 2012
Gums	Gums are secreted at the site of plant injury by specialized secretory cells that appear only in response to injury (wound, mechanical pressure, attack of microorganisms or insects, and physiological disturbances such as water stress or unfavorable environment). Use in the food and pharmaceutical industry, e.g. Karaya gum, Arabic gum, acacia gum	Plant extracts (gum acacia, gum karaya, gum tragacanth) Seaweeds, barley bran, some tree saps and seeds	Shedletzky & Fahn, 1985 Dhingra et al, 2012
Algal polysaccharides	Derived from algae and seaweed. Marine algae contain many polysaccharides including mucopolysaccharides, cell wall structure, and storage polysaccharides. Use in the food and pharmaceutical industry, e.g. carrageenan, agar, alginate.	Seaweed extracts (carrageenan, alginates)	Usman et al., 2017
Lignin	Non-carbohidrate cell wall component. Lignin is a highly cross-linked complex polymer of phenylpropane units. Lignin is insoluble in most solvents and cannot be broken down into monomeric units. Resistant to degradation by most microorganisms.	Plant cell walls, especially xylem (nutrient-transporting) cells. Fruit stones, vegetables (filaments of the garden bean), cereals, soft and hardwood	Popoola-Akinola et al., 2022 Asp, 1987 Liu et al., 2018
Non-digestible oligosaccharides (the prebiotic fibers)	Fibre solubile derivate din vegetale, dar sunt izolate sau modificate într-o formă concentrată care se adaugă la alimente sau suplimente cu fibre.	Non-digestible oligosaccharides (the prebiotic fibers) like inulin, fructo- and galactooligosaccharides	Solange et al., 2007 Atul Rajkumar et al., 2023
Polydextrose	Polydextrose is a complex carbohydrate made from glucose. It's made in a lab and is not digested by the body. Polydextrose is often used as a prebiotic. Polydextrose does not get digested by the human body, but it's digested by good bacteria found in the colon.	Synthesized from dextrose (combined with citric acid and sorbitol), used as a starch replacer in commercial food products	do Carmo et al., 2016 Raza et al., 2017
Resistant starches	Resistant starch: RS1: physically inaccessible; RS2: resistant granules; RS3: retrograded starch, RS4: chemically modified starch	Seeds, legumes, whole grains, potato, corn, green bananas (especially if these foods are cooked then cooled)	Magallanes-Cruz et al., 2017 Mohamed, I. O., 2021
Substances associated with non-starch polysaccharides	Waxes Cutin and suberin are complex polymers present in plant cell walls. These are the polyesters of hydroxy fatty acids. Cutin and suberin are water-insoluble in nature and they come under the category of insoluble dietary fiber.	These occur in plant cells with associated waxes comprising the hydrocarbon chain.	Tungland & Meyer, 2002
Animal origin fibers	Chitosan Chitin, collagen, chondroitin	Fungi, yeasts, invertebrates	Borderías et al., 2005 Tungland & Meyer, 2002

TECHNOLOGICAL FUNCTIONALITY OF DIETARY FIBRE

DF is a complex polysaccharide that shows a wide range of functionalities such as water holding capacity, emulsification, fat replacement, gel-forming, cryoprotectant, thickener, and stabilizer (Figure 2). These technical functionalities are highly influenced by the physicochemical properties of DFs, such as water-holding & binding capacity, oil binding capacity, solubility & viscosity which are discussed (Nayak et al., 2000).

Water holding capacity

Water-holding capacity of DF is usually considered as the amount of water held but the manner in which water is held by the fiber matrix may be more relevant in understanding the role of fiber in technology and nutrition. So, by hydrating a fiber with water, the water enters the pores of the fiber and increases the volume of the fiber, this translates into increasing cooking yields, and probably reducing the caloric content of meat products or similar. Moreover, a high-water holding capacity can control the migration of moisture and the formation of ice crystals, so as to increase the stability during the freezing and thawing process (Gelroth & Ranhotra, 2001). Length, particle size, and porosity of DF components are important because may affect the water-holding capacity and these can contribute to the mouthfeel of the final products (Gelroth & Ranhorta, 2001; Tungland & Meyer, 2002). Longer fibers have an increased capacity to retain water and can lead to changes in texture depending on the fiber level (Yue-yue et al., 2017).

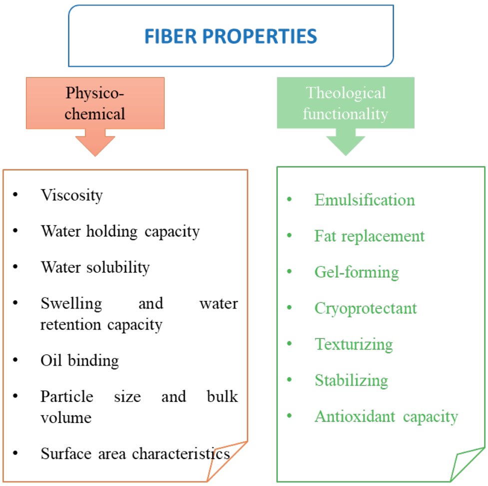

Figure 2. Dietary fiber properties

Swelling and water retention capacity

Fibers are also a great tool for extending freshness because of their water-regulating capacity.

Water solubility

Solubility means the ability of DFs to dissolve in water and the DF solubility depends on several different intern factors structure of fibers but also external factors such as temperature and pH value. Many DF while categorized as being "soluble" are actually poorly soluble in water, and can either aggregate or phase-separate over time. Within the soluble DF, there are known to be substantial differences in their fermentability, with many of them promoting the proliferation of health-promoting bacterial species such as *Bifidobacterium*, *Lactobacillus*, and *Eubacterium*.

Viscosity

Viscosity is a physicochemical property associated with DFs, particularly soluble DFs (Dikeman & Fahey, 2006). Viscosity is an important role of DF, providing rheological properties in the food system including meat products. A high molecular weight or chain length of the fiber increases, and the viscosity of fiber in solution increases. Long-chain polymers, such as β-glucan and gums, exhibit high viscosity in the solution and these are used as thickening agents at low concentrations. Highly soluble fibers that have low viscosity, such as gum arabic, inulins, and oligosaccharides, are generally used to modify texture.

Texturizing

Some fibers can mimic the texture and mouthfeel of fats yet provide less energy, averaging just 2 kcal per gram (as opposed to 9 kcal for fat). Besides acting as a bulking agent and fat replacer, fibers are also used as thickeners to improve the texture and stability of foods (particularly in low-fat and low-kcal products).

Fat holding capacity

Dietary fiber single or in combination with other DF ingredients can be used to reduce fat content special in meat products (Decker & Park, 2010; Mehta et al., 2015). Because they are fat-dispersible and have the capacity to bind, the addition of DF can successfully replace some portion of fat in meat products.

Gel-forming capacity

The gel-forming ability of DF ingredients can contribute to increasing the thickness or viscosity of products. Gelation (gel transition) is the formation of a gel from a system with polymers to form a gel network with a firm three-dimensional structure (Tanaka, 2011; Tungland & Meyer, 2002). This structure may stabilize or modify the physical structure of food products thus helping to minimize shrinkage and improve product density.

Antioxidant capacity

Antioxidants have some health benefits, but up to now, there was less attention paid to the antioxidant properties of DF. The antioxidant effect of DF is based on the polyphenol compounds bound to polysaccharide complexes, which are released in the gut and function as antioxidants (Mézes & Erdélyi, 2018). These polyphenols can be released during digestion or released in the colon after fiber fermentation, which contributes to benefit intestinal health or are excreted in the feces (González-Aguilar et al., 2017).

There are different polyphenol compounds in the antioxidant DF in the plants, therefore their antioxidant capacity varies, but it is approximately equivalent to 50-100 mg DL-α-tocopherol per gram. This antioxidant capacity is considerable and would be suitable for the prevention of some, oxidative stress-related diseases, such as atherosclerosis or other cardiovascular diseases, and colorectal carcinoma (Angulo-López et al., 2023).

It is known that DF can reduce the bioavailability of macronutrients, especially fat, and some minerals and trace elements in the human diet. Because it was demonstrated in humans that pectin strongly decreased the bioavailability of β-carotene (Rock & Swendseid, 1992), DF is probable to also affect the absorption of other carotenoids and probably that of α-tocopherol and polyphenols compounds (Adams et al., 2018; Palafox-Carlos et al., 2011).

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APPLICATION OF DIETARY FIBER IN FUNCTIONAL FOODS

Fibers are very important in food processing because can change the consistency, texture, rheological behavior, and sensory characteristics of the end products. The emergence of novel sources of fibers has been offering new opportunities for their use in food products.

DF holds all the characteristics required to be considered as an important ingredient in the formulation of functional foods, due to its beneficial health effects. DFs used in the food industry are primarily carbohydrate polymers from plant cell walls, such as cellulose, hemicellulose, lignin, and pectin, but several types of DFs can be extracted from waste from cereal, fruit, and vegetable processing (Galanakis, 2012).

APPLICATIONS OF DIETARY FIBERS IN MEAT PRODUCTS

Changing consumer demands and increasing global competition are driving innovation in meat processing. The long-standing positive consumer perception that meat and its products are very important food, is gradually giving way to a more negative view created by media and the new currents regarding food diets (Verbeke et al., 2010). Meat and its products are devoid of DF and the presence of saturated fat (Kausar et al., 2019). It is necessary to improve the total nutrition of meat as a whole by introducing non-meat ingredients that can be incorporated into the meat to boost its functional properties and nutritional value.

Manufactured meat products include a variety of non-meat ingredients that serve various purposes during production or in the finished product. Meat extenders and meat analogues are produced by extrusion of vegetable proteins, resulting in products that have an appearance and texture similar to the fibrilar structure of meat (Fellows, 2017). These extenders often allow for reduced formulation costs but while changing the finished product properties such as water-holding, texture, appearance, and palatability.

The addition of fiber in meat and/or meat products is more common nowadays, as its addition can efficiently provide longer shelf life, and higher quality, as well as improve various processing characteristics. The deficiency of DF can be improved by supplementation of dietary fiber-rich vegetative substances like cereal and pulse flour, vegetable and fruit pulp etc. Fibers such as cellulose, pectin, or fiber extracted from rice, maize, wheat, and beetroot can be used to improve the texture of various meat products including salami and sausages. Are suitable to be used in the preparation of low-fat meat products, such as ‘dietetic hamburgers’. Since DFs are also capable of elevating hydration properties; their inclusion in meat can contribute to rich juiciness.

For example, inulin has been added in different types of meat products including sausages, meatballs and restructured products showing good performance as a fat substitute (Álvarez & Barbut, 2013; Bis et al., 2019) matching its technological and physiological properties improving the stability of emulsions and imprinting characteristics similar to fat.

Resistant starch is suitable in reduced-fat meat emulsion because have the capacity to retain water, decreasing cooking losses and performing a neutral flavor. The same color, texture, and sensorial parameters were not influenced by the replacement of up to 60% fat. However, the research shows that when combined with β-glucan, resistant starch showed to be a suitable ingredient to produce prebiotic sausage (Sarteshnizi et al., 2015, Totosaus, 2009).

Dietary fiber can effectively be incorporated in processed meat products as binders, extenders and fillers they can use as successful alternatives for unhealthy fat components from the products and might increase acceptability by improving nutritional components, pH, water holding capacity, emulsion stability, sensory characteristics, etc. of finished products. Addition of DF in meat products can increase the cooking yield therefore economic gain as well.

Oat fiber can be used as an appropriate fat replacement in ground pork and beef sausage-based products owing to their high-water retention and ability to improve texture and color (Verma & Banerjee, 2010)

Pea hull flour, gram hull flour, apple pulp, and bottle gourd can be used to produce high-fiber functional chicken nuggets with low fat and low salt.

Fortification of DF in meat emulsion can improve emulsion stability and viscosity and decrease cooking loss; moreover, DF may also be associated with the rheological attributes of meat emulsion. Efficient protection against lipid oxidation was attained by the addition of rice bran in frankfurters (Frankfurt sausage) and their antioxidant activity was preserved till 14 days of storage.

APPLICATIONS OF DIETARY FIBERS IN DAIRY PRODUCTS

Milk is free in DF content, and some soluble fibers such as pectin, carboxymethyl-cellulose, inulin, and guar gum are being used as functional ingredients in dairy products such as milk, yogurt, cheese and ice cream.

In cheese products, syneresis is a problem of serious concern, and the addition of guar gum prevents syneresis by water phase management and improves the texture with an addition of up to 3% of the total weight. Guar gum in soft cheeses enhances the yield of curd solids and gives a softer curve with separated whey. The same, guar gum, pectins, and inulin are also added during cheese processing to decrease its percent of fat without losing its organoleptic characteristics, such as texture and flavour (Murtaza et al., 2017)

Numerous studies have proved that the addition of variable amounts of DF in yogurt not only improves its nutritive value, but is also able to influence its texture, rheological characteristics, consistency, and overall consumer acceptability.

Addition of variable amounts of DF in yogurt not only improves its nutritive value, but is also able to influence its texture, rheological characteristics, consistency, and overall consumer acceptability. Yogurt fortified with DF obtained from lemon and orange has exhibited good overall acceptability. The same, Staffolo et al. (2004) reported that yogurt enriched with 1.3% inulin (from wheat and bamboo) and fibers (from apple) is a promising possibility for elevated fiber intake, which also gained increased consumer acceptability (Po Kip & Renger, 2006).

In probiotic products, these fibers can be used as a multi-functional additive because of their satisfactory stability in dairy products. The stabilizer effect can change in dairy products (e.g., ice cream, beverage) with variable composition/formulation.

β-glucan and inulin-type fructans develop textural or rheological properties of dairy products that have relatively more standard composition (such as yogurt, and cheese), at varying degrees depending on the proportion.

The composition and the soluble/insoluble ratio are critical parameters for the exhibited functionality of the added fibres. High content in insoluble fibers led to a reinforcement of the viscosity and thixotropy of ice cream mixes.

Additives used to increase the stability of foods or to extend their shelf life are compounds that are beneficial for health, their usage areas should be increased, and their different potential effects should be known.

APPLICATIONS OF DIETARY FIBERS IN BAKERY PRODUCTS

DFs are common in the manufacture of bread since the flour used can have a low degree of refinement and a high bran content. But for some products, the use of whole meal flour can negatively influence the color, texture, stability and volume of the product. For this reason, food fibers are used to fortify the flour or are added directly in the recipe of biscuits, pasta, etc.

DFs have a high capacity to absorb and retain water, and in the dough preparation process, they compete with gluten, which is also water-loving but with a slower water absorption capacity. This results in low-volume products, because the fibers make the structure of the core difficult, and the gluten network, not being very stable, retains small amounts of gas. The presence of DF influences texture and color, but the overall effect of adding DF e.g., cellulose was smaller compared to cereal bran.

DF derived from pulp or peel of fruits or vegetables is an accessible version adopted by producers who are in search of ingredients with high nutritional value. The baking industry uses a high percentage of insoluble fiber derived from cereals consisting of cellulose fiber, groats, or meal of cereals - especially those from wheat fiber from the structure of the cell walls of soybeans, peas, carrots, citrus and a lower percentage of soluble fiber - gums.

APPLICATIONS OF DIETARY FIBERS IN BEVERAGE

Addition of DF can increase the stability and viscosity of beverages and drinks. Soluble DF is often used due to its higher dispersible properties in water as compared to insoluble fiber.

Pectin, cellulose, and β-glucans are other soluble fibers that gain potential applications. Oat fiber has been supplemented into fruit and vegetable juices, instant beverages (breakfast drinks, milkshakes, sports drinks, iced tea, wine), and other snack products.

DFs can also be incorporated into beverages prepared for people with special needs for weight loss.

Fortification of fiber ingredients such as cellulose gels, guar gums, and alginates can be a good substitute for fat, which is also envisaged to improve emulsion, viscosity, and foam, reduce syneresis, control melting properties, and stimulate the formation of ice crystals. Gums are excellent ingredients used in beverage formulation because don't influence taste or smell when formulated correctly. They can provide many functions, such as stabilising emulsions in drinks, providing a pleasant mouthfeel, and good suspension. New hydrocolloid sources have been developed in recent years which have been used as soluble fiber in beverages, e.g. fructose polymers inulin and oligofructans (Gallo-Torres & O´Donnell, 2003), and polydextrose (Brooks, 2003).

CONCLUSIONS

DFs are valuable ingredients in the recipes of some food products. Water solubility of DF, fiber composition, and the ratio of soluble/insoluble DF in an ingredient are critical parameters for the exhibited functionality of the added fibers.

They can be successfully formulated into different types of food products to improve nutritional values by increasing fiber and reducing sugar or fat and increasing consumer acceptance. DF shows specificity and behavior in different products and for this reason, it is important to know very well the chemical and behavioral properties to help us in food processing. DF are also considered fibers with a functional role both in food and in the body.

ACKNOWLEDGEMENTS

This research was funded by University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania within the internal project "Obtaining an innovative preparation of minced beef, with the addition of fibers from local sources" - FiberBeef, 1066/15.06.2022.

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