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Mini Review

Dietary Fiber and Labeling in Packaged Foods: An Essential Combination

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Abstract

The preagricultural diets considered by hunting and gathering foods consisted of meat, fish, and uncultivated grains, such as nuts, seeds, fruit, and vegetables with higher-fiber content. This period was finished about 10,000 years ago. Long after, during the industrial revolution, when the invention of the steel roller milling system provided an economical process to convert whole grain to white flour at a reasonable price, it resulted in a significant shift to today's lower-fiber bakery products. In the 1960s and 1970s, the dietary fiber hypothesis was developed and postulated that fiber intake was inversely associated with Western diseases. Then, since the mid-1970s, interest in the role of Dietary Fiber in health and nutrition has motivated extensive research and received considerable public attention. Today, supplementing foods with dietary fiber can result in fitness-promoting foods that are lower in calories, cholesterol, and fat. The beneficial health actions of dietary fiber occur in the human gut, and the main components and most significant physicochemical, physiological activity, and characteristics of the sources of dietary fiber must be known for an excellent approach to the patient to improve dietary fiber intake. In addition, essential changes in the food industry have altered consumer eating behavior in recent years. Increasingly busy consumers have limited time to prepare meals, and, at the same time, there is a growing interest in a healthy diet, creating a need for ready-to-eat products. The food industry works to meet consumers' desires concerning foods that bring health benefits, in addition to aspects such as taste and appearance. Therefore, the importance of descriptive analysis of these products, generating complete information on dietary fiber requires clear information about its use. Consequently, packaged food labels must display nutrient content information to guide healthy food choices. Thus, nutritional labeling analysis can guarantee quality information for the consumer and potentially positively influence diet.

Keywords: *Dietary Fiber; Food Label; Food Industry; Fitness-Promoting Foods; Dietary Fiber in Health*

Abbreviations

DF Dietary Fiber; FAO Food and Agriculture Organization of the United Nations; WHO World Health Organization; SACN Scientific Advisory Committee on Nutrition; EFSA European Food Safety Authority; AAP American Academy of Pediatrics); DRI-AI Adequate Intake; IOM Institute of Medicine; FDA: Food and Drug Administration

Introduction

Dietary fiber is an essential nutrient

In the Paleolithic period, the preagricultural diets consisted of meat, fish, and uncultivated grains, such as nuts, seeds, fruit, and vegetables with higher-fiber content. This period, characterized by the hunting and gathering of foods, was finished about 10,000 years ago [1,2]. In 370 BC, Hippocrates once said that "whole meal bread makes larger feces than refined bread," emphasizing the importance of Fiber's physiological benefits [3]. Accordingly, fiber-rich grain products persisted as the primary source of baked foods for a long time; however, during the Industrial Revolution, when the steel roller milling system provided a process to convert whole grain to white flour at a reasonable price, it resulted in a significant shift to today's lower-fiber bakery products [4]. Indeed, the diet now consumed in Western developed countries opposes the preagricultural diet [5]. Subsequently, in the 1970s, the Dietary Fiber Hypothesis was developed and hypothesized that fiber intake was inversely associated with Western diseases [6,7]. Then, since the mid-1970s, interest in the role of Dietary Fiber (DF) in health has motivated extensive research and received substantial public attention. Today, DF can result in fitness-promoting foods that are lower in calories, cholesterol, and fat [8].

Definitions

DF's definitions are based on its chemical composition, the type of analysis, and physiological effects, such as solubility, fermentation, hydration capacity, and fat retention capacity [9,10]. Generally, DF is a "group of carbohydrates resistant to digestion by enzymes in the small intestine and partially fermented by the gut microbiota with favorable health effects" [11]. In addition, "Dietary fiber consists of remnants of plant cells resistant to hydrolysis by the alimentary enzymes of man" [12]. Subsequently, many official regulatory agencies worldwide defined the DF to adapt to its physiologic function rather than its chemical composition. Table 1 designates a summary of DF definitions of the leading institutions worldwide.

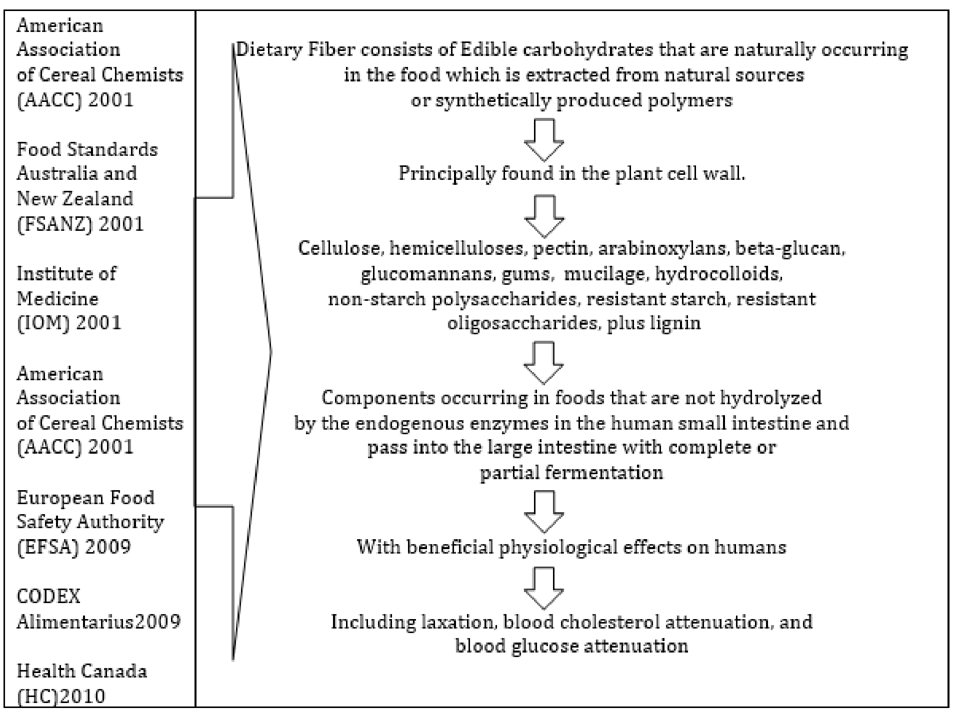

Table 1: *Summary of definitions of dietary fiber according to different organizations. Data compiled from references [13-15].*

Classification of dietary fiber

The most common classification of DF is based on solubility (soluble and insoluble) in water and fermentability (fermentable and nonfermentable) in the human colon. Fermentable dietary fibers are water-soluble, while nonfermentable or least-fermentable DF are water-insoluble [16-18]:

- **Soluble dietary fiber:** Soluble in aqueous solution, shows resistance to digestion in the small intestine and suffers the fermentation process in the large intestine by intestinal microorganisms. Based on dissolution in water, soluble fibers are further divided into Viscous Fiber and Non-Viscous Fiber. Soluble DF enhances the transit time and delay in gastric emptying and reduces glucose absorption. Soluble dietary fibers include beta-glucan, pectin, gums, and inulin. Sources of soluble DF include fruits and vegetables [19].
- **Insoluble dietary fiber:** It is insoluble in water, does not show gel formation, and does not suffer fermentation in the large intestine. When consumed, they enhance the fecal bulk and reduce intestinal transit time. Insoluble dietary fibers include cellulose, hemicelluloses, lignin, cutin, suberin, chitin, and chitosan [20,21].

The beneficial health actions of DF occur in the human gut. DF is transferred from the small intestine, which cannot be digested, to the large intestine. The beneficial microbes from the gut totally or fractionally ferment DF. The fermentation process's efficiency from the gut depends upon the carbohydrate's structure and glycosidic linkages. Consecutively, table 2-5 present the main components and most significant physicochemical, physiological activity, and characteristics of the sources of DF.

Cellulose	Homopolysaccharides are composed of monomers of β-glucose linked by β-1,4-O-glycosidic bonds. It is the most abundant organic biomolecule in nature due is the significant component of the cell walls of all plants. Cellulose, an Insoluble DF, is resistant to digestion [19].
Hemicelluloses	Heteropolysaccharide is formed by more than one type of monomer, generally of five or six monomeric residues: glucose, galactose, xylose, arabinose, mannose, and glucuronic acid, among others. It is the second most abundant biomass component after cellulose. [22].
Pectin	Heteropolysaccharides are considered an important hydrocolloid widely used in food production. Pectin can be used like a DF in structural modifications that chemical or enzymatic processes can carry out [23].
Gums	A variety of gums could be considered DF. Guar gum (poly galactomannan) is a soluble DF obtained from seeds. Also, this compound is widely used in food processing because it confers textural changes such as thickening and stabilizing [24].
Resistant Starch	Starch that is not hydrolyzed in the human small intestine. It is classified into five subgroups: encapsulated starch, resistant granules, retrograded amylose, chemically modified starch, and amylose-lipid complex [25-27].
Oligosaccharides	They are defined as carbohydrates that consist of 3-10 monosaccharide units, linear or branched. The principal oligosaccharides are fructooligosaccharides (FOS = a linear oligosaccharide composed of 10–20 units of fructose) and galactooligosaccharides (GOS = is mainly obtained from enzymatic hydrolysis of lactose) [18,28].
Lignin	It is an organic polymer considered a highly branched phenolic compound with functional groups such as phenolic, methoxyl, carboxyl, p-hydroxy-phenyl, and aliphatic hydroxyl. It is nature's most abundant source of aromatic chemicals [29].

Table 2: *Dietary fiber and its main components.*

Solubility	Its tendency to hydrate is divided into: soluble DF (physiological actions such as slow gastric emptying, delayed glucose absorption, and reduction of serum cholesterol, and protection against cardiovascular diseases; and insoluble DF(associated with effects on the human digestive system (good bowel habits and protection against colorectal cancer).
Viscosity	The gel formation produces gelatinous mass or viscous solutions, which increase the volume and viscosity of the contents of the gastrointestinal tract.
Fermentability	DF act as a substrate for the fermentation process. Soluble DF is fermentable by bacteria in the colon. Bowel functions like fecal weight, stool frequency, colonic pH, and food energy depend on fermentability.
Water holding and binding capacity	The principle of the gel-forming action of polysaccharides defines it.
The binding ability of minerals and bile acids	DF can bind ions and polar materials, and interaction with water forms gel-like structures, showing the binding and trapping of bile acids that are excreted in the feces, causing an increase in the use of cholesterol in the body.
Particle size and porosity	The size of particles changes according to the type of cell wall, source, and level of processing, in addition to interacting with several physiological functions in the human intestine (transit time, digestion, fermentation rate, and fecal excretion).
Oil-binding ability	The Porosity in the DF structure is a factor responsible for the oil binding capacity. The porous of DF components allows oil to bind in the pores present in its structure.

Table 3: *Physicochemical properties of dietary fiber [18,29-31].*

Increased Mastication	Foods with DF are more challenging to process in the mouth as they have compact textures. Foods rich in DF require greater Chewing to increase the feeling of satiety by stimulating saliva secretion and responses of the cephalic and gastric phases, which can reduce the ingestion rate.
Gastric Distention	Due to longer chewing time and sensory interaction during consumption, FA-rich foods can promote gastric distention through increased saliva and gastric acid production. An increase in satiety for high-viscosity meals suggests another mechanism by which Viscosity influences satiety beyond simply delaying gastric emptying.
Gastric Emptying	The viscosity of the gastric contents and the chemical composition of the digestion are considered essential for the delay of gastric emptying.
Effects on Satiety	Satiety inhibits hunger after the end of food intake and prevents further intake. Due to its bulking and texture properties, DF provides greater satiety than digestible polysaccharides, simple sugars, and nutrients such as protein alone. DF chemical structure and physicochemical properties are also crucial for effects on satiety and long-term appetite, hence regulating energy intake. Insoluble DF impacts satiety greater than soluble DF.
Absorption of Nutrients	Soluble DF is thought to encapsulate nutrients and delay their absorption, increasing intestinal transit time and leading to a more gradual absorption of nutrients and prolonged feelings of satiety. The gel matrix of hydrated DF can thicken the small intestine's contents, decreasing the diffusion of cholesterol, sugars, and other nutrients for absorption and limiting contact between food and digestive enzymes, interrupting micelle formation and contact with the intestinal wall. Viscosity can thicken the stationary water layer on absorbent surfaces, decreasing the glucose diffusion rate.

Table 4: *Physiological activity of dietary fiber [18,32,33].*

Cereals	In Western countries, wheat, barley, oats, and maize contribute approximately 50% of df intake. DF in whole grains has a higher proportion of insoluble vs soluble Fiber. These cell walls are composed of cellulose and complex xylans and may contain a significant quantity of lignin.
Legumes	Generally, the insoluble DF of legumes is composed of hemicelluloses and cellulose. On the other hand, the soluble DF is composed of pectin polysaccharides in beans, peas, chickpeas, lentils, soybeans, lupins, sprouts, and peanuts. Legume fibers possess advantages over cereal fibers (higher content of soluble components, leading to a more significant formation of volatile fatty acids (acetic acid, propionic acid, and butyric acid) that inhibit cholesterol synthesis. Beans are the legumes with the highest DF content (60% - 85% insoluble and 40% - 15% soluble DF).
Vegetables	Commonly eaten vegetables offer a range of diverse cell wall structures that comprise the majority of available DF. Root vegetables like carrots contain a lignified ring of cells that effectively limits water transport.
Fruits	The Fiber of the fruits comes from the walls of the parenchyma cells. Plant cell walls contain a group of complex soluble polysaccharides, including mainly pectic polysaccharides. The significant components of fruit peels include non-starch polysaccharides and lignin, neither digested nor absorbed in the human small intestine.

Table 5: *Characteristics of the sources of dietary fiber [15].*

Dietary fiber daily intake recommendations

Dietary guidelines recommend eating various fruits, vegetables, and whole grains. Whole foods may provide additional beneficial micronutrients and phytochemicals beyond DF alone. Intake of DF from natural food sources is generally preferable to supplements [34-36]:

- The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) recommend > 25g per day of DF [37].
- The Scientific Advisory Committee on Nutrition (SACN) recommends that the dietary reference value for average adult intake is 30 g/day [35].
- The European Food Safety Authority (EFSA) recommends an intake of 25 g/day for adequate normal bowel function in adults [38].
- Some public health organizations recommend intake based on energy requirements (14 g/1000 kcal). According to the FDA, the daily intake of DF reported on labels would be 25g for a 2000 kcal/day diet or 30g for a 2500 kcal/day diet [39].
- The Institute of Medicine set the adequate intake for Fiber at 14 g/1000 kcal, which would give around 38 g/day for men and 25 g/day for women [40].
- For children, recommendations vary with a broad range of DF. Table 6 presents the different recommendations.

Dietary fiber and human health

DF has been the focus of many studies because of its ability to improve human health. So, it is essential to understand why DF is considered a nutrient, and therefore, it is necessary to incorporate it into the daily diet. There are numerous physiological benefits related to the consumption of DF. However, further studies are needed to determine appropriate levels of DF to reduce a specific disease. Consumption of adequate DF reduces the risk of the diseases mentioned above [41].

Table 7 presents some of the most representative benefits related to the consumption of DF [29].

Based on...				
Energy	IOM 14 g fiber/1000 kcal		FDA 12 g/1000 kcal	
Grams/day DRI-AI	Adequate Intake			
	1-3 y	4-8 y	9-13 y	14-18 y
	19	25		
	Boys		31	38
	Girls		26	26
Kg body weight AAP	0.5 g fiber/(kg body weight /d) up to 35 g/d			
Age AAP Children older than 3 years of age	Minimum		Maximum	
	Age plus 5g		Age plus 10	
IOM (Institute of Medicine); FDA (Food and Drug Administration); AAP (American Academy of Pediatrics). DRI-AI (Adequate Intake)				

Table 6: *Dietary intake recommendations for dietary fiber for children.*

Laxation and improved intestinal transit time are widely associated with DF intake.
DF helps to regulate glucose, lipid metabolism, and mineral bioavailability.
DF intake can decrease low-density lipoprotein (LDL) levels and reduce the risk of cardiovascular disease.
Consumption has been demonstrated to attenuate the glucose absorption rate.
DF modifies some gut hormones that affect satiety and energy intake, regulating lipid metabolism and energy expenditure and affecting obesity, insulin resistance, and hyperlipidemia, thus reducing weight gain.
Significant antioxidant capacity probably comes from phenolic acids, phenylpropanoids, and flavonoids, which have been reported in DF.
Lower colorectal cancer prevalence.
Prebiotic effects attributed to fermentable fibers (mainly poly- and oligosaccharides) may provide health benefits by altering intestinal microbiota composition.

Table 7: *Benefits related to the consumption of dietary fiber [29].*

Dietary fiber: The consumers and food industry

Nowadays, more and more busy consumers have limited time to prepare meals, with growing interest in a healthy diet and the necessity for ready-to-eat products. Consequently, the food industry works to meet consumers' desires concerning foods that bring health benefits and improve taste and appearance. Consequently, the food industry has altered consumer eating behavior. So, the new type of food consumption and the food industry require an effective way of informing the consumer. These results support recommendations for higher DF intake as a healthy diet. Indeed, a comprehensive review of systematic reviews with a meta-analysis of observational studies on the value of DF highlights that high intake can reduce the risk of total mortality [42]. Therefore, the importance of descriptive analysis of these products, generating information on DF requires precise data to connect DF's properties and health effects. Following these considerations, food labels are essential for displaying adequate information [43].

Packaged food labels display nutrient content information and are intended to guide healthy food choices. Thus, nutritional labeling analysis can guarantee quality information for the consumer and potentially positively influence diet. Two labels on the front of the package inform the consumer of the name, brand, and type of food. Labels on the back of the pack include a Nutrition Facts panel that provides details on the nutritional composition of the food. To help the consumer interpret the information, amounts are also presented as a percentage of the recommended daily intake [44]. Labeling schemes provide visual information about the product, whether based on specific nutrient content or the overall nutritional quality of the product [45]. This was recently demonstrated in a systematic review of various types of food labels, including "front-of-package-FOP" and "back-of-package-BOP" labels, labels on restaurant menus, and labels in supermarkets [46]. Thus, labeling packaged foods would be an excellent way of strengthening communication between the food industry and the consumer. Table 8 presents the declaration of DF content on the nutritional label.

	g of DF/ 100g of food	
	Source	**High content**
FDA	2.5g	5g
European Union	3g	6g
	1.5g per 100 kcal	3g per 100 kcal
	10% or 2.5g of DF	20% or 5g of DF

Table 8: *The declaration of dietary fiber content on the nutritional label.*

The quality of the labeling

Different analyses can be carried out from the labels of packaged foods, one of which can be the amount of DF per portion of food, which in turn allows a better recommendation of Adequate Intake, mainly when associated with nutritional education. When well-designed, labels can potentially have a positive influence on diet. The following evaluation possibilities on the label can be observed: the amount of DF grams/100 grams of food; the amount of DF grams/100 calories of food; the presence of food sources of DF in the list of ingredients; highlight on the packaging the presence of DF; a detailed description of the number of whole grains per serving, and distribution of nutrients in grams/serving [47-49].

Conclusion

Communication strategies for adequate dietary fiber intake

DF is unquestionably part of a healthy diet. Therefore, a diet that includes a variety of fiber sources, especially fruits, vegetables, whole grains, legumes, nuts, and seeds, will help to lower their risk for some chronic diseases. Due to the media's widespread publicity, it has been widely accepted that DF is a necessary component of a healthy diet [39,50]. It is necessary to correct consumer misperceptions, as all whole foods are expensive, unpalatable, and complicated to prepare. Nutrition educators should provide clear and concise information, including advising people to check nutrition labels to find good sources of DF. When shopping, check the Nutrition Facts on food packages to be sure they are getting a good source of DF (at least 3 grams per serving) or an excellent source of Fiber (at least 5 grams per serving) [51,52].

Conflict of Interest

There is no conflict of interest.

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Author Contribution to the Manuscript

Idea/concept, design, literature review, writing, and critical review performed by all the authors.

Bibliography

1. Konner Melvin and S Boyd Eaton. "Paleolithic Nutrition: Twenty-Five Years Later". *Nutrition in Clinical Practice: Official Publication of the American Society for Parenteral and Enteral Nutrition* 25.6 (2010): 594-602.
2. Eaton S Boyd., *et al*. "Diet-Dependent Acid Load, Paleolithic [Corrected] Nutrition, and Evolutionary Health Promotion". *The American Journal of Clinical Nutrition* 91.2 (2010): 295-297.
3. Kritchevsky D. "Dietary Fiber". *Annual Review of Nutrition* 8.1 (1988): 301-328.
4. Eaton S Boyd. "What Did Our Late Paleolithic (Preagricultural) Ancestors Eat?" *Nutrition Reviews* 48.5 (2009): 227-229.
5. Jew Stephanie., *et al*. "Evolution of the Human Diet: Linking Our Ancestral Diet to Modern Functional Foods as a Means of Chronic Disease Prevention". *Journal of Medicinal Food* 12.5 (2009): 925-934.
6. Burkitt DP. "Some Diseases Characteristic of Modern Western Civilization". *BMJ* 1.5848 (1973): 274-278.
7. Trowell H. "Definition of Dietary Fiber and Hypotheses That It Is a Protective Factor in Certain Diseases". *The American Journal of Clinical Nutrition* 29.4 (1976): 417-427.
8. Poutanen Kaisa S., *et al*. "Recommendations for Characterization and Reporting of Dietary Fibers in Nutrition Research". *The American Journal of Clinical Nutrition* 108.3 (2018): 437-444.
9. Slavin Joanne. "Fiber and Prebiotics: Mechanisms and Health Benefits". *Nutrients* 5.4 (2013): 1417-1435.
10. Mora Yesica N., *et al*. "Chemical Composition and Functional Properties from Different Sources of Dietary Fiber". *American Journal of Food and Nutrition* 1.3 (2013): 27-33.
11. Jones Julie Miller. "Dietary Fiber Future Directions: Integrating New Definitions and Findings to Inform Nutrition Research and Communication". *Advances in Nutrition* 4.1 (2013): 8-15.
12. Dhingra Devinder., *et al*. "Dietary Fibre in Foods: A Review". *Journal of Food Science and Technology* 49.3 (2012): 255-266.
13. Howlett John F., *et al*. "The Definition of Dietary Fiber - Discussions at the Ninth Vahouny Fiber Symposium: Building Scientific Agreement". *Food and Nutrition Research* 54.1 (2010): 5750.
14. Jones Julie Miller. "CODEX-Aligned Dietary Fiber Definitions Help to Bridge the 'Fiber Gap". *Nutrition Journal* 13.1 (2014): 34.
15. Stephen Alison M., *et al*. "Dietary Fibre in Europe: Current State of Knowledge on Definitions, Sources, Recommendations, Intakes and Relationships to Health". *Nutrition Research Reviews* 30.2 (2017): 149-190.

16. Slavin JL. "Dietary Fiber: Classification, Chemical Analyses, and Food Sources". *Journal of the American Dietetic Association* 87.9 (1987): 1164-1171.

17. Tungland BC and D Meyer. "Nondigestible Oligo- and Polysaccharides (Dietary Fiber): Their Physiology and Role in Human Health and Food". *Comprehensive Reviews in Food Science and Food Safety* 1.3 (2002): 90-109.

18. Dai Fan-Jhen and Chi-Fai Chau. "Classification and Regulatory Perspectives of Dietary Fiber". *Journal of Food and Drug Analysis* 25.1 (2017): 37-42.

19. Mudgil Deepak and Sheweta Barak. "Composition, Properties and Health Benefits of Indigestible Carbohydrate Polymers as Dietary Fiber: A Review". *International Journal of Biological Macromolecules* 61 (2013): 1-6.

20. Hamaker Bruce R and Yunus E Tuncil. "A Perspective on the Complexity of Dietary Fiber Structures and Their Potential Effect on the Gut Microbiota". *Journal of Molecular Biology* 426.23 (2014): 3838-3850.

21. Holscher Hannah D. "Dietary Fiber and Prebiotics and the Gastrointestinal Microbiota". *Gut Microbes* 8.2 (2017): 172-184.

22. Farhat Wissam., *et al*. "Hemicellulose Extraction and Characterization for Applications in Paper Coatings and Adhesives". *Industrial Crops and Products* 107 (2017): 370-377.

23. Verkempinck SHE., *et al*. "Pectin Influences the Kinetics of in Vitro Lipid Digestion in Oil-in-Water Emulsions". *Food Chemistry* 262 (2018): 150-161.

24. Slavin Joanne L and Norman A Greenberg. "Partially Hydrolyzed Guar Gum". *Nutrition* 19.6 (2003): 549-552.

25. Fuentes-Zaragoza E., *et al*. "Resistant Starch as Functional Ingredient: A Review". *Food Research International* 43.4 (2010): 931-942.

26. Zhao Xue., *et al*. "Resistant Starch and Other Dietary Fiber Components in Tubers from a High-Amylose Potato". *Food Chemistry* 251 (2018): 58-63.

27. Lockyer S and AP Nugent. "Health Effects of Resistant Starch". *Nutrition Bulletin* 42.1 (2017): 10-41.

28. Zhao Chao., *et al*. "Functional Properties, Structural Studies and Chemo-Enzymatic Synthesis of Oligosaccharides". *Trends in Food Science and Technology* 66 (2017): 135-145.

29. Li Yao Olive and Andrew R Komarek. "Dietary Fibre Basics: Health, Nutrition, Analysis, and Applications". *Food Quality and Safety* 1.1 (2017): 47-59.

30. Cummings JH and HN Englyst. "Fermentation in the Human Large Intestine and the Available Substrates". *The American Journal of Clinical Nutrition* 45.5 (1987): 1243-1255.

31. Dikeman Cheryl L and George C Fahey. "Viscosity as Related to Dietary Fiber: A Review". *Critical Reviews in Food Science and Nutrition* 46.8 (2006): 649-663.

32. Fiszman Susana and Paula Varela. "The Role of Gums in Satiety/Satiation. A Review". *Food Hydrocolloids* 32.1 (2013): 147-154.

33. Slavin J and H Green. "Dietary Fibre and Satiety". *Nutrition Bulletin* 32.s1 (2007): 32-42.

34. Smith Caren E and Katherine L Tucker. "Health Benefits of Cereal Fibre: A Review of Clinical Trials". *Nutrition Research Reviews* 24.1 (2011): 118-131.

35. SACN. Scientific Advisory Committee on Nutrition. Carbohydrates and Health. TSO (2015).

36. De Vries Jan., *et al*. "Effects of Cereal, Fruit and Vegetable Fibers on Human Fecal Weight and Transit Time: A Comprehensive Review of Intervention Trials". *Nutrients* 8.3 (2016): 130.

37. WHO. World Health Organization. "Diet, Nutrition and the Prevention of Chronic Diseases". World Health Organization Technical Report Series 916 (2003): 1-149.

38. EFSA. European Food Safety Authority. "Scientific Opinion on the Substantiation of a Health Claim Related to Barley Beta-Glucans and Lowering of Blood Cholesterol and Reduced Risk of (Coronary) Heart Disease Pursuant to Article 14 of Regulation (EC) No 1924/2006". *EFSA Journal* 9.12 (2011): 2471.

39. Anderson James W., *et al*. "Health Benefits of Dietary Fiber". *Nutrition Reviews* 67.4 (2009): 188-205.

40. Institute of Medicine. Dietary Reference Intakes. Proposed Definition of Dietary Fiber. National Academies Press (2001).

41. Dahl Wendy J and Maria L Stewart. "Position of the Academy of Nutrition and Dietetics: Health Implications of Dietary Fiber". *Journal of the Academy of Nutrition and Dietetics* 115.11 (2015): 1861-1870.

42. Veronese Nicola., *et al*. "Dietary Fiber and Health Outcomes: An Umbrella Review of Systematic Reviews and Meta-Analyses". *The American Journal of Clinical Nutrition* 107.3 (2018): 436-444.

43. Kim Youngyo and Youjin Je. "Dietary Fiber Intake and Total Mortality: A Meta-Analysis of Prospective Cohort Studies". *American Journal of Epidemiology* 180.6 (2014): 565-573.

44. Hawley Kristy L., *et al*. "The Science on Front-of-Package Food Labels". *Public Health Nutrition* 16.3 (2013): 430-439.

45. Van Kleef Ellen and Hans Dagevos. "The Growing Role of Front-of-Pack Nutrition Profile Labeling: A Consumer Perspective on Key Issues and Controversies". *Critical Reviews in Food Science and Nutrition* 55.3 (2015): 291-303.

46. Shangguan Siyi., *et al*. "A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices". *American Journal of Preventive Medicine* 56.2 (2019): 300-314.

47. Grunert Klaus G., *et al*. "Nutrition Knowledge, and Use and Understanding of Nutrition Information on Food Labels among Consumers in the UK". *Appetite* 55.2 (2010): 177-189.

48. Temple Norman J and Joy Fraser. "Food Labels: A Critical Assessment". *Nutrition* 30.3 (2014): 257-260.

49. Malloy-Weir L and M Cooper. "Health Literacy, Literacy, Numeracy and Nutrition Label Understanding and Use: A Scoping Review of the Literature". *Journal of Human Nutrition and Dietetics* 30.3 (2017): 309-325.

50. Kohn Jill Balla. "Is Dietary Fiber Considered an Essential Nutrient?" *Journal of the Academy of Nutrition and Dietetics* 116.2 (2016): 360.

51. Asioli Daniele., *et al*. "Making Sense of the 'Clean Label' Trends: A Review of Consumer Food Choice Behavior and Discussion of Industry Implications". *Food Research International* 99 (2017): 58-71.

52. Campos Sarah., *et al*. "Nutrition Labels on Pre-Packaged Foods: A Systematic Review". *Public Health Nutrition* 14.8 (2011): 1496-1506.

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