Annals of Phytomedicine 11(2): 114-121, 2022

DOI: http://dx.doi.org/10.54085/ap.2022.11.2.12

Annals of Phytomedicine: An International Journal

http://www.ukaazpublications.com/publications/index.php

Print ISSN : 2278-9839 Online ISSN : 2393-9885

Review Article : Open Access

Functional foods for better health and weight loss

Nidhi Sharma and Maryam Sarwat◆

Amity Institute of Pharmacy, Amity University, Noida-201301, Uttar Pradesh, India

Article Info

Article history

Received 1 June 2022

Revised 16 July 2022

Accepted 17 July 2022

Published Online 30 December-2022

Keywords

Fruits

Functional foods

Obesity

Vegetables

Weight loss

Abstract

The prevalence of obesity has increased gradually in recent decades. Obesity is a metabolic disorder causing decreased life expectancy and is strongly associated with co-morbidities including diabetes mellitus, hypertension, cardiovascular disorders and cancer. A good diet and changes in lifestyle are important to regulate appetite and satiety through the modulation of adipogenesis and thermogenesis. This has increased consumers' and public health interest in food that may help them to control appetite and weight. In recent years, functional food and its bioactive derivatives are gaining widespread attention due to their diverse biological properties. Green tea, legumes, whole grains, nuts, dairy products and dietary fibers are some examples of functional foods. Regular intake of functional foods may enhance the body's antioxidant, anti-inflammatory and anticholesterol functions. For this reason, functional foods and their components can be used strategically as a weight management tool against obesity. In this review, we have highlighted the protective role of functional foods as a nutritive therapy in obese individuals. Additionally, several functional components, including dietary fibers, fucoidan, polyphenols, tocopherols, tocotrienols, prebiotics, probiotics, *etc*., have been described for their specific actions in weight loss.

1. Introduction

In today's world, lifestyle and health ignorance are the two classical conditions that lead to the development of diseases at a very early age (Farhud, 2015; Wadhwa *et al.*, 2022). It is well documented that stress is the most common reason for unhealthy food choices. It has been found that more than 1.5 billion adults are obese worldwide, making obesity a global epidemic (WHO, 2011). Maintaining constant body weight requires a balance between energy intake and energy expenditure. The availability of processed and high-calorie food, especially those consumed between meals, increased food intake and reduced energy expenditure, leading to obesity (Romieu *et al.*, 2017). Obesity is a metabolic disorder that is associated with lipogenesis and increased adipose tissues. It contributes to the development of several lethal diseases including type 2 diabetes, osteoarthritis, cardiovascular diseases, cancers and early death (Figure 1) (Kyrou *et al.*, 2018). Hence, obesity and weight gain are a matter of concern to our healthcare professionals. However, strictly adhering to the reduced energy diet for a long period of time is very challenging. Therefore, the implementation of effective and preventive strategies are required to overcome these health-related challenges. Foods of high satiety value can help minimize calorie intake and thereby promote weight loss (Sandner *et al.*, 2020). Bioactive compounds are present in small quantities in food items and their effect on human health is continuously being monitored.

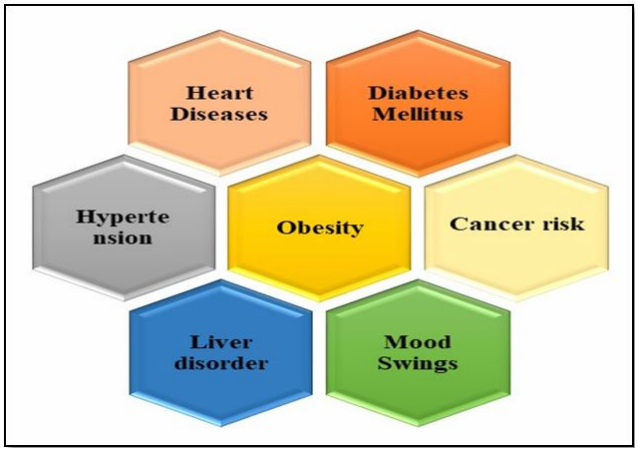

Figure 1:Co-morbidities associated with obesity.

Functional foods were first defined in 1980 as responsible for enhancing body metabolism. They represent potent dietary approaches to support weight management and are often indicated as natural health products or healthy foods (Patel *et al*., 2022). Functional foods have a positive role in fat partitioning and enhancing body metabolism which may be a useful approach for weight loss. Any food can be considered functional when it provides health benefits beyond basic nutrients and eventually minimize the risk of chronic diseases. Functional foods are a very rich source of bioactive compounds (biochemical molecules that promote health by the physiological process) that provide scientifically validated health

Corresponding author: Dr. Maryam Sarwat

Associate Professor, Amity Institute of Pharmacy, Amity University, Noida-201301, Uttar Pradesh, India

E-mail: msarwat@amity.edu, maryam21_7@yahoo.com

Tel.: +91-9990373875

benefits in controlling and preventing several dreadful diseases (Abuajah *et al.*,2015). Additionally, existing pieces of literature conclude that functional food may have a beneficial effect on human health only when it is a part of a balanced diet. The current review summarizes the beneficial effect of functional foods in weight management.

2. Functional foods and their categories

All foods are said to be functional to some extent as they provide taste, aroma, and nutritive value. In addition, food is now being analyzed extensively for its additional physiological benefits. A Japanese Scholarly Society proposed the idea of functional food in the early 1980s. It is defined as potentially healthful food used for several therapeutic purposes. Functional food contains components that are intended to optimize overall health (Konstantinidi and Koutelidakis, 2019). They are gaining widespread attention and have become a part of consumer's daily diet. It is categorized as conventional and modified functional foods. Common examples of functional foods include whole grains, fiber bread (natural products), calcium-fortified milk, vitamin D-fortified milk and vitamin C-fortified fruit juices, margarine with phytosterol, prebiotics (chicory roots and garlic), probiotics (yogurt and kefir), and eggs with increased omega-3 produced by altering chicken feed (Morais *et al.*, 2018). Thus, functional foods provide the body with the suitable amount of vitamins, minerals, proteins, fat, *etc.*, required for its healthy survival.

While designing any functional foods, consumer demands must be taken into consideration. Due to their pleiotropic health benefits, the producers of functional foods have divided them into different categories.

(i) Conventional foods are natural or whole foods that have plenty of vital nutrients including vitamins, minerals, antioxidants and healthy fats. An organic diet includes more beneficial and less toxic components and their metabolites, pesticides and fertilizers. The purpose of these foods is to ensure the nutritional quality of a particular component. Fruits (dry and fresh), vegetables (leafy and non-leafy), nuts, seeds, legumes and spices are common examples of conventional food. This category of functional foods exerts beneficial effects on health (Arshad *et al.*, 2021).

(ii) Modified foods are those that have been fortified with additional specific nutrients at levels greater than those found in original food, to impart additional health-related benefits (Divya, 2022). Enrichment is basically associated with fortification. Fortified juices, dairy products (milk and yogurt), fortified cereals, granola and eggs are some examples of modified foods. Nutritional fortification is used to resolve public health problems related to nutrient deficiency (Arshad *et al.*, 2021).

3. Functional components of food

Functional components are non-conventional biomolecules or non-nutritive secondary metabolites present in food. They regulate metabolic processes and pathways in the body and impact positively on wellness (Rebello *et al.*, 2014). Research has provided us with shreds of evidence about the health-promoting roles of functional components in disease control.

Functional components include plant-derived phytochemicals that are mainly responsible to prevent the onset of certain communicable diseases. There are more than 900 phytochemicals present in foods. 100 different phytochemicals are there in one serving (about 120 g) of fruit or vegetables (Srividya *et al.*, 2010). Thus, they can be effectively applied to a daily diet to keep ourselves away from diseases. Along with plant foods, functional components are equally present in animal products such as milk, fermented milk products, and cold-water fish. Examples include probiotics, dietary fibers, fruits, vegetables, dairy products and long-chain omega-3,-6 and-9 fatty acids (Figure 2). Functional components occur in different forms including thiolate, glycosylated, hydroxylated and esterified materials in food.

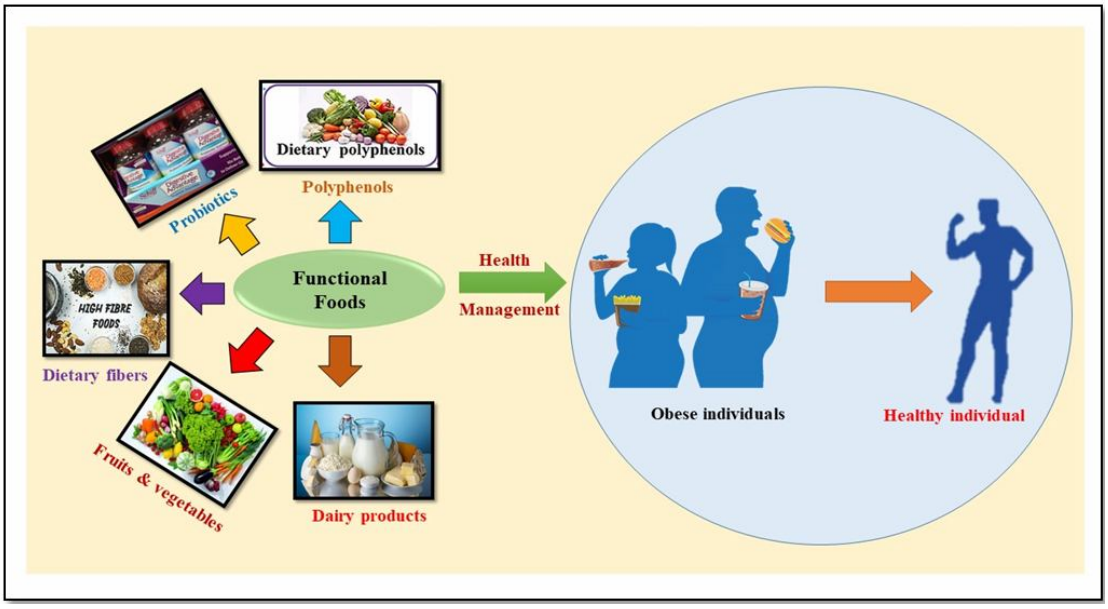

Figure 2: Functional foods in health management.

3.1 Non-starchy carbohydrates

They are structural and storage carbohydrates which are polymers of simple sugars or glucose molecules including fructose, xylose, galactose and arabinose. They are not hydrolyzable by the human digestive enzyme as they are non-starchy in nature. They usually undergo fermentation by the probiotic microbes present in the colon. Non-starchy carbohydrates include dietary fibers and fucoidan.

3.1.1 Dietary fibers

They are either soluble or insoluble non-starchy polysaccharides that are the essential structural component of the cell walls of cereals and micro-organisms. Chemically, they are the polymers of glucose in the hetero-structural configuration consisting of β (1, 3:1, 4) or β (1, 3:1, 6) bonds. Gums, pectins, mucilage, and, β-glucans are water-soluble fibers, whereas lignin, cellulose and hemicellulose are water-insoluble fibers (Paul *et al.,* 2020; Andlauer and Furst, 2002; Charalampopoulos *et al.,* 2002).

Sources: Foods rich in soluble dietary fiber include cranberries, apples, mango, oranges, asparagus, broccoli, walnuts, carrots, peanuts, most legumes, oats and psyllium while those rich in insoluble dietary fiber are apples, bananas, berries, broccoli, green peppers, spinach, almonds, sesame seeds, most legumes, brown rice, whole-wheat bread and cereals.

Functions: Dietary fibers entrap carcinogens and harmful toxins in the digestive tract as they have a long fibrous structure. Water-soluble dietary fibers lower serum cholesterol. Additionally, they have good water retention capacity, hydro-colloidal forming properties and good water retention capacity. For this reason, they have gained special attention in attributing numerous health benefits. On the other hand, insoluble dietary fibers add fecal bulk and increase the rate of passage of food through the intestinal tract. It also dilutes out potential carcinogens and decreases contact of toxins and carcinogens with the intestinal tract and speeds up their passage out of the body (Izydorczyk and Dexter, 2008).

3.1.2 Fucoidan

It is also known as sulfated and non-starchy polysaccharides. It consists of a complex structure that varies according to its source. It is basically a polymer of α-(1 → 3) linked fucose pyranose sugar units with sulfate groups substituted at C-2 and C-4 positions on some fucose residues. Traces of galactose, xylose and glucuronic acid are found in fucoidan (Becker and Lowe, 2003). The lack of a hydroxyl group on the carbon at the six-position (C-6) and its L-configuration make fucose different from other six-carbon sugars present in mammals.

Sources: Brown seaweeds and some medicinal mushrooms are found to be rich sources of fucoidan (Wine Brenner., 2007).

Functions: It helps in the synthesis of several immune cell types to increase protection against infections. It is known to stimulate phagocytic actions of macrophages due to the presence of polysaccharides in it. Additionally, it inhibits the spread of cancerous cells through apoptosis in human T-cell leukemia virus type I (HTLV-1) (Ahmad *et al.,* 2012).

3.2 Antioxidants

Antioxidants include groups of compounds that help in neutralizing free radicals and reactive oxygen species (ROS) inside the cells (Sharma *et al.,* 2021). Free radicals are associated with the formation of lipids, carbohydrates and fats. For *e.g.*, carotenoids and phytosterol.

3.2.1 Carotenoids (*lycopene and lutein*)

They are lipid-soluble plant pigments that can either be oxygenated ornon-oxygenated hydrocarbons consisting of 40 carbons and an extensive conjugated double bond system. The predominant non-polar functional carotenoids include α-carotene, β-carotene and lycopene while the primary polar functional carotenoids is leutin. They are found esterified in fatty acids and un-esterified in plant tissues. The total carotenoid quantity of fruits and vegetables is completely dependent on age and storage (Parker, 2000).

3.2.2 Phytosterol

Phytosterols are steroids that are similar to cholesterol and serve as structural components of the biological membranes of plants. β-sitosterol, campesterol and stigmasterol are the common bioactive phytosterols. Approximately, 250 mg of unsaturated phytosterols are present in a daily non-vegetarian diet while a vegetarian diet consistsof over 500 mg. Sitostanol (plant stanol)is the saturated derivative of plant sterols (Abuajah *et al.,* 2015).

Functions: Regulation of the redox potential within a cell and the reduction of potential initiators of cell death and carcinogenesis are the main functions of antioxidants. Apart from this, phytosterol/stanols sequester cholesterol in the intestinal tract and reduce its absorption. The dietary phytosterols may offer protection from most of the common cancers in western societies as suggested by epidemiological and experimental studies (Abuajah *et al.,* 2015).

3.2.3 Polyphenols

Polyphenols are the widely distributed group of functional molecules that consist of one or more benzene rings and a varying number of hydroxyl (OH), carbonyl (CO) and carboxylic acid (COOH) groups. They usually exist in conjugated forms with one or more attached sugar residues. Flavonoids are the most common class of polyphenols. Over 8000 polyphenolic compounds are reported in the literature. The reported total polyphenol content in foods and fruits are as follows: barley and millet (590 to 1,500 mg/100 g dry matter); fresh brussel sprouts (6 to 15 mg/100 g dry matter); fresh onions and leeks (20 to 20.25 mg/100 g dry matter); oats and corns (8.7 to 30.9 mg/100 g dry matter); blueberries, strawberries, cranberries and raspberries (total polyphenol content is about 37 to 429 mg/100 g dry matter) (Cory *et al.,* 2018).

Functions: Polyphenols has the ability to bind to toxins and carcinogens in the intestinal tract, thereby preventing their transformation and absorption (Cory *et al.,* 2018).

3.2.4 Tocopherols and tocotrienols

These are the lipid-soluble functional component consisting of a phenolic chromanol ring linked to an isoprenoid side chain that is either saturated (tocopherols) or unsaturated (tocotrienols). Alpha, beta, gamma, and delta are the four primary forms of tocopherols and tocotrienols. They have differentnumbers and positions of

methyl groups on the phenolic-chromanol ring. Additionally, tocopherols have three asymmetrical carbons at positions 2, 4, and 8 of the isoprenoid side chain (Lobo *et al.,* 2010).

Sources: Vegetable oils, nuts, and the germ portion of grains are rich sources of tocopherols and tocotrienols (Szewczyk *et al.,* 2021).

Functions: They neutralize active oxygen species, and thus possess potential chemopreventive and immunomodulatory properties (Szewczyk *et al.,* 2021).

3.2.5 Garlic extract

Garlic extract has also shown numerous health benefits. Its oil extract showed a reduction of mental disorders and prevention of blood coagulation even in diabetics while its water extract is effective in treating liver cancer (Konstantinidi and Koutelidakis, 2019; Abuajah *et al.,* 2015).

3.3 Probiotics and prebiotics

Probiotics are the living micro-organisms that after administration in an adequate amount confer health benefits to the host (Begum *et al.,* 2017), whereas prebiotics are the non-digestible food ingredients that enhance the activity and growth of probiotics in the digestive system (Florowska *et al.,* 2016). They basically help good bacteria to grow and flourish in the gut. Lactobacillus (LAB), bifidobacterium, *etc*., are some examples of probiotics, β-glucan and inulin is potent prebiotics.

Sources: Foods claimed to provide probiotics are cereal juice, frozen yogurt, granola, candy bars and cookies (Semyonov *et al*., 2012). Asparagus, sugar beet, garlic, chicory, onion, Jerusalem artichoke, wheat, honey, banana, barley, tomato, rye, soybean, human's and cow's milk, peas, beans, *etc*., are excellent sources of prebiotics (Davani-Davari *et al.,* 2019).

Functions: Probiotics are believed to maintain a healthy balance between good and bad micro-organisms in our digestive tract. When the digestive tract is healthy, it eliminates harmful microbes, toxins, chemicals, and other waste products. On the other hand, it utilizes all the things that our body needs, including nutrients from food and water. Apart from this, probiotics help in providing protection to our immune system (Abuajah *et al.,* 2015).

3.4 Fruits and vegetables

Consumption of fruits and vegetables in the required quantity offers pleiotropic health benefits against many chronic diseases (Singh and Chellamal, 2022). As recommended by WHO, a regular intake of 400 g of edible fruits and vegetables per day may prevent micronutrient deficiencies (Prabhakar, 2022). The presence of different functional components in fruits and vegetables are responsible for maintaining good health. Crujeiras *et al.* (2006) conducted a nutritional intervention study of eight weeks on obese individuals, who followed an energy-restricted diet and consumed enriched fruits. The results showed improved antioxidant capacity and low oxidized LDL levels in obese patients.

Some researchers have administered apples to wistar rats resulting in reduced body weight, fat deposits and glucose. This showed that apples possess antiobesity properties which are due to the regulation of genes responsible for adipogenesis, fat oxidation, and lipolysis (Boqué *et al.,* 2013).

Pomegranates are rich sources of phytochemicals including anthocyanins, phenolic acids and ellagitannins. It exerted anti-obesity properties both *in vivo* and *in vitro*. In addition, it exhibited hypoglycemic activity, suppressed α-glucosidase enzyme activity, reduce total cholesterol, improved blood lipid profiles and retard inflammation by modulating PPAR pathways (Medjakovic and Jungbauer, 2013).

Furthermore, green tomato extract when administered to mice along with a high-fat diet promotes weight loss by activating the AMP-activated protein kinase (AMPK, an enzyme essential in regulating cellular energy homeostasis) and acetyl-CoA carboxylase phosphorylation in the liver. Additionally, green tomatoes decreased liver weight, liver cholesterol, serum cholesterol levels and epididymal tissues (Choi *et al.,* 2013).

Onion peel tea suppressed weight gain, levels of epididymal fat tissues and lowered serum cholesterol when administered to high fat diet-induced obese (Balb/c) mice (Matsunaga *et al.,* 2014).

3.5 Beverages

Camellia sinensis or tea is the most consumed beverage across the world. Green tea, black tea, and oolong tea are reported to contain polyphenols in good quantity. Green tea and black tea are fermented, whereas oolong tea is partially oxidized. The polyphenolic compounds in oolong tea affect lipid metabolism by inhibiting pancreatic lipase (Yuda *et al.,* 2012). Green tea is well known for its immunomodulatory properties. It helps in enhancing humoral and cell-mediated immunity, thereby decreasing the risk of cancer and cardiovascular diseases. Caffeine is the main constituent of tea that exerts a thermogenic effect and induces the oxidation of fat. Caffeine enhances basal metabolic activity rate by 3% to 4% in obese individuals when consumed at 100 mg/ serving (Dulloo *et al.,* 1999).

Blueberry juice and mulberry juice are rich sources of anthocyanins. Researchers have investigated the potential of these juices in providing protection against obesity in high-fat-fed C57BL/6 mice. The results showed that juices reduced body weight, size of the fat cells, and epididymal fat. Apart from this, they suppressed the genes (PPARγ and FAS), involved in the fatty acid synthesis, and thereby altering lipid metabolism (Wu *et al.,* 2013). Additionally, noni juice is a rich source of phenolic acids including gentisic and chlorogenic acids. Scientists have reported that feeding noni juice to hamsters for six weeks at 3,6, 9 mg/kg body weight reduced liver and visceral accumulationof fat and inflammatory proteins (TNF-a, IL-1b, iNOS, and COX-2, MMP9) expression, whereas they significantly increased fecal lipid/bile content and liver antioxidant capacities (Lin *et al.,* 2013).

3.6 Calcium and dairy products

Adiposity has a strong correlation with the consumption of dairy products and calcium. Consumption of dairy products induces weight loss in energy-restricted diets. Dietary calcium plays a prominent role in the modulation of energy metabolism and obesity risk (Van Loan *et al.,* 2011). They are rich source of calcium that impede fat absorption by increasing the excretion of fecal fat. An excessive increase of calcium in the diet reduces its intracellular accumulation in adipocytes which further decreases the expression of the enzyme (fatty acid synthase) required for lipid synthesis. Inhibition of bile acid, fat absorption, increased fecal fat excretion

and conversion of cholesterol to bile acid are some of the potential mechanisms of calcium that occurs in the GI tract (Zemel *et al.*, 2002). Many randomized trials have been conducted investigating the effect of calcium from dairy sources or supplemental calcium on weight loss or satietyhad given some inconsistent results (Rodríguez *et al.*, 2010; Lorenzen *et al.*, 2007). Additionally, in individuals with low calcium intake, fat loss is promoted by supplementation with calcium and vitamin D (Major *et al.*, 2008).

Some functional components of food, their sources and potential health benefits for various diseases are described in Table 1.

Table 1: Functional components of food, their sources and potential health benefits for various diseases

Functional components	Source	Health benefits
Non-starchy polysaccharides		
Insoluble dietary fibers	Wheat bran	Reduces the risk of breast or colon cancer and induces weight loss.
Soluble dietary fibers	Oats, barley	Reduces risk of cardiovascular diseases, protects against heart diseases, lower LDL, total cholesterol and manages weight gain.
Fucoidan	Mushrooms, brown seaweeds	Immune modulation, apoptosis of cancer cells, stimulates brain development, anticlotting effect, lower blood cholesterol level, stabilizes blood sugar and exerts antiobesity properties.
Phenolics		
Catechins	Tea	Reduce the risk of cancer and neutralizes free radicals and thus reduce weight gain.
Flavones	Fruits and vegetables	Reduce the risk of cancer, neutralizes free radicals and promote weight loss.
Anthocyanidins	Fruits	Reduce the risk of cancer, neutralizes free radicals and antiobesity properties.
Lignans	Flax, rye, vegetables	Prevention of cancer and renal failure.
Tannins	Cranberries, cocoa, chocolate	Improve the health of the urinary tract, reduces the risk of cardio-vascular diseases and obesity.
Plant sterols		
Stanol esters	Corn, soy, wheat, wood, oils	Lower blood cholesterol levels by inhibiting cholesterol absorption.
Prebiotics and probiotics		
Fructo-oligosaccharide	Jerusalem artichokes, shallots, onion powder	Improve gastrointestinal health and lowers the risk of obesity.
Lactobacillus, Bifidobacterium	Yogurt and other dairy products	Improve gut microflora and possess antiobesity properties.
Carotenoids		
Lutein	Green vegetables	Decrease the risk of muscular degeneration and weight gain.
Lycopene	Tomato products	Reduce the risk of prostate cancer and promotes weight loss.
α/β-carotene	Fruits and vegetables	Neutralize free radicals and beneficial in weight loss.
Fruits and vegetables		
Apples	-	Possess antiobesity property.
Pomegranate	-	Exerts hypoglycemic activity, suppresses α-glucosidase enzyme activity, reduces total cholesterol, improves blood lipid profiles and retard inflammation.
Green tomato extract	-	Decreases liver weight, liver cholesterol, serum cholesterol level and epididymal tissues
Onion peel tea	-	Lowers serum cholesterol and promotes weight loss.
Calcium		
Calcium	Dairy products and eggs	Regulates energy metabolism and decreases the risk of obesity.
Beverages		
Blueberry juice and mulberry juice	Blueberry and mulberry	Exert antioxidant and antiobesity properties.
Camellia sinensis	Tea	Possesses immunomodulatory properties and oxidation of fat.

4. Role of functional components of food in weight management

Efficacy and feasibility are the important parameters in offering functional food to suppress appetite (Blundell, 2010). The purpose of assimilating functional foods into weight management is to increase satiety and suppress appetite. Functional food reported to suppress appetite must be placed into products with performance-related claims. In this way, they will be able to regulate the body's physiological functions or feelings of appetite. Food products designed to reduce appetite should have limited flavors, aroma and taste which make the food less palatable. Palatable foods are high caloric and possess a direct relationship with overeating and weight gain. Therefore, while formulating functional food, the goal is to produce low-calorie products including fibers, which influence the texture and taste of the product and decrease its palatability (Deighton *et al.*, 2016). Logically, this will reduce food intake and eventually leads to weight loss.

Regular intake of functional food may treat any metabolic syndrome including obesity weight gain and gastrointestinal diseases.The mechanism through which functional foods are believed to facilitate weight loss includes enhancement of satiation and suppression of between-meal appetite. Different functional components have different mechanisms to reduce appetite. For example, fiber-rich foods may provide bulk, leading to gastric distension and developing a feeling of satiety. In this way, dietary fibers contribute to weight management (Dikeman and Fahey, 2006). Furthermore, polyphenols work by activating AMP-activated protein kinase (AMPK) that is present in the liver, skeletal muscles and adipose tissues (Yang *et al.*,2016). Similarly, carotenoids show a positive effect on weight management as they help in improving the metabolic parameters of the body (Mounien *et al.*, 2019). Ginger may regulate obesity in different potential ways including increasing thermogenesis and lipolysis, suppression of lipogenesis, inhibition of intestinal fat absorption, and controlling appetite (Ebrahimzadeh *et al.*, 2018). In this way, functional components in food play a positive role in weight loss.

5. Role of exercise and physical activity in augmenting functional food effects

A healthy lifestyle and physical activity are the primary preventive measures against obesity, diabetes mellitus, cardiovascular diseases, *etc*., (Warburton *et al.*, 2006). Perhaps the interest of individuals in functional foods and their bioactive components highlights the protective role of structured and unstructured exercise in weight loss. Regular exercise and physical activity along with the consumption of functional food reinforce other protective functions including reduced lipid peroxidation and anti-inflammatory functions (Klonizakis *et al.*, 2013). Making exercise strategy an integral part of your daily routine enhances the cardio-metabolic protective benefits of diets. Strength training is usually recommended for weight loss and its management (Suchomel *et al.*, 2016). However, limited shreds of literature have reported the combined effects of strength type training and functional foods for obesity prevention. Such a combination is likely to produce good compliance and long-term adherence in obese individuals. Additionally, strength training plays an important role in reducing postmenopausal-related vascular risks such aspositive effects on adipose biomarkers of arterial stiffness.

6. Conclusion

Clearly, weight gain is associated with many lethal diseases and some of which have no cure. For this reason, improving eating habits and setting a healthy lifestyle are required for the eventual ideal of the "health for all" vision. Consuming functional food as a part of a balanced diet is the best alternative method of weight loss. However, the bioavailability of the functional components of food and the levels required in humans are necessary to optimize health-related benefits. This paper discusses the potential role of functional foods and their components in weight management. Strict adherence to healthy eating habits contributes to the proper functioning of the GI tract, resulting in the attainment of proper human physiology. Moreover, functional foods possess some limitations too along with providing health benefits. They are relatively more expensive than regular food products. Proteins and fibers constitute the major portion of functional foods and their prices are much higher than that of other ingredients used in the food industry. Additionally, in order to prevent malnutrition, a complex of vitamins and minerals are added to these products which enhances the cost of food. Therefore, all target communities could not afford most of the functional food which is considered one of the weaknesses of this type of product.

Conflict of interest

The authors declare no conflict of interest relevant to this article.

References

Abuajah, C.I.; Ogbonna, A.C. and Osuji C.M.(2015). Functional components and medicinal properties of food: A review. Journal of Food Science and Technology, **52**:2522-2539.

Ahmad, A.; Munir, B.; Abrar, M.; Bashir, S.; Adnan, M. and Tabassum, T.(2012). Perspective of β-glucan as functional ingredient for food industry. Journal of Nutrition and Food Sciences, **2**(2):133-139.

Andlauer, W. and Fürst, P.(2002). Nutraceuticals: A piece of history, present status and outlook. Food Research International, **35**(2-3):171-176.

Arshad, M.S.; Khalid, W.; Ahmad, R.S.; Khan, M.K.; Ahmad, M.H.; Safdar, S. and Suleria, H.A. (2021). Functional foods and human health: An overview. Functional Foods-Phytochem. Health Promoting Potential, pp:1-14.

Becker, D.J. and Lowe, J.B. (2003). Fucose: Biosynthesis and biological function in mammals. Glycobiology, **13**(7):41R-53R.

Begum, P.S.; Madhavi, G.; Rajagopal, S.; Viswanath, B.; Razak, M.A. and Venkataratnamma, V. (2017). Probiotics as functional foods: Potential effects on human health and its impact on neurological diseases. International Journal of Nutrition, Pharmacology, Neurological Diseases, **7**(2):23-33.

Blundell, J.(2010). Making claims: Functional foods for managing appetite and weight. Nature Reviews Endocrinology, **6**(1):53-56.

Boqué, N.; de la Iglesia, R.; de la Garza, A.L.; Milagro, F.I.; Olivares, M.; Bañuelos, Ó.; Soria, A.C.; Rodríguez Sánchez, S.; Martínez, J.A. and Campión, J. (2013). Prevention of diet induced obesity by apple polyphenols in Wistar rats through regulation of adipocyte gene expression and DNA methylation patterns. Molecular Nutrition and Food Research, **57**(8):1473-1478.

Charalampopoulos, D.; Wang, R.; Pandiella, S.S. and Webb, C.(2002). Application of cereals and cereal components in functional foods: A review. International Journal of Food Microbiology, **79**(1-2):131-141.

Choi, K.M.; Lee, Y.S.; Shin, D.M.; Lee, S.; Yoo, K.S.; Lee, M.K. and Yoo, H.S. (2013). Green tomato extract attenuates high-fat-diet-induced obesity through activation of the AMPK pathway in C57BL/6 Mice. The Journal of Nutritional Biochemistry, **24**(1):335-342.

Cory, H.; Passarelli, S.; Szeto, J.; Tamez, M. and Mattei, J. (2018). The role of polyphenols in human health and food systems: A mini-review. Frontiers in Nutrition, **21**:1-9.

Crujeiras, A.B.; Parra, M.D.; Rodríguez, M.C.; de Morentin, B.E. and Martínez, J.A.(2006). A role for fruit content in energy-restricted diets in improving antioxidant status in obese women during weight loss. Nutrition, **22**(6):593-599.

Davani-Davari, D.; Negahdaripour, M.; Karimzadeh, I.; Seifan, M.; Mohkam, M.; Masoumi, S.J.; Berenjian, A. and Ghasemi, Y.(2019). Prebiotics: Definition, types, sources, mechanisms, and clinical applications. Foods, **8**(3):92-121.

Deighton, K.; Frampton, J. and Gonzalez, J.T.(2016). Test-meal palatability is associated with overconsumption but better represents preceding changes in appetite in non-obese males. British Journal of Nutrition, **116**(5):935-943.

Dikeman, C.L. and Jr Fahey, G.C.(2006). Viscosity as related to dietary fiber: A review. Critical Reviews in Food Science and Nutrition, **46**(8):649-663.

Divya. (2022). Role and importance of spinach fortification in Indian traditional foods. Ann. Phytomed., **11**(1):53-67.

Dulloo, A.G.; Duret, C.; Rohrer, D.; Girardier, L.; Mensi, N.; Fathi, M.; Chantre, P. and Vandermander, J.(1999). Efficacy of a green tea extract rich in catechin polyphenols and caffeine in increasing 24-h energy expenditure and fat oxidation in humans. The American Journal of Clinical Nutrition, **70**(6):1040-1045.

EbrahimzadehAttari, V.; MalekMahdavi, A.; Javadivala, Z.; Mahluji, S.; ZununiVahed, S. and Ostadrahimi, A.(2018). A systematic review of the anti obesity and weight lowering effect of ginger (Zingiberofficinale Roscoe) and its mechanisms of action. Phytotherapy Research, **32**(4):577-585.

Farhud, D.D.(2015). Impact of lifestyle on health. Iranian Journal of Public Health, **44**:1442-1444.

Florowska, A.; Krygier, K.; Florowski, T. and Dłużewska, E. (2016). Prebiotics as functional food ingredients preventing diet-related diseases. Food and Function., **7**(5):2147-155.

Izydorczyk, M.S. and Dexter, J.E. (2008). Barley β-glucans and arabinoxylans: Molecular structure, physicochemical properties, and uses in food products a review. Food Research International, **41**(9):850-868.

Klonizakis, M.; Alkhatib, A.; Middleton, G. and Smith, M.F.(2013). Mediterranean diet-and exercise-induced improvement in age-dependent vascular activity. Clinical Science, **124**(9):579-587.

Konstantinidi, M. and Koutelidakis, A.E. (2019). Functional foods and bioactive compounds: A review of its possible role on weight management and obesity's metabolic consequences. Medicines, **6**(3):94-118.

Kyrou, I.; Randeva, H.S.; Tsigos, C.; Kaltsas, G. and Weickert, M.O.(2018). Clinical problems caused by obesity. Endotext., South Dartmouth.

Lin, Y.L.; Chang, Y.Y.; Yang, D.J.; Tzang, B.S. and Chen, Y.C.(2013). Beneficial effects of noni (*Moringa citrifolia* L.) juice on livers of high-fat dietary hamsters. Food Chemistry. **140**(1-2):31-38.

Lobo, V.; Patil, A.; Phatak, A. and Chandra, N.(2010). Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy Reviews., **4**(8):118-126.

Lorenzen, J.K.; Nielsen, S.; Holst, J.J.; Tetens, I.; Rehfeld, J.F. and Astrup, A.(2007). Effect of dairy calcium or supplementary calcium intake on postprandial fat metabolism, appetite, and subsequent energy intake. The American Journal of Clinical Nutrition, **85**(3):678-687.

Major, G.C.; Chaput, J.P.; Ledoux, M.; St Pierre, S.; Anderson, G.H.; Zemel, M.B. and Tremblay, A.(2008). Recent developments in calcium related obesity research. Obesity Reviews, **9**(5):428-445.

Matsunaga, S.; Azuma, K.; Watanabe, M.; Tsuka, T.; Imagawa, T.; Osaki, T. and Okamoto Y.(2014). Onion peel tea ameliorates obesity and affects blood parameters in a mouse model of high fat diet induced obesity. Experimental and Therapeutic Medicine, **7**(2):379-382.

Medjakovic, S. and Jungbauer.(2013). A. Pomegranate: a fruit that ameliorates metabolic syndrome. Food and Function, **4**(1):19-39.

Morais, R.M.; Morais, A.M.; Dammak, I.; Bonilla, J.; Sobral, P.J.; Laguerre, J.C.; Afonso, M.J. and Ramalhosa, E.C.(2018). Functional dehydrated foods for health preservation. Journal of Food Quality, **18**:1-30.

Mounien, L.; Tourniaire, F. and Landrier, J.F.(2019). Antiobesity effect of carotenoids: Direct impact on adipose tissue and adipose tissue-driven indirect effects. Nutrients, **11**(7):1562-1576.

Parker, R.S.(2000). Phytochemicals: Carotenoids. Wiley encyclopedia of Food Science and Technology, **3**:909-915.

Patel, V.; Rai Chandra, D.; Singh Pratap, U. and Rathaur, A.(2022). Development of functional ice cream using niger (Guizotia-abyssinica (L.f.) Cass.) seed oil microcapsules. Ann. Phytomed, **11**(1):588-594.

Paul, A.A.; Kumar, S.; Kumar, V. and Sharma, R.(2020). Milk Analog: Plant based alternatives to conventional milk, production, potential and health concerns. Critical Reviews in Food Science and Nutrition, **60**(18):3005-30023.

Prabhakar, B.N.(2022). Vegetables as nutraceuticals and future plant drugs. Ann. Phytomed., **11**(1):1-6.

Rebello, C.; Greenway, F.L. and Dhurandhar, N.V.(2014). Functional foods to promote weight loss and satiety. Current Opinion in Clinical Nutrition and Metabolic Care, **17**(6):596-604.

Rodríguez-Rodríguez, E.; Perea, J.M.; López-Sobaler, A.M. and Ortega, RM.(2010). An adequate calcium intake could help achieve weight loss in overweight/obese women following hypocaloric diets. Annals of Nutrition and Metabolism, **57**(2):95-102.

Romieu, I.; Dossus, L.; Barquera, S.; Blottière, H.M.; Franks, P.W.; Gunter, M.; Hwalla, N,.; Hursting, S.D.; Leitzmann, M.; Margetts, B. and Nishida, C.(2017). Energy balance and obesity: What are the main drivers?. Cancer Causes and Control, **28**(3):247-258.

Sandner, G.; König, A.; Wallner, M. and Weghuber, J.(2020). Functional foods-dietary or herbal products on obesity: Application of selected bioactive compounds to target lipid metabolism. Current Opinion in Food Science, **34**:9-20.

Semyonov, D.; Ramon, O.; Kovacs, A.; Friedlander, L. and Shimoni, E.(2012). Air-suspension fluidizedbed microencapsulation of probiotics. Drying Technology, **30**(16):1918-1930.

Sharma, N.; Biswas, S.; Al-Dayan, N.; Alhegaili, A.S. and Sarwat, M.(2021). Antioxidant role of kaempferol in prevention of hepatocellular carcinoma. Antioxidants, **10**(9):1419-1436.

Singh, H. and Chellamal, J.S. (2022). Fruits that heal: Biomolecules and novel therapeutic agents. Ann. Phytomed., **11**(1):7-14.

Srividya, A.R.; Venkatesh, N.; and Vishnuvarthan, V.J.(2010). Nutraceutical as medicine. International Journal of Advance Pharmaceutical Sciences, **1**(2):132-133.

Suchomel, T.J.; Nimphius, S. and Stone, M.H.(2016). The importance of muscular strength in athletic performance. Sports Medicine, **46**(10):1419-1449.

Szewczyk, K.; Chojnacka, A. and Górnicka, M.(2021). Tocopherols and tocotrienols: Bioactive dietary compounds; what is certain, what is doubt?. International Journal of Molecular Sciences, **22**(12): 6222-6239.

Van Loan, M.D.; Keim, N.L.; Adams, S.H.; Souza, E.; Woodhouse, L.R.; Thomas, A.; Witbracht, M.; Gertz, E.R.; Piccolo, B.; Bremer, A.A. and Spurlock, M. (2011). Dairy foods in a moderate energy restricted diet do not enhance central fat, weight, and intra-abdominal adipose tissue losses nor reduce adipocyte size or inflammatory markers in overweight and obese adults: A controlled feeding study. Journal of Obesity, **11**:1-15.

Wadhwa, R.; NayakUmesh, S.; Patel, N. and Alim, H.(2022). Clinical study to evaluate the efficacy of *Pippalyadi basti* and *Lekhan basti* in the management of obesity. Ann. Phytomed., **11**(1):260-265.

War burton, D.E.; Nicol, C.W. and Bredin, S.S.(2006). Health benefits of physical activity: The evidence. Canadian Medical Association Journal, **174**(6):801-809.

WHO. (2011). Obesity and overweight.

Wine Brenner, J. (2007). Fucose or fucoids are the fourth essential sugar. Nutr. Health Newsl., **2**(5):1-3.

Wu, T.; Tang, Q.; Gao, Z.; Yu, Z.; Song, H.; Zheng, X. and Chen, W.(2013). Blueberry and mulberry juice prevent obesity development in C57BL/6 mice. PLoS One, **8**(10):1-7.

Yang, C.S.; Zhang, J.; Zhang, L.; Huang, J. and Wang, Y.(2016). Mechanisms of body weight reduction and metabolic syndrome alleviation by tea. Molecular Nutrition and Food Research, **60**(1):160-174.

Yuda, N.; Tanaka, M.; Suzuki, M.; Asano, Y.; Ochi, H. and Iwatsuki, K.(2012). Polyphenols extracted from black tea (*Camellia sinensis*) residue by hot compressed water and their inhibitory effect on pancreatic lipase *in vitro*. Journal of Food Science, **77**(12):H254-H261.

Zemel, M.B.; Thompson, W.; Zemel, P.; Nocton, A.M.; Milstead, A.; Morris, K. and Campbell, P.(2002). Dietary calcium and dairy products accelerate weight and fat loss during energy restriction in obese adults. In American Journal of Clinical Nutrition, **75**(2):342S-343S.

Citation **Nidhi Sharma and Maryam Sarwat (2022). Functional foods for better health and weight loss. Ann. Phytomed., 11(2):114-121. http://dx.doi.org/10.54085/ap.2022.11.2.12.**