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Functional Foods and Nutraceuticals-Modern Approach to Food Science

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Abstract: Functional foods and nutraceuticals provide an opportunity to improve the human health, reduce health care costs and support economic development in rural communities. The phrase "Let food be the medicine and medicine be the food," coined by Hippocrates over 2500 years ago is receiving a lot of interest today as food scientists and consumers realize the many health benefits of certain foods. This review article focused on the definition and differences between functional food and nutraceuticals. The challenges and opportunities, motivating the development and regulations of functional foods and nutraceuticals were discussed. This article also focused on some examples of the functional foods and nutraceuticals and their health benefits, like probiotics and prebiotics, proteins and peptides, oils and fatty acids, carbohydrates and fibers, catchine and lycopin.

Key words: Definition And Differences · Challenges and Opportunities · Regulations · Active Components · Health Benefits

INTRODUCTION

The phrase "Let food be the medicine and medicine be the food," coined by Hippocrates over 2500 years ago is receiving a lot of interest today as food scientist and consumers realize the many health benefits of certain foods. These foods contain ingredients that aid specific body function and improve our health and well-being. There are many ways to think about food, in the simplest sense, food is a fuel, food provides the energy needed to perform daily functions and maintain normal metabolic processes. But we all know that food is more than fuel; food contains nutrients that are essential to prevent diseases. For example, scurvy will occur if vitamin C is not continually present in the human diet. Similarly, blindness can occur where diets are deficient in vitamin A. The "essential nutrients" those that are needed to prevent specific diseases have been a major focus of human nutrition research for the past century [1]. The Egyptians, Chinese and Sumerians are just a few civilizations that have provided evidence suggesting that, foods can be effectively used as medicine to treat and prevent disease. The medicinal benefits of food have been explored for thousands of years [2]. The modern nutraceuticals and functional foods market have begun to develop in Japan during the 1980. In contrast to the natural herbs and spices used as folk medicine for centuries throughout Asia, the nutraceuticals and functional foods industry has grown alongside the expansion and exploration of modern technology [3], new research conducted among food scientists has shown that, there is more to Food Science than what was understood just a couple decades ago. Until just recently, analysis of food was limited to the flavor of food (sensory taste and texture) and its nutritional value (composition of carbohydrates, fats, proteins, waters vitamins and minerals). However, there is growing evidence that other components of food may play an integral role in the link between food and health [3]. Consumers are increasingly interested in the health benefits of foods and have begun to look beyond the basic nutritional benefits of food to the disease prevention and health enhancing compounds contained in many foods [2]. This combined with a more widespread understanding of how diet affects disease, health-care costs and aging populations have created a market for functional foods and natural health products. Functional

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foods and nutraceuticals provide an opportunity to improve the health, reduce health care costs and support economic development in rural communities. They also offer a way for some producers to diversify their agriculture and marine-based crops. According to market statistics, the global functional foods and nutraceuticals market is growing at a rate that is outpacing the traditional processed food market [4].

Global acceptance of functional foods is mixed; on the positive side, several countries have provided legislation permitting health claim use and regulation, although this process has not yet resulted in permission for the use of such claims. Health claims on foods continue to be disallowed, despite a consultative process for establishing a regulatory framework that has been ongoing for 5 years. On the less positive side, there are at least 2 telltale harbingers of slower growth for the functional foods industry. First, the marketplace is recording a number of casualties for functional food items and categories. Two major suites of functional food products launched by multinational firms have been discontinued over the past 5 years in various countries. In the United States, sales of the most recently launched major functional food item, plant sterols in spreads and other foods, have been more disappointing than anticipated. However, heightened consumer awareness, the move toward health claims approval and the accumulating food-disease scientific database all predict growth in the functional foods sector in the short-to-medium term [5].

Functional foods and dietary supplements are a rapidly growing segment of the overall food market and contain numerous biologically active compounds that may contribute to the health-promoting properties of these foods. It is important both for the food industry and for the food inspection authorities to have analytical tools for quality and authenticity control of functional foods and related products. However, because of the complex matrices, the lack of validated analytical methods and the limited availability of reference compounds, the analysis of raw material and finished products may pose a challenge [6]. This review article focused on the definition and differences between functional food and nutraceuticals. The challenges and opportunities, motivating the development and regulations of functional foods and nutraceuticals were discussed. This article also focused on some examples of the functional foods and nutraceuticals and their health benefits, like probiotics and prebiotics, proteins and peptides, oils and fatty acids, carbohydrates and fibers, catchine and lycopin.

Differences in the Definition Between Functional Foods and Nutraceuticals: Today the exploration and exploitation of the disease fighting properties of a multitude of phytochemicals found in both food and nonfood plants have created a renaissance in human health and nutrition research. At the same time, many opportunities for the development of novel dietary products have been created. With all new fields of study come new terms. *"Nutraceuticals"* and *"functional foods"* are two new terms used to describe health-promoting foods or their extracted components. Although debate continues regarding the exact meaning of these terms, it is convenient to consider *nutraceuticals* as healthful products that are formulated and taken in dosage form (capsules, tinctures, or tablets). *Functional foods*, on the other hand, are products that are consumed as foods and not in dosage form [7]. The term *"nutraceutical"* was coined from *"nutrition"* and *"pharmaceutical"* in 1989 by Stephen DeFelice, MD, founder and chairman of the Foundation for Innovation in Medicine (FIM), Cranford, NJ. According to DeFelice [8], nutraceutical can be defined as, *"a food (or part of a food)* that provides medical or health benefits, including the prevention and/or treatment of a disease."However, the term *nutraceutical* as commonly used in marketing has no regulatory definition [8] and [9]. Kalra [10] redefined *functional foods and nutraceuticals*. When food is being cooked or prepared using "scientific intelligence" with or without knowledge of how or why it is being used, the food is called *"functional food"*. Thus, *functional food* provides the body with the required amount of vitamins, fats, proteins, carbohydrates, etc, needed for its healthy survival. When functional food aids in the prevention and/or treatment of disease(s) and/or disorder(s) other than anemia, it is called a nutraceuticals. (Since most of the functional foods act in some way or the other as anti-anemic, the exception to anemia is considered so as to have a clear distinction between the two terms, *functional food and nutraceuticals*). Thus, a functional food for one consumer can act as a nutraceuticals for another consumer. Examples of nutraceuticals include fortified dairy products (milk) and citrus fruits (orange juice) [3]. *A functional food* is similar in appearances to or may be conventional food that consumed as a part of unusual diet and is demonstrated to have physiological benefit and/or reduce the risk of chronic diseases beyond basic nutritional function. In another definition, a nutraceuticals is a product isolated or purified from foods that is generally sold in medicinal forms not usually associated with foods. When a nutraceuticals is demonstrated to

have a physiological benefit or provide protection against chronic disease, the functional foods are defined broadly as foods that provide more than simple nutrition; they supply additional physiological benefit to the consumer [11].

Challenges and Opprtunities: The field of nutraceuticals and functional foods is new and many gaps exist in the knowledge base, for example, it is widely accepted that the health-promoting properties of foods are not necessarily due to single components, but rather a few or several active ingredients. This creates a significant paradigm shift from the pharmaceutical model, which is based on the efficacy of single agents. Many of the bioactive phytochemicals under investigation have long been ignored, thus methods for their handling and measurement are lacking. Manufacturers wish to make specific claims of health benefits on their product labels. Clearly such claims must be based on solid scientific evidence, which to date is often lacking. Government regulatory bodies also face challenges in this new category of health products, which lies between foods and drugs. However, all parties share the desire to improve personal and public health through diet modification, to reap the consequent social and economic benefits [12]. The field of nutraceuticals and functional foods is at times confused, or at least lumped together with the field of biotechnology and genetic modification [13]. The two areas are distinctly different, although there is some potential for overlap. Techniques in genetic modification may be applied to enhance the phytochemical content of food and nonfood plants. Although the complex series of biochemical reactions used by plants to synthesize specific phytochemicals is often not well understood, there is tremendous potential to harness the plant's sophisticated biochemical machinery to synthesize valuable compounds and ultimately enhance human health [14]. There are numerous challenges in getting a new product into the food market. Currently, more and more people understand the significant correlation between diet, consumption of quality food and good health and those people are the best targets. Furthermore, customers are looking for name-brand products to assure superior quality, even if the price may be a little higher [15].

Motivating the Development of Functional Foods and Nutraceuticals: The genesis of the functional foods and nutraceuticals industry has occurred for a number of reasons. First, consumers are aware of the possible positive role diet can play in disease risk management. Despite a lack of consistency in the information that they have received, consumers, perhaps because of their advancing average age, are becoming increasingly interested in the relations between food and quality of life. Indeed, a recent poll conducted in the United States found that 95% of the population believe that food possesses the potential to improve health by doing more than just providing nutrients [16]. Most of the individuals questioned were also interested in learning more about foods with these functional abilities. Increased education may also be partly responsible, as well as an overall heightening of interest in the general area of preventive health. Second, regulatory bodies have become increasingly cognizant and supportive of the public health benefits of functional foods. Accordingly, legislative frameworks are now well developed in countries such as Japan that allows more than 200 functional foods to be marketed under existing FOSHU (Foods for Specialized Health Use) legislation [17] and the United States where the Food and Drug Administration (FDA) permits health claims to be made for about 15 categories of food [18]. Third, governments looking at regulatory issues for functional foods are more aware of the economic potential of these products as part of public health prevention strategies; however, to date the cost savings that might be realized have not been assessed. Processes for the systematic investigation of existing data linking functional foods to physiological mechanisms that affect disease risk have been developed; however, the robustness of the process varies considerably from country to country. The FDA now convenes a group of independent scientists to gather and weigh all the relevant clinical data for each health claim submission. Development of this exhaustive review process has improved the authenticity of health claims, which in itself has led to the birth of the functional food industry [11]. One way to enhance a company's positions is to produce foods that have value-added features. To make it possible to create such added value, certain institutional preconditions must allow the development and sale of foods with health effects. Sweden is seen as a pioneer, alongside Japan, in this respect. Sweden boasts excellent cooperation between food companies, research organizations and authorities and there is an adequate regulatory system for marketing [19].

Regulations and Health Claim: Within the oversight of the Federal Food and Drug Administration (FDA) [18], unlike many other countries such as Canada, the use of

broad-based definitions creates inconsistent credibility distinguishing the standards, function and effectiveness between "nutraceuticals" and "dietary supplements". Within this loose regulatory oversight, legitimate companies producing nutraceuticals provide credible scientific research to substantiate their manufacturing standards, products and consumer benefits and differentiate their products from "dietary supplements". Despite the international movement within the industry, professional organizations, academia and health regulatory agencies to add specific legal and scientific criterion to the definition and standards for nutraceuticals and functional foods, within the United States the term is not regulated by FDA. The FDA still uses a blanket term of "dietary supplement" for all substances without distinguishing their efficacy, manufacturing process, supporting scientific research and increased health benefits [20]. In 2005, the National Academies Institute of Medicine and National Research Council created a blue-ribbon committee to create an improved framework for the Federal Food and Drug Administration to evaluate dietary supplements. Though the improved framework fails to distinguish between "nutraceuticals" and "dietary supplements" with the continued use of a broad definition and lacking greater distinction, a cost-effective and scientifically based framework was needed to evaluate the safety of "dietary supplements" including those consumer products recognized internationally as "nutraceuticals" [12]. Unfortunately, current government regulations leave room for misleading claims; deception is promoted by the fact that legislation of health claims for foods is layered: there are soft claims, which require soft evidence and hard claims, which require harder evidence. For example, a draft regulation of the Codex Commission of the United Nations, which sets international food standards, recognizes claims about nutrient content “rich in calcium” and disease reduction “prevents osteoporosis”, as well as various intermediate categories. Manufacturers have therefore made the formulation of soft claims into a fine art, creating claims that imply health effects without actually naming a disease. Regulations differ between countries. Japan was the first country to recognize functional foods as a separate category when in 1991 it introduced the FOSHU (Foods for Specific Health Use) system to evaluate health claims. This system has valuable aspects: it regulates both safety and health and it demands that the food be analyzed for the amount of effective components [21]. The Japanese have a wide variety of foods to choose from that have been approved by their health regulatory officials. Instead of using the term *functional foods* the Japanese coined the term *FOSHU* or *foods for specific health use*. Since this system was put into place in 1993, over 69 foods have been approved and therefore can carry the FOSHU label. The Japanese system is based on a list of approved foods and ingredients that the Japanese Department of Health feels have enough scientific evidence to support health claims. If a company can show that its food product contains one of these approved foods / ingredients, then it can carry the FOSHU label. So in Japan it is not necessary to provide evidence that wheat bran, for example, has health benefits. You only have to show that wheat bran is in your product [17]. Foods or ingredients that are eligible for FOSHU designation can be classified into the familiar categories of carbohydrates, proteins, mineral etc. as shown in Table 1. Carbohydrates are by far the largest group of foods or ingredients.

Table 1: FUSHU foods and Ingredients

FOSHU Foods / Ingredients	
CARBOHYDRATES	PROTEINS
Polydextrose	Casein phospho peptide
Indigestible dextrin	Casein dodeca peptide
Galacto oligosaccharides	Soy protein
Lactulose	
Lactosucrose	MINERALS
Isomalto oligosaccharides	Phosphorus
Maltitol	Calcium as citrate malate
Palatinose	Heme iron
Soybean oligosaccharides	
Fructo oligosaccharides	OTHER
Xylo oligosaccharides	Rice globulin
Wheat bran	Eucommia leaf glycoside
	Lactobacillus GG

What things are on Japan’s approved list? Table 1 is a listing of the foods or ingredients that qualify for FOSHU status. Also included is the number of products that currently have approval because they contain that specific ingredient (Table 2). Japanese food manufacturers are using the food labeling legislation and FOSHU system to supply the Japanese consumer with functional food products.

Even though the evidence required has been reduced in recent years and is minimal by pharmaceutical standards, most manufacturers opt for softer categories of claims, which require little evidence. An example is the unproved but lawful statement that extra vitamins help to maintain healthy skin and mucosa. Watering down of regulations has also occurred in the United States,

Table 2: Foods or Ingredients that qualify for FOSHU status

FOSHU Foods and Ingredients in Japanese Food Products	
Food or ingredient with FOSHU status	Number of approved products
Rice globulin	
Phosphorus	
Xylo oligosaccharides	3 products
Calcium as citrate malate	3 products
Fructo oligosaccharides	10 products
Soybean oligosaccharides	8 products
Palatinose	4 products
Maltitol	3 products
Isomalto oligosaccharides	2 products
Soy protein	5 products
Wheat bran	
Lactosucrose	15 products
Casein dodeca peptide	
Casein phospho peptide	2 products
Lactulose	
Galacto oligosaccharides	
Citosan	3 products
Indigestible dextrin	4 products
Polydextrose	3 products
Partially hydolyzed guar gum	
Green tea polyphenols	3 products
Ertthritol	
Heme iron	
Lactobacillus gg	
Eucommia leaf glycoside	

which once had a solid system for disease reduction claims for foods, which were allowed only if there was "significant scientific agreement" that the claim was valid [22]. However, the Food and Drug Administration's oversight over health claims has eroded and the United States now allows "qualified health claims" for which there is hardly any evidence, as long as a disclaimer is included. In the European Union the safety of novel foods is thoroughly regulated but health claims are not—EU legislation for nutrition claims is complex, fragmented and poorly enforced. Paradoxically, current EU regulations prohibit claims that a food ingredient prevents a disease even when the claim is true—for example, that folic acid prevents neural tube defects. Finally, Canada, Australia and New Zealand have introduced new systems to regulate health claims, but experience with these is still limited. The lack of proper regulatory oversight has led to some functional foods and nutraceuticals that are no more than quackery; while at the same time other functional foods do promote health and prevent disease. The potential for effective functional foods is certainly there. Foods and food components could prevent or ameliorate many diseases [23], but not enough research is being done to identify effective ingredients and substantiate their efficacy and safety. Whether such research will be done depends to a large extent on proper regulation. Major food companies are eager to expand into health promoting foods, but there is no incentive to underpin such health effects with solid research when products can be successfully marketed on the basis of vague allusions alone. But there is hope. After more than 20 years of deliberations the European Commission recently agreed on new regulations that would prohibit vague claims and that would allow hard claims of disease reduction for foods if the evidence is solid [24], the commission even wants to grant companies seven years of exclusivity for truly novel claims backed up by solid data. If the European Parliament accepts these proposals it would be a step in the right direction. The World Health Organization (WHO) is also working in this area hoping to develop an international standard for nutrient profiles that could be used by many countries: "Currently, we have different systems in different countries: for example, one in France, one in New Zealand, a couple in the United States of America and two in the United Kingdom" [25].

Exmples of Bioactive Components in Food and Health Benefits: Bioactive Compounds are the naturally occurring chemical compounds contained in, or derived from, a plant, animal or marine source, that exert the desired health/wellness benefit. Functional Ingredients are the standardized and characterized preparations, fractions or extracts containing bioactive compounds of varying purity, that are used as ingredients by manufacturers in the food and by manufacturers in the cosmetics and pharmaceutical sectors [7,16]. It is a common knowledge that foods provide nutrients that help to nourish our bodies and keep our systems in proper working condition. However, from early in human history, it was also known that certain foods confer additional health benefits to humans such as prevention and treatment of various types of diseases [98]. Recently, scientists have become focused on the health-promoting effects of foods and there is now abundant evidence that supports the role of various foods/food components in promoting human health [99]. Such health-promoting foods or compounds are generally classified into 2 major categories: Functional Foods and Nutraceuticals. Let us now take a closer look at a few specific examples of foods and/or compounds that have been shown to have potential beneficial health effects in humans. Because there are many functional foods now exist in various countries. The following examples are provided, because each highlights a particular feature.

Probiotics and Prebiotics: We have bacteria living in our gut. Some of them could make me sick; however there are also bacteria that are actually beneficial. These "friendly" bacteria help keep bad bacteria and yeast from growing in the intestinal tract. Bacteria also help make vitamin K and keep immune system functioning properly. Normally we have an abundance of friendly bacteria, however antibiotic therapy, stress and poor dietary choices may all cause intestinal dysbiosis, which is a bacterial imbalance that results in overgrowth of bad bacteria and yeast. A common cause of dysbiosis is antibiotic therapy. The antibiotics that we take for killing an infection will also kill the healthy bacteria in the digestive tract [26, 27]. Prebiotics and probiotics can restore the balance of bacteria in our digestive tract. Probiotics are beneficial bacteria that can be found in various foods. When we eat probiotics, we will add these healthy bacteria to our intestinal tract. Common strains include *Lactobacillus* and *Bifidobacterium* families of bacteria. Probiotics bacteria like *lactobacilli* are naturally found in fermented foods like sauerkraut and yogurt. Some foods will have added probiotics as healthy nutritional ingredients, which will be evident on the label [28, 29]. Prebiotics are non-digestible foods that make their way through our digestive system and help good bacteria grow and flourish. Prebiotics keep beneficial bacteria healthy. Prebiotics that feed the beneficial bacteria in the gut mostly come from carbohydrate fibers called oligosaccharides. Sources of oligosaccharides include fruits, legumes and whole grains. Fructo-oligosaccharides may be taken as a supplement or added to foods [29, 30]. Many studies have demonstrated the potentially extensive impact of prebiotics on the composition of the gut micro biota, stimulating directly or indirectly putative beneficial gut commensal other than lactic acid bacteria. Consequently, these findings open other exciting areas of research for the discovery of new probiotic strains and symbiotic combinations. Well-designed clinical studies in humans are still needed to further investigate the optimal dose, duration and specific effects of each probiotic strain and/or prebiotic when embedded in food matrices, for different populations such as infants and elderly that have a different gut microbial composition and immune status. By elucidating the mechanisms of probiosis and prebiosis, scientists can design enhanced functional foods tailored to improve host health [31, 32]. The indigenous *Lactobacillus plantarum* Lp9 exhibits high resistance againstlow pH and bile and possessed antibacterial, antioxidative and cholesterol lowering properties with a potential for exploitation in the development of indigenous functional food or nutraceuticals [33]. The symbiotic fermented milk containing probiotics and a prebiotic may contribute to improve intestinal health and may have a positive effect on the humoral and cell-mediated immunity of host animals [34]. On the other hand Mugambi *et al.* [35] revealed that, there is not enough evidence to state that supplementation with probiotics or prebiotics results in improved growth and clinical outcomes in exclusively formula fed preterm infants.

Proteins and Peptides: Proteins are long-chain polymers of amino acids while peptides represent the shorter forms. Proteins in our foods can act as health promoters in 2 ways, firstly, by acting as indigestible substances in our digestive tract, they trap and expel (through feces) toxins and bile, thereby reducing the re-absorption of cholesterol from the large intestine. Buckwheat and soybean proteins are known to contain substantial amounts of indigestible proteins and their increased consumption is beneficial to maintaining a clean and healthy gut. Secondly, proteins can be converted into peptides during digestion and are then absorbed into the blood circulatory system. Some of these bioactive peptides, especially from soybean proteins, have been shown to be capable of preventing the production of cholesterol by liver cells, which can lead to lower levels of cholesterol in the blood [1]. Most food derived bioactive peptides thus far have been isolated from milk-based products. A wide range of activities has been described for bioactive peptides including antimicrobial and antifungal properties, blood pressure-lowering effects, cholesterol-lowering ability, antithrombotic effects and enhancement of mineral absorption, immunomodulatory effects and localized effects on the gut. Although there is still considerable research to be performed in the area of food-derived bioactive peptides, it is clear that the generation of bioactive peptides from dietary proteins during the normal digestive process is of importance. Therefore, it will become necessary when determining dietary protein quality to consider the potential effects of latent bioactive peptides that are released during digestion of the protein [36, 37]. Peptides can also be made by custom-designed enzyme digestion of proteins in a reaction vessel. Ingestion of such peptides either as part of a food or drink or in pill forms has been shown to reduce blood pressure in hypertensive patients. A sour milk drink product that contains bioactive peptides is widely sold in Japan and some European countries. In the USA, a milk powder that contains antihypertensive peptides is also available as a

functional food for blood pressure reduction. Milk is also fractionated into alpha-lactalbumin (which is rich in tryptophane), which has been shown to ameliorate sleep disorders and help sustain alertness in the morning after overnight sleep. Dairy whey protein fractions (sold as whey powder), obtained during cheese-making, contains compounds that can boost our natural immunity, decrease the risk of cancer formation, reduce the severity of muscle tissue degeneration associated with liver diseases and reduce susceptibility to diarrhea [38]. The biological relevance of fungal immunomodulatory proteins (FIPs) for allergy mitigation lies in the observation that they were able to inhibit food allergic and respiratory-allergic reactions in mouse models when applied orally or nasally [39]. FIP could be applied in local nasal immune therapy to suppress allergic responses to house dust mite allergy in mice [40, 41].

Recent research has shown that overweight people actually have very high levels of leptin (Leptin is the body's main fat burning hormone), but that their bodies are resistant and unresponsive to it. This is known as "leptin resistance". Whey protein has been shown to promote weight loss in 2 ways: 1) by reducing leptin resistance, making the body more responsive to this fat-burning hormone and 2) by blocking the release of ghrelin, a hormone that stimulates appetite. In the same time the many scientific findings revealed that, the milk proteins are known to exert a wide range of nutritional, functional and biological activities. Apart from being a balanced source of valuable amino acids, milk proteins contribute to the consistency and sensory properties of various dairy products. Furthermore, many milk proteins possess specific biological properties which make them potential ingredients of health-promoting foods. These properties are attributed to both native protein molecules and to physiologically active peptides encrypted in the protein molecules. Considerable progress has been made over the last twenty years in technologies aimed at separation, fractionation and isolation in a purified form of many interesting proteins occurring in bovine colostrum and milk [42]. Industrial-scale methods have been developed for native whey proteins such as immunoglobulins, lactoferrin, lactoperoxidase, alpha-lactalbumin and beta-lactoglobulin. Their large-scale manufacture and commercial exploitation is still limited although validated research data about their physiological health benefits is rapidly accumulating. Promising product concepts and novel fields of use have emerged recently and some of these molecules have already found commercial applications [100]. The same applies to bioactive peptides derived from different milk proteins. Active peptides can be liberated during gastrointestinal digestion or milk fermentation with proteolytic enzymes. Such peptides may exert a number of physiological effects *in vivo* on the gastrointestinal, cardiovascular, endocrine, immune, nervous and other body systems [42]. Different bioactive components derived from food, bovine milk and avian eggs contain an array of bioactivities due to proteins and peptides present in active form, such as lactoferrin, immunoglobulins, growth factors and hormones and many bioactivities are biofunctional peptide activity currently most studied in food proteins and appears to be those that inhibit Angiotensin-converting-enzyme (ACE) which plays a central role in the regulation of blood pressure. Numerous ACE inhibitor peptides have been isolated from milk proteins. However, a greater understanding of the biological mechanisms surrounding control of the cardiovascular system within the body is necessary in order to effectively design and produce new food derived antihypertensive agents [43]. The beneficial effects of food-derived antioxidants in health promotion and disease prevention are being increasingly recognized. Recently, there has been a particular focus on milk-derived peptides; as a source of antioxidants, these peptides are inactive within the sequence of the parent protein but can be released during enzyme hydrolysis. Once released, the peptides have been shown to possess radical scavenging, metal ion chelation properties and the ability to inhibit lipid peroxidation [44, 45]. A high-protein diet leads to greater activation than a normal-protein diet in the nucleus tractus solitarius and in the arcuate nucleus. More specifically, neural mechanisms triggered particularly by leucine consumption involve 2 cellular energy sensors: the mammalian target of rapamycin and AMP-activated protein kinases. In addition, reward and motivation aspects of eating behavior, controlled mainly by neurons present in limbic regions, play an important role in the reduced hedonic response of a high-protein diet [46]. Recombinant bovine and human lactoferrin is now available for development into nutraceutical/ preservative/ pharmaceutical products. Among conditions for which the products are being investigated are: angiogenesis; bone remodeling; food preservation; infection in animals, humans, plants; neoplasia in animals, humans; inflammation in intestine, joints; wound healing; as well as enhancement of antimicrobial and anti-neoplastic drugs and prevention of iron induced oxidation of milk formula [47]. Whey protein components, β-lactoglobulin, α-lactalbumin and serum albumin were studied and

showed that, they have anticancer potential. The minor component lactoferrin has received the most attention; it inhibits intestinal tumors. Lactoferrin acts by induction of apoptosis, inhibition of angiogenesis and modulation of carcinogen metabolizing enzymes and perhaps acting as an iron scavenger. Supplementing cows with selenium increases the content of selenoproteins in milk, which on isolation inhibited colon tumorigenesis in rats [48]. Some of the physiological functions of food proteins have been demonstrated to date are cholesterol reduction, immune enhancement and anti-hypertensive effects and even increased satiety [49]. In relation to cancer therapy, hydrophobic peptides from soy proteins have been found to have anticancer activity. Galvez [101] discovered in 2001 a 43 amino acid peptide called lunasin that has a motif that binds specifically to non-acetylated H3 and H4 histones and can therefore be used for cancer therapy. This binding prevents acetylation of H3 and H4 and allows the targeting of lunasin to specific cancerous cells. Lunasin is now considered a novel peptide that can suppress chemically-induced carcinogenic transformation in mammalian cells and in the skin of mice. Promising results have been found in short-term clinical studies when using diets containing soy protein in the management of obesity. With respect to the use of peptides, Fujita [50] developed an anti-obesity formula containing soy proteins, soy peptides and other ingredients. Robles-Ramirez *et al*. [51] revealed that, germinated soy protein isolates could be a bioactive ingredient of functional food. Miura [52], also formulated non-sugar beverages and diets containing soybean protein hydrolysates.

Carbohydrates and Fibers: Carbohydrates take the form of sugars, oligosaccharides, starches and fibers and are one of the three major macro-nutrients which supply the body with energy (fat and protein being the others). There is now good evidence that at least 55% of our daily calories should come from carbohydrates. Whereas it is important to maintain an appropriate balance between calorie intake and expenditure, scientific studies has suggested that a diet containing an optimum level of carbohydrates may help to prevent body fat accumulation; starch and sugars provide readily accessible fuel for physical performance; dietary fibers, which is a carbohydrate, helps keep the bowel functioning correctly[102]. Apart from the direct benefits of carbohydrates for the body, they are found in a wide range of foods which themselves bring a variety of other important nutrients to the diet. For this reason it is recommended that carbohydrates be supplied from diverse food sources to ensure that the overall diet contains adequate nutrients [53]. Fructose oligosaccharide and galactose oligosaccharide fortified infant formulas are currently on the market; these are intended to support the developing immune systems of neonates [54]. Fructans are an important ingredient in functional foods because evidence suggests that they promote a healthy colon (as a prebiotics agent) and help reduce the incidence of colon cancer [55]. Foods containing sugars or starch can be broken down by the enzymes and bacteria in the mouth to produce acid which attacks the enamel of the teeth. After an acid challenge, saliva provides a natural repair process which rebuilds the enamel [103]. When carbohydrate-containing foods are consumed too frequently, or nibbled over time, this natural repair process is overwhelmed and the risk of tooth decay is increased. However in recent years the availability of fluoride and the widespread use of good oral hygiene practices have been widely heralded as responsible for the low rate of tooth decay in today's children and adolescents. This improvement has happened independent of any change in sugar or fermentable carbohydrate intake. Keeping plaque bacteria at bay and strengthening the teeth with fluoride reduces the risk of decay [56]. There is no evidence that sugar consumption is linked to the development of any type of diabetes. However there is now good evidence that obesity and physical inactivity increase the likelihood of developing non-insulin dependent diabetes, which usually occurs in middle age [104]. Weight reduction is usually necessary and is the primary dietary aim for people with non-insulin dependent diabetes. Consuming a wide range of carbohydrate foods is an acceptable part of the diet of all diabetics and the inclusion of low glycaemic index foods is beneficial as they help regulate blood glucose levels [105]. Most recommendations for the dietary management of diabetes allow a modest amount of ordinary sugar as the inclusion of sugar with a meal has little impact on either blood glucose or insulin concentrations in people with diabetes [57, 53]. In fact, scientists have made some very interesting findings from the exhaustive studies using glyconutritionals (over 20,000 worldwide in 1998 alone), getting back to thinking about protecting oneself and strengthening the immune system [59]. Glyconutritionals have been found to increase natural killer cells (the immune system's first line of defense) in healthy people 50% and in sick people up to 400% and have a modulating effect on the immune system which has never been seen before. For instance,

scientists have found that in lupus patients, the hyper-active immune functioning is decreased and hypo-active immune functioning is increased. They also stimulate glutathione production, meaning glyconutritionals act very effectively as anti-oxidants, have anti-viral and antibacterial effects, completely non-toxic and Have no drug interaction.

Carbohydrates in all shapes and forms are good for our health. They can help to control body weight, especially when combined with exercise, are vital for proper gut function and are an important fuel for the brain and active muscles. The most important messages for the public recommended by the recent report from the World Health Organization and the Food and Agriculture Organization of the United Nations on carbohydrates in human are: An optimum diet contains at least 55% of energy from carbohydrates and 20-35 g dietary fiber/day for all those over two years of age, a wide range of carbohydrate-containing foods should be consumed so that the diet is sufficient in essential nutrients and dietary fiber [58].

Dietary fiber is found in plant foods (fruit, vegetables and whole grains) and is essential for maintaining a healthy digestive system. Fiber cannot be fully digested and is often called bulk or roughage. The two types of fiber found in food are soluble and insoluble [61]. Soluble fiber, which can dissolve in water, is found in beans, fruits and oat products and can help to lower blood fats and maintain blood sugar. Insoluble fiber cannot dissolve in water, so passes directly through the digestive system. It's found in whole grain products and vegetables and it increases the rate at which food passes through the gut. High-fiber foods take longer to digest, so keep you feeling fuller for longer. The slow and steady digestion of food through the gut helps control blood sugar and assists with weight maintenance. Fiber helps in the digestive process and can help lower blood cholesterol. Fiber promotes bowel regularity and keeping the gastrointestinal tract clean to help reduce the risk of developing diverticular disease and constipation. A high-fiber diet may reduce the risk of developing diabetes and colorectal cancer [58]. Dietary intake of plant fibers is important for maintaining a healthy gut and reducing glucose absorption, which can be beneficial to diabetic patients. Consumption of insoluble fibers such as cellulose and hemicelluloses, as found in bran, leafy vegetables or fruit skins (e.g. apples and pears), serve as roughage and help to reduce the caloric value of diets, which is important in obese and diabetic conditions [59]. Soluble fiber (also called gums and pectin) is abundant in whole grain barley and oats, as well as in fruits such as ripe strawberries and bananas; this type of fiber forms a viscous indigestible mass in the gut and helps trap digestive enzymes, cholesterol, starch, glucose and toxins that are then expelled through the feces. In this way, soluble fiber can help obese people reduce the amount of calories they absorb from their food and help diabetics by reducing the rate of starch digestion and glucose absorption [60]. Fibers and phytochemicals have long been recognized as the active nutrients responsible for the health benefits of fruits and vegetables to humans. Interest in incorporating bioactive ingredients such as dietary fiber and phenolic antioxidants into popular foods like bread has grown rapidly, due to the increased consumer health awareness. The added bioactive ingredients may or may not promote the development of bread dough [61]. They have different functional properties that may affect perceived taste or use in different food applications [62]. Spreadbury [63] reported that, a diet of grain-free whole foods with carbohydrate from cellular tubers, leaves and fruits may produce a gastrointestinal microbiota consistent with our evolutionary condition, potentially explaining the exceptional macronutrient-independent metabolic health of non-Westernized populations and the apparent efficacy of the modern "Paleolithic" diet on satiety and metabolism. Galacto-oligosaccharides (GOS) as functional food constituents play a special role as prebiotics in gastrointestinal tract [64]. Zoetendal *et al*. [65] suggested that rapid uptake and fermentation of available carbohydrates contribute to maintaining the micro biota in the human small intestine.

Lipids and Fatty Acids: Fish oil has long been recognized as a functional food because of its ability to reduce blood pressure and lower the risk for other cardiovascular disorders such as abnormal heart beat and blockage of blood vessels by cholesterol. The health-promoting effect of fish oil is now known to be due to the omega-fatty acids, especially omega-3 and omega-6. The main omega-3 fatty acids in fish oil are docosahexaenoic (DHA) and eicosapentaenoic acids (EPA) [68]. DHA in particular has been shown to be an important structural component of the brain and contributes to improved memory functions. Recently, increased incorporation of DHA into margarines and baby foods has been promoted to enhance brain memory development; a role in reducing the severity of Alzheimer's disease has been suggested for DHA [66, 67]. Other omega-fatty acids such as linoleic and linolenic acids also provide increased cardiovascular benefits; they

are abundant in fish oil, vegetable oils (canola, soybean and sunflower) and nuts such as peanuts and almonds. Consumption of nuts is highly recommended since they are also packed with high levels of antioxidants that help maintain integrity of organs, blood vessels and genes [79]. Apart from the omega fatty acids, conjugated linoleic acid (CLA) is another important lipid that has been shown to positively impact human health. CLA is found mostly in dairy products or meat products derived from ruminant animals (cow, goats and sheep) [5, 68]. Several studies reported possible anti-cancer effects of *n*-3 fatty acids (particularly breast, colon and prostate cancer) [69, 71]. Omega-3 fatty acids reduce prostate tumor growth slowing histopathological progression and increased survival. Among n-3 fatty acids [omega-3], neither long-chain nor short-chain forms were consistently associated with breast cancer risk [72]. Lands and William [73] suggested that, the in-vitro anti-inflammatory activity of *n*-3 acids translates into clinical benefits. Cohorts of neck pain patients and rheumatoid arthritis sufferers have demonstrated benefits comparable to those receiving standard non-steroidal anti-inflammatory drugs (NSAIDs). Those who follow a Mediterranean-style diet tend to have less heart disease; higher HDL ("good") cholesterol levels and higher proportions of *n*-3 in tissue highly unsaturated fatty acids. Overall, omega-3 PUFA supplementation was not associated with a lower risk of all-cause mortality, cardiac death, sudden death, myocardial infarction, or stroke based on relative and absolute measures of association [74]. Also, Mickleborough [75] reported that, Omega-3 polyunsaturated fatty acids (PUFAs) have been shown to decrease the production of inflammatory eicosanoids, cytokines and reactive oxygen species, possess immunomodulatory effects and attenuate inflammatory diseases. Goksu *et al*. [76] reported that, Omega-3 fatty acids and sesame oil showed similar protective effects against cyclosporine A (CsA-induced nephrotoxicity), as revealed by a remarkable decrease in histopathological changes and apoptotic cell count. However, impaired renal function tests were not improved with omega 3-fatty acids (O-3)/ sesame oil (SO) treatment. SO and O-3 can be used as chemoprotectants against Cyclosporine A (CsA). CLA also reduces development of adipose fat and it may play a role in weight loss, although this has not yet been thoroughly proven in human trials. Research with rat models also suggested that CLA can reduce progression and severity of chronic kidney disease, which could reduce the need for and frequency of dialysis. Soybean oil had the greatest antioxidant capacity, likely due to its high tocopherol content, whereas peanut oil was less effective [77]. Grape seed extract supplements in high fat diet might normalize body weight, epididymal and back fat weights, lipid concentrations and carnitine levels through controlling lipid metabolism [72, 78]. Cold pressing of avocados produces very high-quality oil with very low levels of acidity and oxidation products whilst retaining the vitamin E content; Avocado oil carefully prepared and stored, contains components which can bring many health benefits, while also providing the sensory and culinary benefits expected of food oil [79]. The oil because of its nutritional benefits is an excellent contributor to a healthy and balanced diet and is of particular benefit in diets which help to prevent coronary heart disease, diabetes and possibly prostrate problems [80, 81]. The greatest exponent of monounsaturated fat is olive oil and it is a prime component of the Mediterranean Diet. People who consumed 25 milliliters (mL)-about 2 tablespoons-of virgin olive oil daily for 1 week showed less oxidation of LDL cholesterol and higher levels of antioxidant compounds, particularly phenols, in the blood [82]. But while all types of olive oil are sources of monounsaturated fat, EXTRA VIRGIN olive oil, from the first pressing of the olives, contains higher levels of antioxidants, particularly vitamin E and phenols, because it is less processed. Olive oil is clearly one of the good oils, one of the healing fats. Most people do quite well with it since it does not upset the critical omega 6 to omega 3 ratio and most of the fatty acids in olive oil are actually omega-9 oil which is monounsaturated. Spanish researchers suggested that including olive oil in your diet may also offer benefits in terms of colon cancer prevention [83]. On the other hand, Theresa *et al*. [84] reported that, wheat germ oil can be taken either as a dietary supplement or as a topical cream or lotion and has recently gained popularity in the cosmetic world due to the healing and rejuvenating effect it has on skin. Wheat germ is a common ingredient in breakfast cereals, however many of the health benefiting properties of the wheat germ oil are obtained only through oil that has not been heated. Wheat germ oil is extremely rich in vitamin E and is a powerful anti-oxidant. It is also high in vitamins A and D and contains vitamins B-1, B-2, B-3 and B-6, vitamin F, essential fatty acids, protein and minerals. Wheat germ oil is used for both healing and cosmetic purposes such as reducing scars and stretch marks; healing dry, damaged skin; retarding the effects of aging; relieving and healing eczema, psoriasis and sunburns; and treating muscle fatigue from overexertion. Table 3 shows fatty acid composition of food oils.

Table 3: Fatty Acid Composition of Food Oils

Food	Stats	Omega-9 MUFA (oleate)	Omega-6 Linoleate	Omega-3 a-linolenate
Avocado oil	13.4	72	9	0.5
Olive oil	17.3	66.8	11.8	0.6
Peanut butter	21.6	51.6	26.2	-
Maize oil(corn oil)	17.2	28.7	47.8	1.5
Canola oil	7.8	58.2	20.8	10.1
Wheat germ oil	20.1	15.4	53.6	10.4
Almonds	8.3	70.9	19.1	0.5

Table 4: The Catechin content of some foods (Error! Reference source not found.) (Error! Reference source not found.)

Food	Catechins mg/serving	Catechins,mg/100g food
Chocolate	23-30	46-61
Beans	70-110	35-55
Apricot	20-50	10-25
Cherry	10-44	5-22
Grape	6-35	3-17.5
Peach	10-28	5-14
Apple	20-86	10-43
Red raspberry	2-48	2-48
Strawberry	2-50	2-50
Blackberry	9-11	9-11
Green tea	20-160	10-80
Black tea	12-100	6-50
Red wine	8-30	8-30
Cider	8	4

Catechins (Proanthocyanides): Catechin is a very abundant component in green tea, although black tea also contains sufficient quantities. For tea drinkers to reap maximum benefits, it is important that the tea is boiled for several minutes to extract high quantities of catechins into the liquid beverage. Catechins are strong antioxidants that inhibit damage to DNA and blood vessels, thereby reducing the risks of cancer development and cardiovascular diseases, respectively. Cranberry juice contains high levels of epicatechin polymers that prevent adhesion of viruses and bacteria to the urinary tract; regular consumption of cranberry juice or cranberry concentrate tablets has been shown to reduce antibiotic requirements in women experiencing urinary tract infection [9, 85]. Murphy *et al.* [86] reported that, cocoa flavanol and procyanidin supplementation for 28 days significantly increased plasma epicatechin and catechin concentrations and significantly decreased platelet function. Table 4 illustrates the Catechin content of some foods.

Lycopene: This is a compound that is very abundant in tomatoes and other brightly colored foods such as papaya, watermelon, carrot, pink guava and pink grapefruit. For the best source of lycopene, consumption of concentrated tomato products such as tomato paste, canned pizza sauce, spaghetti sauce, barbecue sauce and ketchup are highly recommended. In addition, consumers should note that cooked tomato products provide better availability of lycopene than raw tomato products. Lycopene provides health benefits by neutralizing hazardous waste products such as reactive oxygen species (ROS) that our bodies normally produce during conversion of nutrients into energy [87]. ROS are dangerous compounds that can damage DNA and promote cancer formation. They also damage lipids that are vital to keeping our hearts and blood vessels functioning properly; such damage can lead to development of hypertension. Increasing consumption of lycopene-containing food products can reduce blood pressure in hypertensive patients by reducing plaque development (hardening of blood vessels). Also Previous studies have also shown that men who ate 10 or more servings of tomato products (pizza sauce, tomato sauce) per week or those with high levels of lycopene in their blood were substantially less likely (about 34%) to develop prostate cancer than those who consumed little or no tomato products [87]. Tomato purée revealed a much stronger, dose-dependent, anti-mutagenic effect compared with corresponding doses of pure lycopene. Results indicated that lycopene has anti-mutagenic effects, although the effects are lower than that of tomato purée, which contains a complex mixture of bioactive phytochemicals. The anti-mutagenic effect is connected with the chemoprotective role of lycopene, tomatoes and tomato products in the prevention of carcinogenesis [88]. Lycopene-the carotenoid responsible for the red color of tomatoes-has attracted attention because of its role in the prevention of chronic diseases in which oxidative stress is a major etiological factor, such as cancer, cardiovascular and neurodegenerative diseases and hypertension, among others. Antioxidants, including lycopene, interact with reactive oxygen species, can mitigate their damaging effects and play a significant role in preventing these diseases [89], also Palozza *et al*. [90] reported that, the experimental basis of lycopene for such health benefits is not fully understood. One of the possible mechanisms for its protective activities is by down-regulation of the inflammatory response.

Vitamins: Mankind has been relatively unsuccessful in the search for the ultimate panacea for all ills; however, in the field of functional foods, few nutritional components have so many fundamental and diverse biological properties as folic acid and related B group vitamins. B vitamins, particularly folate, may give considerable protection against serious diseases such as cancer, heart disease and birth defects [55]. Micronutrient malnutrition, the so-called hidden hunger, affects more than half of the world's population, especially women and preschool children in developing countries [91]. Even mild levels of micronutrient malnutrition may damage cognitive development, lower disease resistance in children and increase the incidence of childbirth mortality. The costs of these deficiencies, in terms of diminished quality of life and lives lost, are enormous. The clinical and epidemiological evidence is clear that select minerals (iron, calcium, selenium and iodine) and a limited number of vitamins (folate, vitamins E, B6 and A) play a significant role in the maintenance of optimal health and are limiting in diets [43]. Folic acid fortification appears to have had a positive effect on the incidence of neural tube defects. The new dietary recommendation for folic acid takes into account the benefits of protecting against these birth defects, but makes no recommendation on the benefits of protecting against heart disease. However, that folic acid supplementation greatly affects homocysteine levels and hence, coronary artery disease [92]. Older adults need more vitamin B6 than younger adults, for example, to reduce high plasma homocysteine levels. Food and Nutrition Board, Institute of Medicine [93] reported that, the upper limit for vitamin B6 is based on the fact that people taking large amounts of B6 in supplements have been shown to have sensory neuropathy. An acidic environment is necessary to break the bond between vitamin B12 and protein so that the vitamin can bind with the intrinsic factor for absorption. About 10 to 30% of adults older than 50, have low gastric acid levels and are probably absorbing inadequate amounts of B12 from food. To prevent this, adults older than 50 should obtain most of their vitamin B12 from supplements or fortified foods because synthetic B12 is not bound to protein. Foods fortified with B12 include meat, poultry and egg substitutes; meal replacements; and enriched plant-based beverages, such as soy milk. Both vitamin B6 and vitamin B12 usually in conjunction with folic acid, plays an important role in protecting against cardiovascular disease. Vitamin D can contribute not only to prevention of osteoporosis but also to a reduction in certain cancers and multiple scleroses and to an improvement in the prognosis of patients with osteoarthritis. Research on the role of vitamin E in protecting against heart disease is equivocal. Vitamin E supplementation of at least 100 IU per day for 2 or more years reduced adverse outcomes related to heart disease by 37% in men and 41% in women [92]. Also vitamin C plays an important role in providing antioxidant protection; vitamin C supplementation for 10 or more years was associated with a substantial reduction in risk of cataracts [93]. Higher vitamin C intake among elderly people might also provide some protection against both cognitive impairment and cerebrovascular disease [94]. The vitamin and mineral contents of peas may play important roles in the prevention of deficiency-related diseases, specifically those related to deficiencies of Se or folate. Peas contain a variety of phytochemicals once thought of only as anti-nutritive factors [95]. Pliz *et al*. [96] reported that, vitamin D may play a role for cardiovascular health. Expression of the vitamin D receptor (VDR) and enzymes for vitamin D metabolism have been identified in the vasculature as well as in the heart. VDR knock-out mice suffer from cardiovascular disease (CVD) and even selective VDR deletion in cardiomyocytes causes myocardial hypertrophy. Many, but not all observational studies showed that vitamin D deficiency is associated with CVD and its risk factors. Chickpea is a good source of important vitamins such as riboflavin, niacin, thiamin, folate and the vitamin A precursor β-carotene. As with other pulses, chickpea seeds also contain anti-nutritional factors which can be reduced or eliminated by different cooking techniques. Chickpea has several potential health benefits and , in combination with other pulses and cereals, it could have beneficial effects on some of the important human diseases such as cardiovascular diseases, type 2 diabetes, digestive diseases and some cancers. Overall, chickpea is an important pulse crop with a diverse array of potential nutritional and health benefits [97]. Table 5 shows food sources and health benefits of selected vitamins.

Table 6 displays examples of functional food components.

Table 7 shows some functional foods and drugs with identical targets available on the global market.

Table 5: Food sources and health benefits of selected vitamins

Vitamin	Food source	Health benefits
Folate	Legumes, grains, leafy greens, oranges	Neural tube defects, cardiovascular disease, cancer
Vitamin B6	Meat, fish, poultry, legumes, bananas	Stroke
Vitamin B12	Meat, fish, poultry, eggs, dairy products	Stroke
Vitamin D	Fluid milk, margarine, fatty fish and fish Oils	Bone health
Vitamin E	Vegetable oils, almonds, sunflower seeds,	
peanut butter	Heart disease, cancer	
Vitamin C	Citrus fruit, strawberries, broccoli, red	
peppers, potatoes	Eye health, cancer	
Vitamin K	Leafy greens, soy and canola oils	Bone health
Vitamin A	Retinol: organ meats, dairy products;	
		Carotenoids: deep green or yellow orange
Vegetables	General health, including Immunity	
Thiamin	Grain products, pork, legumes	Health of elderly people
Riboflavin	Dairy products, meat, fish, legumes	Health of elderly people
Niacin	Meat, fish, poultry, nuts	Health of elderly people
Pantothenic acid	Widely distributed in food supply	Health of elderly people
Choline	Milk, liver, eggs, peanuts, processed foods with added lecithin	Health of elderly people

Table 6: Examples of Functional Food Components

Functional components	Source	Potential benefits
Source: International Food Information Council (http://www.sourcewatch.org/index.php?title=International_Food_Information_Council)		
Carotenoids		
Alpha-carotene		
Beta-carotene	Carrots, Fruits, Vegetables	Neutralize free radicals, which may cause damage to cells
Lutein	Green vegetables	Reduce the risk of macular degeneration
Lycopene	Tomato products (ketchup, sauces)	Reduce the risk of prostate cancer
Dietary Fibre		
Insoluble Fibre	Wheat Bran	Reduce risk of breast or colon cancer
Beta-Glucan	Oats, barley	Reduce risk of cardiovascular disease. Protect against heart disease and some cancers; lower LDL and total cholesterol
Soluble Fibre	Psyllium	
Fatty Acids		
Long chain omega-3		
Fatty Acids-DHA/EPA	Salmon and other fish oils	Reduce risk of cardiovascular disease. Improve mental, visual functions
Conjugated Linoleic Acid (CLA)	Cheese, meat products	Improve body composition. Decrease risk of certain cancers
Phenolics		
Anthocyanidins	Fruits	Neutralize free radicals; reduce risk of cancer
Catechins	Tea	
Flavonones	Citrus	
Flavones	Fruits/vegetables	
Lignans	Flax, rye, vegetables	Prevention of cancer, renal failure
Tannins (proanthocyanidines)	Cranberries, cranberry products, cocoa, chocolate	Improve urinary tract health. Reduce risk of cardiovascular disease
Plant Sterols		
Stanol ester	Corn, soy, wheat, wood oils	Lower blood cholesterol levels by inhibiting cholesterol absorption
Prebiotics/Probiotics		
Fructo-oligosaccharides (FOS)	Jerusalem artichokes, shallots, onion powder	Improve quality of intestinal microflora; gastrointestinal health
Lactobacillus	Yogurt, Other dairy	
Soy Phytoestrogens		
Isoflavones:	Soybeans and soy-based foods	Menopause symptoms, such as hot flashes Protect against heart disease
Daidzein		and some cancers; lower LDL and total cholesterol
Genistein		

Table 7: Some functional foods and drugs with identical targets available on the global market

Food	Target	Drugs
Enriched with phytosterol-stanolesters	Low density lipoprotein cholesterol	Statins, Ezetimibe
Containing bioactive peptides	Blood pressure	Antihypertensive drugs (such as thiazide diuretics)
Containing melatonin	Quality of sleep	Benzodiazepines
Containing omega 3 fatty acids	Depression	Antidepressants
Containing β glucan	Blood sugar values	
Low density lipoprotein cholesterol	Insulin, oral hypoglycaemic drugs	Statins, ezetimibe
Containing prebiotics	Bowel frequency	Laxatives
Containing probiotics	Immune functioning Diarrhea (wet stools)	Loperamide
Containing extra calcium or vitamin D, or both	Bone health	Alendronate, calcitonin, Oestrogens
Containing protein or bioactive peptides	Obesity and type 2 diabetes	Orlistat, Rimonabant

CONCLUSIONS

The beneficial effects of functional foods and nutraceuticals can be concluded that: Reduced risk of cardiovascular diseases, reduced risk of cancer, weight loss/management, reduced osteoporosis, improved memory, quicker reaction time, improved fetal health and reduced risk of other many diseases. Functional foods and nutraceuticals will be hopeful to good health in the future; it has been convincingly demonstrated to be beneficial for their intended purposes when consumed as part of a generally well-balanced and healthful diet. Also, more information and evidences must be available to assist consumer for the correct choosing and using the functional foods and / or nutraceuticals to achieve the promised health benefits.

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