Chapter

Functional Foods and Human Health: An Overview

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Abstract

Functional food is a whole ingredient or a part of food that used as food for specific therapeutic purposes. It is divided into two wide categories: Conventional and modified functional foods. Conventional functional Foods are composed of natural or whole-food ingredients that provide functional substances while modified functional is food or food products in which add additional ingredients for specific health purposes. Plant-based food such as fruits, vegetables, herbs, cereals, nuts and beans contain vitamins, minerals, fiber, omega-3 fatty acids, antioxidants and phenolic compounds that play a functional role in the human body against chronic diseases including cancer, cardiovascular and GIT-related disease. Some other foods or food products like juices, dairy products, fortified eggs and seafood are composed of functional components. Fish contain omega-3 fatty acids (EPA and DHA) that are played a functional role in heart health and brain development.

Keywords: functional food, conventional food, modified food, antioxidants, health

1. Introduction

Functional food is concerned with promoting health or protection from diseases [1]. The word functional food can also be used to describe traits that have been purposefully bred into established edible plants, such as purple or gold potatoes with lower anthocyanin or carotenoid content [2]. These foods are prepared for functional benefits and aid in reducing the risk of long term diseases beyond basic nutritional functions and can look like traditional food and be eaten as part of a daily diet [3].

The functional food sector, which includes the food, beverage, and supplement industries, is one of the many sectors of the food industry that has seen significant growth in recent years. The global demand for functional foods is expected to hit 176.7 billion dollars in 2013, with a compound annual growth rate (CAGR) of 7.4%. The functional food sector will grow at a 6.9% CAGR, while the supplement sector will grow at a 3.8 percent CAGR, and the functional beverage sector will grow at a

10.8 percent CAGR [4]. This type of expansion is fueled not only by technological advancements and the introduction of new goods to meet the needs of health-conscious customers but also by health claims that cover a broad range of ailments. Consumer skepticism remains, owing to the fact that the advantages of using the goods can be difficult to discern. Any businesses may be deterred from launching their products if any of the functional food statements are scrutinized closely [5].

Functional foods contain a rich source of bioactive components. When these components are used in reliable, non-toxic, and defined quantities, so these provide a scientifically validated and recorded health benefit for the prevention, control, or treatment of chronic diseases" [6]. However, establishing a formal concept for these foods would help in their commercialization. The inclusion of bioactive compounds, which are biochemical molecules that promote health by physiological processes, improves the idea of functional foods. Functional Food Center (FFC) has advanced the functional food concept to provide clarification and a more detailed understanding of its context [7].

Health benefits are commonly associated with functional foods. Physical performance, psychological activity, organ or system function, emotional, mental, and curing chronic illness are the physiological benefits of functional foods or bioactive compounds [8].

2. Definitions of functional food

In the early 1980s, a Japanese scholarly society proposed the idea of functional foods. The law for functional foods was first introduced in the 1980s as FOSHU,

Sources	Definition of functional food	References
Functional Food Center (FFC)	"Natural or processed foods containing known or unknown biologically active compounds that provide a scientifically supported and established health benefit for the prevention, management, or treatment of chronic diseases is prescribed, appropriate, and non-toxic amounts"	[11]
Food and Drug Administration (FDA)	"The word "functional foods," which is recently being used as a marketing idiom for the group, does not have a legal meaning"	[7]
Institute of Food Technologists (IFT)	"Foods and food ingredients that have health benefits in addition to basic nutrition." These products provide necessary nutrients in amounts that are often more than what is needed for regular operation, health, and production, as well as other pharmacologically active components that have a positive effect on health."	[12]
International Life Sciences Institute (ILSI)	"Foods that by virtue of the presence of physiologically active food components provide health benefits beyond basic nutrition"	[13]
European Food Safety Authority (EFSA)	"A food, which beneficially affects one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease. A functional food can be a natural food or a food to which a component has been added or removed by technological or biotechnological means, and it must demonstrate their effects in amounts that can normally be expected to be consumed in the diet"	[6]

Table 1.
Different definitions of functional food.

which stands for "Foods for Specified Health Use." Functional foods were originally characterized as foods that can modulate body functions and thus help in disease prevention [9]. Functional foods are described by EFSA as "a food that, above sufficient dietary benefits, has a beneficial impact on the multiple body functions in a way that is related to either an enhanced health condition and well-being or a decreased risk of disease". The FSGs law encompasses a small number of well-defined food groups that are deemed important for human health and certain categories of, especially vulnerable individuals. Processed cereal-based diets and baby food, complete diet substitute for weight loss, infant formula and follow-up formula and food for special medical purposes [6]. A functional food should be a natural food or a portion of food to which an ingredient has been added or extracted using technical or biotechnological methods, and it must represent the effects in amounts that can be fairly believed to be consumed in the food" [10].

The Functional Food Center in the United States (FFC) has defined functional foods as "real or processed foods that contain known or unknown biologically active compounds that, efficient, in defined and non-toxic quantities, recorded health benefit or provide a scientifically validated using unique biomarkers for the prevention, treatment or control of chronic disease or its symbiotic diseases" [11]. There are different definitions of functional food are listed in **Table 1**.

3. Foods that contain functional components

Plant foods contain a variety of functional components such as vitamins (C, A and E) minerals, phenolic compounds, antioxidants and phytochemicals [14]. These Secondary metabolisms produce physiologically active molecules that are helpful for the human body. The various classes of health-promoting substances (phytosterols, carotenoids, phytosterols, phenolic compounds, nondigestible carbohydrates, tocotrienols and organosulfur compounds) are discussed together with the dietary origins as well as the biological and chemical properties that justify their mechanisms of action [15].

Plant-based functional foods (broccoli and other cruciferous vegetables, fruit, grapes, tomato, soybean, oat, oranges, flaxseed, garlic, wine, and tea) are played a functional role in the healthy body, as well as the phytochemicals concerned and benefits of health-promoting function. The study stresses the relevance of eating fruits and vegetables for people's overall wellbeing, as well as certain science and technological prospects in developing countries [16].

Phytochemicals found in whole grains, fruits, and vegetables are the most abundant sources of functional components. Conversely, animal products like milk, fermented milk products, and freshwater fish include antioxidants, covalently linked linolenic acid, long-chain omega-3, −6, and − 9 polyunsaturated fatty acids and organic acids [17]. **Table 2** lists several food ingredients, their biological roles and their typical origins.

4. Functional component

4.1 Fibers

Even though dietary fiber is not a "nutrient," it is an essential substance of our foods. Fiber is beneficial because it moves through the body without being digest. Dietary fiber is made up of polysaccharides, its present in soluble and insoluble form in different foods. Pectin, mucilages and beta-glucan soluble whereas lignin,

Component	Sources	Biological role	References
Flavones	Fruits and vegetables	Reducing cancer risk by neutralizing free radicals	[18]
Catechins	Tea	Tea Catechins improve diabetes, obesity and cardiovascular diseases	[19]
Anthocyanidins	Fruits	Due to antimicrobial and antioxidative ability anthocyanidins aid in neurological and non-communicable diseases.	[20]
Flavanones	Citrus fruit	It aids to prevent chronic diseases and Alzheimer's disease	[21, 22]
Lignans	vegetables, Flax seeds and rye	Cancer prevention and kidney cure	[23, 24]
Tannins	Fruits, vegetable, legume seeds, cereal grains and nuts	Reduce the risk of cardiovascular disease and improve urinary tract health	[25, 26]
Lutein	Green vegetable	Reduce the chances of developing muscle degeneration and improve visual problem	[27, 28]
Alpha-carotene and Beta-carotene	Fruits and vegetables	Free radicals can neutralize which can inflict cell damage	[29]
Lycopene	Tomato	Reduce the chances of developing prostate cancer	[30, 31]
Quercetin	Onion, red grapes, cherries and citrus fruits	Improve liver function and prevent obesity	[32]
Total phenolic content	Blueberries, and pomegranate	Reduce risk of cardiovascular diseases and improve neuron cells	[33, 34]
Carotenoid	Kiwifruit and kale	Aid in chronic deceases	[35]

Table 2.
Components, sources and biological role of functional food.

cellulose and hemicellulose insoluble are present in various plant foods [36]. These components are not digested or absorbed in the small intestine and passes into the large intestine in an intact form and is immune to enzymatic digestion. Fibers are graded as soluble or insoluble based on their solubility. Fiber fortification also helps dairy foods enhance their sensory qualities, shelf life, and structural properties [37].

The previous indications evaluated that fiber plays a functional role in the human body against various diseases. Because fiber is the non-digestible component that passes through the small intestine to the large intestine without absorbing. In the small intestine nutrients like fat and glucose are absorbed, however, fiber attracts extra fat and glucose, and pushes them to the large intestine, where stool is prepared. Moreover, extra fat and glucose are made part of the stool. However, in this way fiber prevents extra glucose and fat into the blood that's aids in inhibiting the chances of diabetes and CVD disease [37, 38].

4.2 Vitamins

Food fortification with essential micronutrients including vitamins A, D, and E improves human health by ensuring sufficient intake to avoid diseases (such as osteoporosis, osteoarthritis, a suppressed immune system, cancer, vision loss and

heart disease) and enhances life quality and survival. Malnutrition statistics in many populations, especially in developing countries, have increased the need for food fortification with lipophilic vitamins A, D and E. Foods usually contain these vitamins, but in inadequate quantities, and human body absorption is insufficient to achieve the optimal level of health benefits [39].

Some vitamins including A, C and E act as antioxidants. During processing, the oxidation process is started. These vitamins inhibit the oxidation process due to antioxidants activity. When these vitamins enrich foods are consumed then that's can help in different chronic diseases [40].

Around 2 billion people worldwide are believed to be deficient in one or more micronutrients, placing them at risk of death, illness, or disability. Food fortification and supplementation (i.e., the availability of nutrients in a form other than food) are both effective methods for ensuring adequate daily intakes of minerals and vitamins. A good vitamin or mineral compound for food fortification should have two main characteristics including high bioavailability and no reaction with the food matrix [41].

4.3 Minerals

The minerals have many roles and potentials in metabolism and homeostasis, mineral deficiency can cause a variety of common disorders and disease symptoms. Mineral absorption and bioavailability can be significantly improved by ensuring mineral content details in terms of safe food fortification and processing methods. The most popular minerals used to fortify various food preparations are iron, calcium, zinc, and iodine. The bioavailability of food minerals can be accurately measured using isotope ratio methods. Modern processing techniques have less detrimental effects on the consistency of micro-and macro minerals than conventional process parameters [42].

Food fortification and supplementation are the most cost-effective ways to combat global mineral malnutrition. Because of political, social, infrastructure-related, and technical constraints, most interventions to improve mineral nutrition have been less effective in most developing countries. The most potential solution has been salt iodization (iodine fortification), which has substantially decreased the incidence of goiter and other IDD symptoms in areas where it has been introduced [43].. Selenium (Se) is an effective nutritious antioxidant that exerts natural effects by incorporating it into selenoproteins. Since selenoproteins play a vital role in the regulation of reactive oxygen species (ROS) and redox states in practically all tissues. The selenium "improving" the immune system maintained by investigation on aging immunity [44]. Zinc is an important trace mineral and plays a vital role in many physiological functions. Zinc is essential for the growth and function of immune cells in the innate and adaptive immune system. Zinc homeostasis is well controlled in all cells, and any stress-free regulation will result in compromised normal function. In several disease models, such as infections, allergies, autoimmune diseases and cancer, the significances of homeostasis disorders can be detected [45].

4.4 Antioxidants

Antioxidants are substances that aid in prevent oxidation. Fruits, vegetables, nuts, cereals and beans contained different types of antioxidants. These substances are used as functional ingredients in many foods and food products [46]. As a functional ingredient, antioxidants help to protect from many diseases. In the human body, these functional ingredients played a vital role to protect from chronic diseases such as cancer and cardiovascular diseases [47].

5. Functional food categories

Consumer demands must be taken into account when designing functional foods, which can be found in nearly all food categories. Functional foods have been produced in almost every food category, but their distribution across consumer segments is not standardized, and product preferences different prebiotics, probiotics, symbiotic foods, isoflavones, phytosterols, anthocyanins, fat-reduced foods, sugar-reduced foods, and antioxidants are some of the functional food groups [48].

Functional foods have been introduced mainly in the dairy, confectionery, soft drinks, bakery, and baby-food industries, among other food markets. Vitamins and/or minerals such as vitamin C, vitamin E, folic acid, zinc, iron, and calcium are used to preparation of fortified food. Following that, the emphasis turned to foods fortified with various micronutrients, such as omega-3 fatty acids, phytosterol, and soluble fiber, to encourage good health and avoid diseases such as cancer [49]. Due to the wide range of health benefits, the producers of food have divided functional food into two groups including Conventional food and modified food that shown in **Figure 1**. Taken a stand proactive actions to produce foods that provide multiple health benefits in a single serving.

5.1 Conventional food

Foods that are composed of natural or whole-food ingredients that provide functional substances such as heart-healthy fatty acids, antioxidants, vitamins and minerals are called conventional functional food. A safe and organic diet includes more bioactive compounds and less harmful substances including persistent toxins, their metabolites, pesticides, and fertilizers. Organic food helps to maintain a balanced lifestyle and reduces the risk of developing. In the supply chain, the Purpose of these foods is aid to in ensuring the nutritional quality of particular foods or products [50].

Organic foods, rather than traditional foods, have become increasingly popular in recent years. Fruits (dry and fresh), vegetables (leafy green and non-leafy), nuts, seeds, legumes, herbs and spices are the conventional functional foods as show in **Figure 1**. Conventional functional foods contain bioactive substances that beneficial effects on health [51].

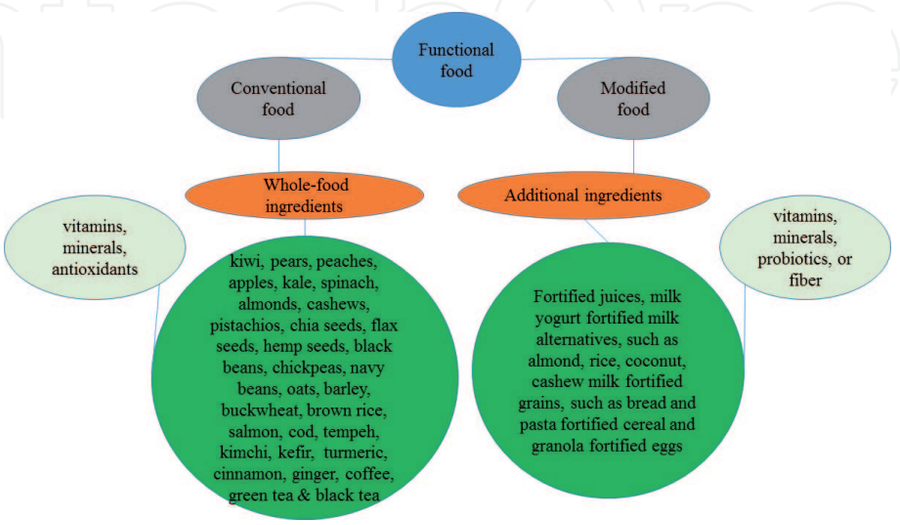

Figure 1.
Conventional food and modified food are forms of functional food. It is present in food products natural (whole-food ingredients) and additional (additional ingredients). The vitamins, minerals, fiber and antioxidants are functional components present in different functional foods and food products.

5.2 Modified food

Food or food products in which add additional ingredients (vitamins, minerals, probiotics and fiber) for specific health purposes are called modified foods. Fortified food products such as fortified juices, dairy products (milk and yogurt), fortified milk alternatives (almond, rice, coconut, and cashew milk), fortified grains (bread and pasta), fortified cereal and granola and fortified eggs are modified functional food products that show in **Figure 1**. The progress of modern biotechnological achievements has culminated in genetic modification or genetic engineering in the form of genetically modified plants and genetic modification, and eventually the outcomes in the form of genetically modified food. Which has the potential to end world hunger, poverty and malnutrition [52].

5.3 Fortified food

"Food fortification" refers to the addition of nutrients at levels greater than those found in the original food. Enrichment is associated with fortification. The term "restoration" refers to the addition of nutrients to food to compensate for the nutrients lost during processing. Food fortification is usually done at the industrial level, but it can also be done at the household or group level [53].

Nutritional fortification is one of three approaches used to resolve public health problems of micronutrient deficiency. When designing a micronutrient fortification program, a variety of factors must be taken into account. Trends in global micronutrient deficiency, dietary patterns, production and marketing of potential food vehicles, government policies, and regulations are all factors to consider. A five-step procedure, which can be visualized as a linked loop, is usually followed when constructing a fortification intervention (**Figure 2**). The measures can be performed in any order or even simultaneously. The cycle will begin at a different stage depending on what relevant information is already available in the region or country [54].

Figure 2.
Fortification cycle.

Although fortification has the potential to be a successful strategy, there is little evidence of its effectiveness in the developing world. Programs must monitor the direct impact of fortification on morbidity and mortality. According to the World Health Organization (WHO), more than 2 billion people are deficient in key vitamins and minerals, especially vitamin A, iodine, iron, and zinc. The majority of these individuals are from developing countries, where multiple micronutrient deficiencies (MMN) are normal [53].

6. Functional food development

From definition to effective consumer execution, functional food production includes several distinct phases. Consumers enthusiastically support food products with health claims attesting to a practical capacity to promote health beyond the provision of essential nutrients, which is likely to result in lower morbidity and mortality, as well as the improved overall quality of life in the general population [55].

The FDA's approval of qualifying health claims for many ingredients when used in specific quantities has aided the growth of the functional food industry and raised consumer awareness of nutraceutical ingredients like omega-3 fatty acids, dietary fiber, plant sterols, and soy protein. In the last decade, the number of functional food product releases with unique target health categories has increased. Gut health, cardiac health, immune function, bone health, and weight control have all been the subject of functional health statements [56].

For a successful product development process, a thorough understanding of the fundamental science of the heart, as well as a thorough understanding of the materials and processes available, is required. To create a cost-effective and tailor-made suitable for its intended use (final food product), the final product shape (liquid or dry) and demand (size and value) must be defined at the outset. These variables may have a huge impact on the products, formulations, and methods available. This is the time to verify physical performance and characteristics, core stability, and possible interactions with other ingredients during the formulation and operation [57].

Functional foods have been developed in almost every food group. From the standpoint of a commodity, the functional property can be used in a variety of ways. According to a different classification, certain functional products "bring good to your life," such as improving normal stomach and colon functions (pre-and probiotics), or "improve children's lives," such as promoting their cognitive ability and providing a conducive learning environment. On the other hand, finding good biomarkers for cognitive, behavioral, and psychological functions is challenging. Another form of functional food is designed to assist people in managing a pre-existing health condition, such as high cholesterol or high blood pressure. The third group includes items that "make your life easier" (for example, lactose-free and gluten-free products) [48].

The creation of indicators that could validate the effects of modern food ingredients and could be used during their protection evaluation is enabled by scientific knowledge of how particular Food ingredients have an influence on body processes that affect well-being and health [58]. The production of functional ingredients using cutting-edge food science and biochemical approaches will benefit consumers by improving their health and lowering their disease risk. These trials must be properly designed and carried out in order to provide empirical justification for the acceptance of health assurances and the effective modification of existing functional foods. The advancement of functional foods and their associated health

benefits will be accompanied by advancements in food security, which will ensure the legitimacy of the claims and also the food's protection. Technology cannot be governed in and of itself, and practical food science only serves as the systematic foundation for these legislation [59].

A food that is useful may be a normal food, one with which a diet element has been inserted or one through which a part has been omitted for particular health purposes, one in which a material has been changed by technical or biochemical processes to have a particular health benefit, one where the bioactivity of a product has been changed, or a mixture of all of these [60].

While the words "nutraceutical" and "functional food" are widely used across the globe, there is no general agreement about what they mean. The following concepts have been suggested by the Bureau of Nutritional Sciences of Health Canada's Food Directorate: A functional food resembles or is related to a traditional food, is eaten as part of a daily diet, and has been found to have metabolic advantages and/or lower the risk of developing chronic diseases beyond specific dietary functions. Nutraceuticals are foods that have been found to provide biochemical effects that offer protection against a chronic illness that are marketed in powders, tablets, and other medical products not typically associated with fruit. A nutraceutical, a pharma food, or a nutritional supplement are obviously not the same thing as a functional meal. It is a substance, not a drug, and it has health benefits that are typically disease prevention rather than medicinal [61].

7. Conclusion

It is concluded that functional food prepared by a conventional or modified procedure, has a functional role in human health. Some natural foods like plant-based food including fruits, vegetable, nuts, herbs, cereals and beans, seafood for example fish, and dairy product like milk are rich sources of vitamins, minerals, antioxidants, fiber, phenolic compound and omega-3 fatty acid, these all components have kept the specific functional role in human health against diseases. Conclusively statement shows that functional foods are designed to improve health and chronic diseases.

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