

ROLE OF FUNCTIONAL FOODS IN HUMAN HEALTH: AN OVERVIEW

Abstract

Food and health are directly related, and this has inspired several scientific investigations to determine the impact of dietary substances on particular bodily functions. In recent years a number of studies have been done on functional characteristics which have direct association to the health benefits of diverse foods made from plants and animals. Certain food ingredients are essential for improving our health and wellbeing. In addition to supplying essential nutrients, these foods, sometimes referred to as Functional Foods, assist in lowering the risk of specific illnesses and other ailments. An entire ingredient or a portion of food that is used as food for specific therapeutic purposes is referred to as a functional food. Due to the presence of various types of physiologically active functional components it has various beneficial healthy functions in the body beyond nutrition. Functional foods fall into two groups based on their functional components: Traditional or conventional functional foods made with natural or whole foods and nonconventional or modified functional foods with extra additives for certain health benefits. On the basis of sources functional foods are obtained from plants like fruits, vegetables, herbs, spices, nuts, beans, cereals, millets, etc; animal sources like dairy products, sea foods, fortified products, etc, microbial sources like good microorganisms such as *Lactobacillus casei* or numerous *Bifidobacter* species, which are also referred as probiotics and other sources like algae, mushrooms etc. Due to the presence of various types of nutrients and non nutrients in them like vitamins, minerals, essential fatty acids like omega-3 fatty acids (ALA, EPA and DHA), antioxidants, phenolic

Authors

Dr. Meenu Sirohi

Assistant Professor
Department Of Home Science
(Foods and Nutrition)
Rani Bhagyawati Devi Mahila
Mahavidyalaya, Bijnor
R.B.D. Mahila Mahavidyalaya
Uttar Pradesh, India.
meenusirohi22jan@gmail.com

Dr. Shikha Singh

Assistant Professor
Department of Home Science
Rajkiya Mahila Snatkottar Mahavidyalaya
Ghazipur, Uttar Pradesh, India.
shikhasngh032@gmail.com

compounds, etc; the dietary substances are considered as functional and can provide protection to the people against risk of various degenerative conditions like diabetes, uncontrolled cell division, cardiovascular disease, and others.

Keywords: Antioxidants, degenerative diseases, functional foods, health, nutrition

I. INTRODUCTION

Foods having a variety of dietary bioactive substances with significant health advantages, providing a great opportunity to improve public health and wellbeing (Gul *et al.*, 2018). The connection between nutrition and health has dramatically increased over the past few years as a result of growing evidence that a balanced diet can help reduce the risk of acquiring a range of degenerative disorders (Henson *et al.*, 2008). Dietary substances having functional properties not only contain nutrients but may also have additional health advantages that could improve people's quality of life. They present a chance to lower the direct and indirect medical expenses linked to several common chronic diseases like high blood sugar, heart ailments, uncontrolled cell division, etc. Beyond providing appropriate nutrition, functional foods have positive effects on one or more target bodily processes that either improve general health and wellbeing or reduce the likelihood that an illness may occur (Alzamora *et al.*, 2005). A widespread belief in the health advantages of food has given rise to the interesting term "functional foods" (Milner, 2002). Bioactive ingredients are abundant in functional foods. According to Martirosyan and Singharaj (2016), it has been observed that when dietary substances having functional properties are administered in reliable, non toxic and defined amounts show scientifically proved health benefits by preventing, controlling or treating chronic disorders. The idea of functional food is improved by the inclusion of bioactive substances, which are biochemical molecules that boost health through physiological processes in the body. Functional foods or bioactive components have a number of physiological benefits that are frequently linked to improved health, including improved bodily and cognitive performance, organs functionality, soundness of emotions, and the prohibition and cure of degenerative disorders (Granado-Lorencio and Hernandez Alvarez, 2016).

II. CONCEPT AND DEFINITION OF FUNCTIONAL FOODS

The concept of functional food was first suggested by a Japanese scholarly society. FOSHU, or "Foods for Specified Health Use," is the acronym for the law governing functional foods, which was initially adopted in the 1980s. Functional foods were first defined as being able to improve bodily functions and so help in the preventing and treating various disease ailments (Shimizu, 2003). Various national and international organizations revealed about functional foods in various ways.

1. According to the International Life Sciences Institute (ILSI), 'A functional food is one that offers health advantages above and beyond basic nutrition due to the presence of physiologically active dietary components' (Crowe and Francis, 2013).
2. According to European Food Safety Authority (EFSA) "Beyond the nutritional impacts, functional food has positive effects on one or more specific bodily functions that are related to either an enhanced state of health and well-being or a decreased risk of disease". A functional food must exhibit its benefits in doses that are consistent with what would typically be taken in the diet. It might be a substance that is naturally occurring or one that has had a component added or removed using biotechnological or technological methods (Martirosyan and Singharaj, 2016).

3. According to Goldberg (1994) “Any food or food component that, in addition to its nutritional worth, benefits a person's health, physical performance, or mental state is called as functional food”.
4. According to Institute of Food Technologists (IFT) “In addition to providing essential nutrients, food and food additives it also provides health advantages. In addition to providing essential nutrients in quantities that are frequently greater than those required for normal operation, health, and production, these products also contain other pharmacologically active ingredients that promote good health (MacAulay *et al.*, 2005).
5. According to Functional Food Centre (FFC) “Prescribed, appropriate, and non-toxic levels of natural or processed foods containing known or unidentified biologically active substances containing a documented health benefit for the management, prevention, or treatment of chronic disorders are called functional dietary substances” (Martirosyan and Pisarski, 2017).
6. Food and Nutrition Board of the National Academy of Sciences defines functional food as any modified food or food substance that can provide health benefits in addition to the ordinary nutrients it contains” (Committee on Opportunities in the Nutrition and Food Sciences, Food and Nutrition Board, Institute of Medicine, 1994).
7. In 1999 the American Dietetic Association's defined Functional foods as those that are whole, fortified, enriched, or enhanced. More importantly, however, the ADA notes that these foods must be regularly consumed as part of a balanced diet at appropriate amounts (American Dietetic Association, 1999).

III. FOODS HAVING FUNCTIONAL COMPONENTS

Various types of health promoting substances which are also called as functional components are found in plant foods like vitamins like Ascorbic acid, tocopherol, etc, minerals like selenium, zinc, etc, phenols, phytosterols, carotenoids, phytoestrogens, dietary fibre, tocotrienols, organo-sulphur compounds, essential fatty acids, antioxidants and phytochemicals (Cartea, 2011). These secondary metabolites produce chemicals that are beneficial to the human body and are physiologically active. Functional foods found in plants, such as broccoli and other cruciferous vegetables, fruit, grapes, tomatoes, soybeans, oats, oranges, flaxseed, walnuts, garlic, wine, tea, whole grains, and millets, among others, have a purpose in the body that helps to promote health. The animal foods like fermented and non-fermented dairy products, freshwater fish etc contain essential fatty acids like polyunsaturated fatty acids (omega 3 and 6), various minerals having antioxidant properties like selenium, etc (Abuajah, 2015).

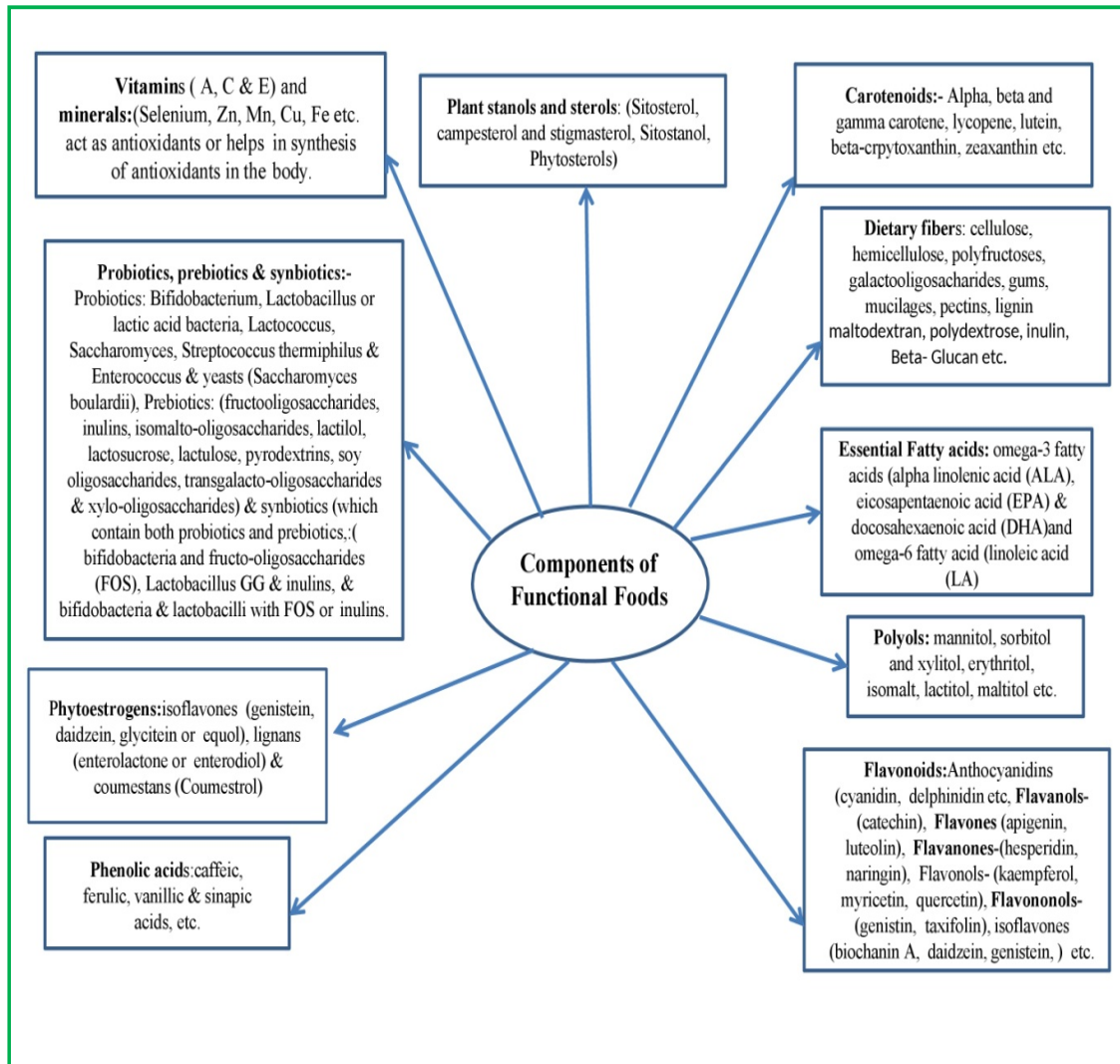


Figure 1: Components of Functional Foods

Source: Guine *et al.* (2011)

Table 1: List of Dietary Substances along with their Functional Components

Component	Source	Physiological Role
α and β -carotene	Different varieties of coloured veggies and fruits	Neutralize the free radicals which causes destruction of cells
Lutein, Zeaxanthin, etc.	Green vegetables (kale, spinach, broccoli, asparagus), corn, carrots	Lowering the likelihood of developing muscle degeneration and maintaining eye health
Lycopene	Tomatoes, watermelon, red/pink grapefruit	Reduce the risk of development of prostate

		cancer
Anthocyanins like Cyanidin, Delphinidin, Malvidin, Pelargonidin, etc.	Found in fruits like berries, cherries, red grapes etc.	Control neurological and degenerative diseases because of antimicrobial and antioxidant properties
Flavanols - such as catechins, epicatechins, epigallocatechin etc.	Found in apples, cocoa, chocolate, tea leaves, grapes, etc.	Controls hyperglycemia, obesity, various cardiovascular diseases etc.
Flavones	Fruits and vegetables contain flavones	Lower the threat of uncontrolled cell division by reducing oxidative stress
Flavanones: (Hesperetin, Naringenin etc.)	Citrus fruits	Inhibit chronic diseases and neurodegenerative diseases like Alzheimer
Flavonols such as Isorhamnetin, Kaempferol, Myricetin, Quercetin, etc.	Found in onions, apples, tea, broccoli etc.	Maintain the integrity of cells and functioning of cellular antioxidant defences by counteracting free radicals.
Tannins	Fruits, vegetables, seeds from legumes, grains from cereal, and nuts	Maintain the health of kidney and lower the possibility of heart disorder
Quercetin	Cherries, citrus fruits, onions, red grapes, & others.	Boost hepatic system and avoid chubbiness.
Phenolic acids like caffeic acid & ferulic acid	Citrus fruits, some vegetables, whole grains, coffee, apples, pears, blueberries, pomegranates etc.	Lower risk of cardiovascular illness and strengthen neurons
Prebiotics- Oligosaccharides like Fructo, isomalto, soy, transgalacto and xylo, lactulose, lactosucrose, pyrodextrins inulins, etc	Fortified foods and beverages, grains, millets, <i>Allium cepa</i> , <i>Allium sativum</i> , honey, fruits like banana	Maintains intestinal health, improves calcium absorption, etc.

Bifidobacterium, Lactobacillus, Lactococcus, Saccharomyces, Streptococcus thermophilus, Enterococcus, yeasts (Saccharomyces boulardii), and other particular types of helpful bacteria are examples of probiotics.	Found in fermented dairy products like curd and other non - dairy products also.	Maintain digestive & immune health, reduce colon cancer
Phytoestrogens like Isoflavones (genistein, daidzein, glycitein, or equol), lignans (enterolactone or enterodiol), and coumestans (coumestrol).	Soybeans and soy-based products, flax, pumpkin, and rye seeds as well as triticale's and other seeds and nuts.	Maintain Bone Mineral Density, immune health, cardiovascular system, cognitive functions, supports health of menopausal women etc.
Diallyl sulfide, Allyl methyl trisulfide, and dithiolthiones are thiols and sulfides.	Garlic, onions, cruciferous vegetables etc.	Enhance the elimination of harmful substances and aid in maintaining digestive, immunological, and cardiovascular health
Vitamins and minerals	Found in all food groups	Nutritional importance as well as antioxidant properties
Fatty acids: Monounsaturated fatty acids (MUFAs)	Canola oil, olive oil, and tree nuts	Lowers the chance of heart problems
Polyunsaturated fatty acids (PUFAs) like α -linolenic acid (ALA) and EPA and DHA	α -linolenic acid found in walnuts, flaxseeds, flaxseed oil, mustard oil, rice bran oil, etc. EPA and DHA found in sea foods	Supports the maintenance of heart & eye health & cognitive function, maintain antioxidant defence system in body
Dietary Fibre (Soluble & Insoluble)	Peas, beans, apples, citrus fruits, psyllium seed husk, wheat bran, corn bran, fruit peel, etc.	Maintain gut health and lowering the risk of cancer and CHD

Source: Abdel-Aal *et al.* (2013); Baldi *et al.* (2020); Benvenuti *et al.* (2021); Buscemi *et al.* (2018); Chen *et al.* (2020); Choi *et al.* (2011); Girard and Awika, (2018); Granato *et al.* (2018); Goni *et al.* (2006); Guine *et al.* (2011); Ilic *et al.* (2011); Karatas *et al.* (2017); Khoo *et al.* (2017); Kozłowska and Wegierek, (2017); ; Lange *et al.* (2014); Laparra and Sanz, (2010); Li. *et al.*

(2014); Lutz *et al.* (2019); Montes-Avila *et al.* (2017); Oakley, (2010); Oliveira *et al.* (2018); Oviasogie *et al.* (2009); Panche, *et al.* (2016); Shankar *et al.* (2015); Rodriguez *et al.* (2019); Sharma *et al.* (2019); Silva and Alcorn, (2019); Xia *et al.* (2020).

IV. FUNCTIONAL FOOD CATEGORIES

Dietary substances containing functional properties have been classified into two parts namely traditional or conventional food and nonconventional or modified food, based on the wide range of health benefits provided by them. Such functional properties which are present in almost all food categories must be designed with consumer demands in mind. Prebiotics, probiotics, synbiotics, symbiotic foods, isoflavones, phytosterols, anthocyanins, antioxidants, and foods with lower levels of both fat and sugar are examples of functional food groups. Although product preferences differ, and their distribution across consumer segments is not uniform (Siro *et al.*, 2008). Among other food markets, dietary substances with functional properties have mostly been developed in industries or plants related to milk, baby-food, carbonated drinks, bakery and confectionery. Fortified foods are made with vitamins like ascorbic acid, tocopherol, and minerals like Zn, Fe, & Ca, etc. After afterwards, attention turned to foods having inclusion of various micronutrients along with soluble dietary fiber, phytosterol, and omega-3 fatty acids, to promote wellness and ward against diseases like cancer (Bigliardi and Galati, 2013).

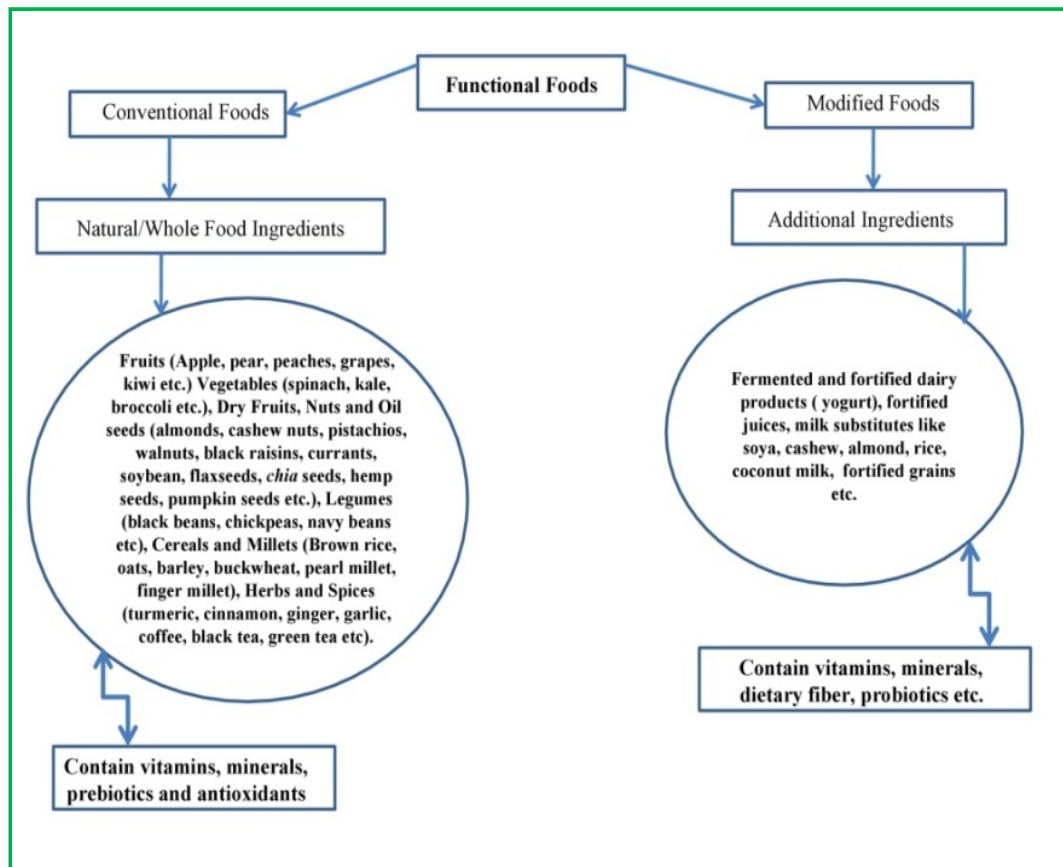


Figure 2: Conventional Food and Modified Food are Forms of Functional Foods.

Source: Arshad *et al.* (2021)

V. HEALTH BENEFITS OF FUNCTIONAL FOODS

Some people have found it to be an interesting challenge to categorize which foods are considered to have health benefits and which are not, especially since a variety of factors, such as the quantity consumed, foods that are consumed with it, the length of exposure, physiological state, etc., can affect the body's overall response to a food. It is best to say at this time that all foods likely serve some purpose and that, depending on the situation, some may have immediate or long-term advantages.

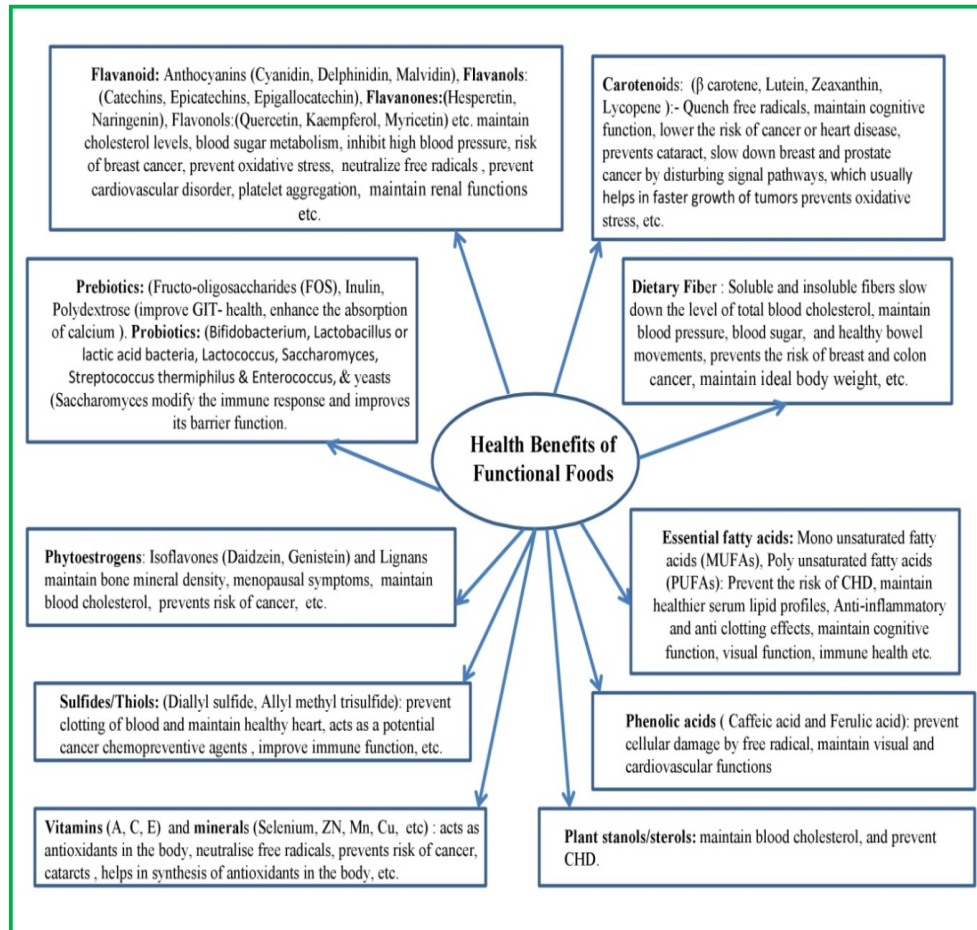


Figure 3: Health Benefits of Functional Foods

Source: Jalgaonkar *et al.* (2019)

VI. CLASSIFICATION OF DIETARY SUBSTANCES HAVING FUNCTIONAL PROPERTIES ON THE BASIS OF ORIGIN AND MECHANISM OF ACTION

Functional foods are categorized according to their origins, which include plant, animal, microbial, and other sources like algae and mushrooms. Aside from source of origin, the objective of such dietary substances is to control oxidative stress in the body to manage various degenerative diseases like cardiovascular diseases (CVDs), uncontrolled cell division, immune boosting, health of the gut, health of menopausal women, premature aging, high blood glucose level, anxiety, etc.

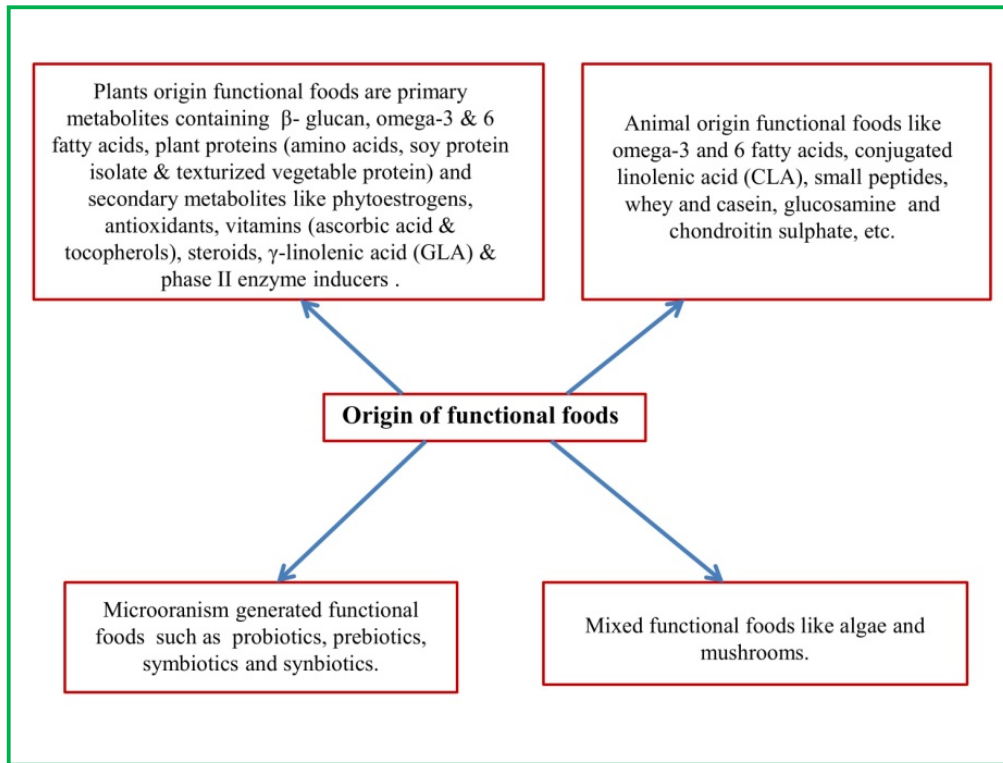


Figure 4: Origin of Functional Foods
Source: Arai *et al.*, (2016); Arai, (2005); Hasler, (2002)

1. Plants Originated Functional Foods: Dietary substances having functional properties which are obtained from plants are categorised into primary and secondary metabolites. β glucan, omega-3 and 6 fatty acids, and plant proteins come in the category of primary metabolites and whereas phytoestrogens, vitamins like ascorbic acid & tocopherols, plant steroids, γ -linolenic acid (GLA) having antioxidant like properties and phase II enzyme inducers are known as secondary metabolites. Examples of plant proteins are amino acids, soy protein isolate, and texturized vegetable protein. The secondary metabolite such as β -glucan which is found in oats shows its functional properties by reducing the absorption of cholesterol in the body. Soybean and flaxseed contain substances having oestrogen like properties which are known as phytoestrogens. Due to the presence of these substances they have functional properties which are helpful in reducing the risk of breast cancer and other menopausal symptoms like hot flushes, night sweats, dryness of vagina, etc. among women having menopause (Arai *et al.*, 2016).

Colouring pigments like anthocyanins, vitamins such as ascorbic acid and tocopherol found in fruits, vegetables, oilseeds, etc have functional properties. They act as antioxidants by quenching reactive oxygen species, and controls oxidative stress. Additionally present in oilseeds, steroids compete with cholesterol for absorption and serve as functional foods. γ -linolenic acids (GLA) involve in the synthesis of prostaglandins and prevent the occurrence of inflammation (Hasler, 2002). Phase II enzyme inducers are found in vegetables belong to Brassica family like cabbage, broccoli, cauliflower, brussels sprouts etc which assist in glycosylating insoluble toxins to soluble

toxins for their easy excretion from the body. They also prevent the detoxification system of the phase I enzyme and reduce oxidative stress.

- 2. Animal Originated Functional Foods:** Some animal foods which contain polyunsaturated fatty acids (α -linolenic acid, docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), linoleic acid, conjugated linolenic acid), small peptides, milk protein (whey and casein), etc act as functional foods in animals body (Arai, 2005). A sea food especially salmon is a rich source of EPA and DHA. Linoleic, γ -linolenic acid (GLA), and arachidonic fatty acids come under the category of omega-6 fatty acids (Hasler, 2001). Omega-3 and omega-6 fatty acids aid in boosting immunity, prevent swelling in the body and maintain the functioning of nervous system. Although a fatty liver could form as a side consequence, CLA, a fatty acid found in milk, functions as a functional food by lowering risk of uncontrolled cell division, and adipose differentiation (Hassler, 2002). Small peptides perform similarly to whey and casein, milk proteins that operate as functional foods by being readily absorbed and digested and aid in the development of lean muscle mass (Arai *et al.*, 2016).
- 3. Microorganisms Originated Functional Foods:** Good microflora is called as probiotics. Probiotics are healthy, naturally occurring microorganisms that are found in the gastrointestinal tract (GUT), such as *Lactobacillus casei*, *Bifidobacter* species, etc (Hassler, 2002). Such dietary components which assist probiotic bacteria to grow in the gut are known as Prebiotics. When probiotics and prebiotics work together in combination in the body are called as synbiotics while when prebiotics and probiotics come together at random basis are called as symbiotics. The mechanism of action of functional food is to encourage the growth of good microflora (Probiotics) so that the growth of harmful bacteria can be controlled to some extent.
- 4. Mixed Functional Foods:** Some functional foods are made from various substances, including algae and mushrooms. Algae synthesise PUFA which helps in strengthening immune system, prevent ailments related to functioning of nervous system, and prevent inflammation in the body due to the presence of antioxidant like properties in it. Mushrooms have functional properties as they act against virus, bacteria and reduce cause of inflammation.

VII. CONCLUSION

In this way it can be concluded that functional foods obtained from natural or modified sources have a vital role in maintaining human health and wellness. Various studies showed that functional foods having bioactive components not only maintain human health but also reduce the chance of various degenerative disorders by suppressing/neutralising formation of free radicals and maintains oxidative stress under control due to antioxidant defence mechanism in the body. Various studies reported that natural origin foods like some plant (fruits, vegetables, nuts, oilseeds, etc), animal (fermented and non fermented dairy products, sea foods, etc), microorganisms, algae or mushroom contain functional properties. The bioactive substances present in them are vitamins (ascorbic acid, tocopherol), probiotics, preiotics, synbiotics, symbiotics, anthocyanins, antioxidants, phenols, phytochemicals, phytoestrogens, complex carbohydrates, polyunsaturated fatty acids (Omega-3 and 6 fatty acids) etc. Modified foods are enriched or fortified with such substances (nutrients or non-

nutrients) which contain antioxidant properties and act as functional foods in the body. A number of studies have showed that the functional substances present in these foods continue to play a distinct functional role in protecting human health from various degenerative disorders.

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