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Functional foods, their components and relevant health benefits: A review

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Abstract

The relation between the food and health has taken the scientific study to find out solution on food and food ingredients on some specific function in human body. The term functional food can be defined as the food with some beneficial functions, it was first introduced in Japan. The health benefits of plant based food can be related to both antioxidant as well as anti-inflammatory method by wide formation of phytochemicals present in fruits, millets, herbs and spices. This present review focus on the information of functional foods, their development concept, and some studies based on development of functional based on millets, fruits, and spice and herbs. In this review along with some studies the beneficial needs of functional food has been discussed. Some of the functional foods with high antioxidant properties are being discussed. The studies on chemicals present in the food commodity and their health impacts is carried out. Many functional foods based on various factors has good impact on human health but due to lack of studies these are not been utilized and hence the industries do not focus on production of required functional foods. In this review we will study the compound of functional foods and their impact on health.

Keywords: Functional food, millets, fruits, herbs and spices

Introduction

‘Functional Food’ was firstly coined in Japan. The native of Japan were first to state food plays important role in human health rather than just giving energy, pleasure of eating and nutrients to human being. Japan is the only country where we can find highest number of development of functional foods. The market of Japan is having huge varieties of functional food. It is also the first ever country to pass laws for these products in “Food of Specified Health Use” (FOSHU). The western countries like America and Europe included this concept of value addition of food later on. Studies have found that there is no such legal agreement between Europe and USA regarding a solid definition, which creates great confusion among professionals and consumers that what should be this type of food called, either nutraceutical food or pharmaceutical food or designer food. USA mostly prefer to call it as nutraceutical food, whereas European scientist decided according to “Functional Food Science in Europe” (FUFOSE) project, which come under “European Union and International Life Science Institute of Europe” to coin it as “Functional Foods” likewise that of legal agreement of definition.

The food can be considered as functional food when it is acceptably shows some helpful effect on one or more targeted function in the body, along with some of the nutritional effects, somehow that is applicable to improved health and minimizing the disease risk (Paliwal *et al.*, 2016) [35] (Birch & Bonwick, 2019) [4].

Nowadays, Diet has been closely connected with the range of diseases conditions and important age related diseases, therefore the functional food having favourable health related compounds has enhanced the researcher and food industry to focus on it (Shlisky *et al.* 2017) [44].

The consumption of functional food in required amount should be given along normal diet will show some satisfactory effects on human health. Recent studies say that the main aim of the researchers and food industrialist is to expand the functional food development which can upraise the quality of human life. Consumer are demanding more and more solutions that help to prevent long-term illness and improve health (S. Khan *et al.*, 2016) [21].

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The functional foods are basically designed to have better metabolism and some good biological framework in human body which helps in treatment of non-transmissible diseases like cardiovascular diseases, osteoporosis, cancer, diabetes, etc. (Jędrusek-Golińska *et al.*, 2020) ^[16].

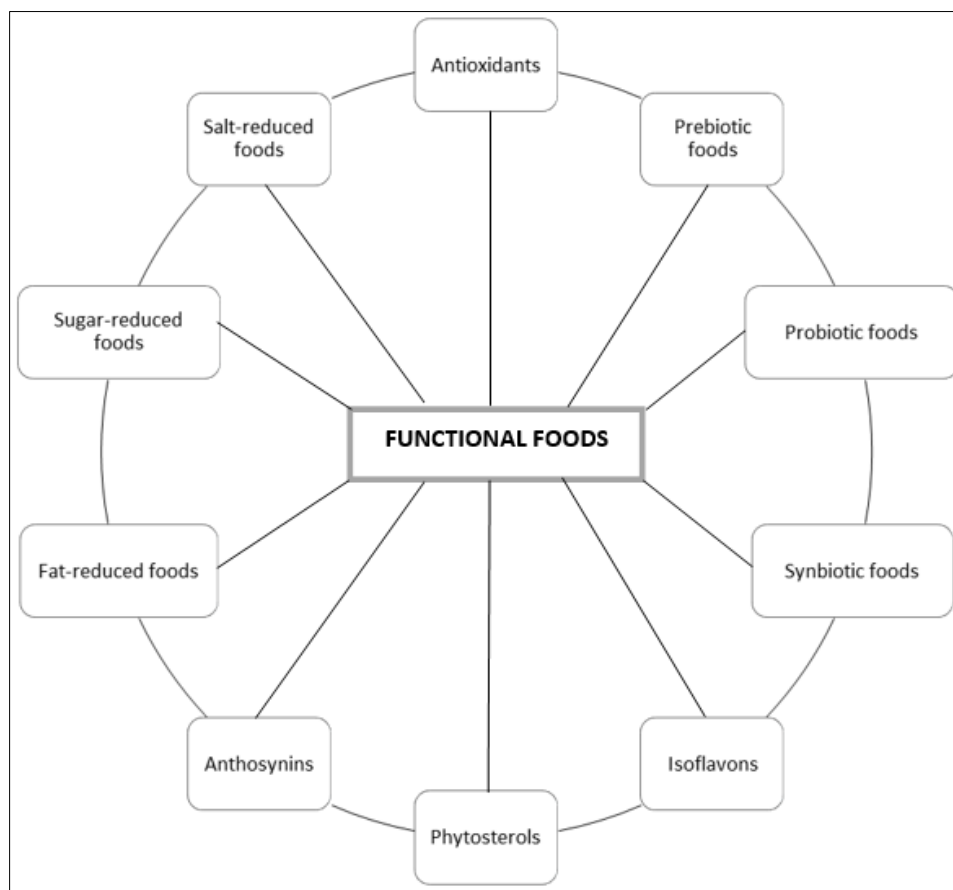
The food can be called functional only when it sufficiently shows the effect on targeted function in body along with some nutritional factors, which can give result regarding well being or has reduce the risk of disease. The food can be made functional by incorporating or enriching the required component. Therefore science of functional food works on either uplifting the functions or lowers the risk of disease.

There are many countries where we do not find any law-making definition of the term and hence they are stating

undecided line in between conventional and functional foods which is more challenging for nutritional and food science.

Functional Foods

In simple terms, functional foods are those which strengthen some functions, to cure diseases or to prevent them. Thus, there are various methods to obtain functional foods which include the addition or removal of a compound or component, genetic engineering, modification in the food processing etc, which helps the food industries with development of new product having some beneficial value for the consumers. Till date, the component which are most important and that can be added to food are:



Probiotics: Micro-organisms which can be consumed in certain amounts, having some good impact on health, which goes far off some traditional nutritional effects (Isolauri *et al.*, 2001) ^[15]. The bacteria widely used as probiotics are Lactobacilli and Bifidobacteria. They can be consumed along with fermented foods such as curd, fermented vegetables or meats and they can stay shortly in the gut.

Prebiotics: Ingredients or compounds having good healthy outcome on the gut microflora in the host itself, such as fibre, fructose, oligosaccharides, inulin, polyalcohol. They might be short-chain carbohydrates which can undergo fermentation in the huge quantity and stimulates the growth of possible favourable bifido bacteria (Linares *et al.*, 2017) ^[27].

Synbiotics: It is a combination of pre and pro biotics.

Nutrients: It includes all the mineral, vitamins, fatty acids or dietary fibre, that are specific and have a very projected action. It involves all the required vitamins, minerals, dietary

fibre and fatty acids, which are specific and have estimated action.

Definition of functional foods

Basically, the food which is sold as functional food are enriched with some component which are developed with the help of ingredients that are developed by advance methods and are having specific health benefits (Niva, 2007) ^[34]. However, the word “functional food” has already been defined many of time but till date there is not a single acceptable definition for this type of food. So far, a many of national authorities, academic groups and the industries has given various statements for functional foods which varies from the very simple one to the most complex one; “Foods which might provide health benefits beyond required nutrition” and “Food similar to that of conventional food that is intended to be consumed as part of a our regular diet, but it is been modified to promote normal functioning beyond the provision of basic nutrient requirements” are best examples

for the two approaches (Bech-Larsen & Grunert, 2003) ^[3]. The form of and daily intake of functional food should be as much as required in dietary purposes. In European laws, functional food is considered as a concept instead of some special category foods (Coppens *et al.*, 2006) ^[5].

Development of functional foods

From the perspective of research and development, functional foods suggests a area where the experts like food chemists, food nutritionists, food technologists, and medical doctors, must be collaborate to get result of innovative products or at least they should maintain some advanced standard of the

conventional foods. On the other hand, these foods must also be able to balance some physiological parameter related to the health or disease prevention *Figure 1*. Planning and development of functional foods are entirely related to the safety assessment and law-making aspects and also to the market plan and consumer behaviour. Although we know that the laws and consumer needs are not from the topic of this paper, they represent two main factors underlying the development of functional food. In specific manner, it is expected that a more limiting laws on health claims will increase the quality of the studies carried out by food companies.(Fogliano & Vitaglione, 2005) ^[10].

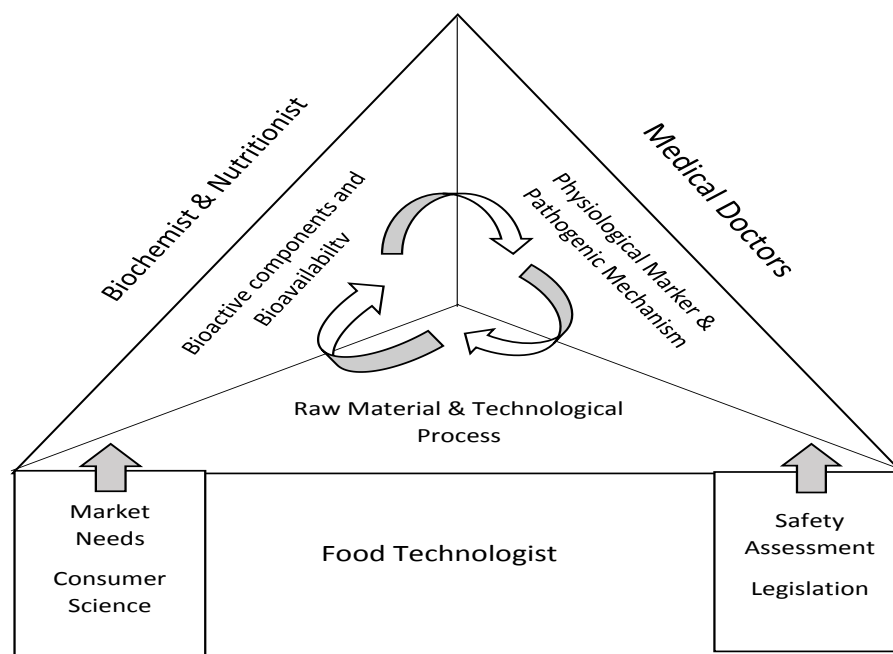


Fig 1: Steps of Planning and Development of Functional Food (Fogliano & Vitaglione, 2005) ^[10].

Functional Foods Based on Multigrain (Millets)

Millets are mostly small seeded grass which are hard and cultivated in dry areas along with some rain-fed crops, having minimum fertility of soil and moisture. In many of the developing countries millets are consumed as primary food. The millets food is said to be high in nutrition, high in energy and in most recent years, it is considered as one of the important element in processed food. Some of the important and mostly consumed millets are sorghum and pearl millet. In small millets category we find finger millets, white millets, foxtail millets, kodo millets, barnyard millets, and little millets (Singh *et al.*, 2018) ^[46].

Millets are developed into nutraceutical form which are more commonly food base and which are highly in the form of medicine or therapeutic agents as we know they are rich in amino acids, flavonoids, and minerals (Kumar *et al.*, 2016) ^[26]. Finger millets is a type of millets which is having numerous but unknown source of some of the nutraceutical properties in comparison with the other cereals which are consumed. As stated by agenda of 2017, FAO and WHO is in the state of growing, divide, and drawback of food security over food diversity, the particular properties of finger millets should be considered to expand the novel functional food based on millets (FAO and Bioversity International, 2017) ^[7]. The western countries along with developing and underdeveloped countries are looking forward to biofortification of millets to lower problem related to

nutritional disaster and global health. According to latest studies biotechnology plays major roles and helps in enrichment of some nutritive value of millets which allows the future scope on millets in processing and development sector (Puranik *et al.*, 2017) ^[37].

In old aged group, the deficiency of calcium is noted in the form of osteoporosis, so the daily intake of calcium results the cost effective way to overcome deficiency. Finger millets naturally contain high calcium amount which can play important role in old aged group for the calcium deficiency (Kumar *et al.*, 2016) ^[26]. We can find only limited research on genetic modification of finger millets for its nutritive content in providing minerals, calories, proteins, etc. Finger millets can be the best model to carry research in agriculture and nutrition studies as it will become very effective to increase nutritional content in millets (Kumar *et al.*, 2016) ^[26].

We should agree that, most of the strategies for development of crops are been aimed at staple cereals like rice, wheat, maize, etc. therefore the minor cereals like finger millets and some costly functional foods remains as it is in many of developing countries (S. M. Gupta *et al.*, 2017) ^[13].

We can find only some studies related to genetic modifications of finger millets which are carried out for its nutritional content providing minerals, calories and protein which makes it unique for nutritional-agricultural research. The improved genetic control in nutrient content will be helpful in improvement of millets (SM. Gupta *et al.* 2017) ^[13].

Table 1: Millets, benefits and their utilization

Sr. No.	Millets	Benefits	Utilization	References
1	Sorghum/great millet	Rich in B vitamin, excellent source of fibre, antioxidant	The flour is used in making chapattis, different snacks. Extraction of the seeds is effective for urinary bladder and kidney complaints.	(Manish, 2018) ^[28]
2	Pearl millet	Helps to reduce cholesterol, lower blood pressure, high fiber.	It is used as food and in malt making. Powder is prepared and soaked in water and applied on scalp to remove lice.	(N. Gupta <i>et al.</i> , 2012) ^[12]
3	Finger millet	Helps in strengthening of bones in growing children as well aged people	For calcium fulfilment of lactating ladies traditional sweets are prepared. Useful in biliousness for diabetics as a whole food.	(Teena Rathore, Rakhi Singh, Dinkar B Kamble, 2019) ^[51]
4	Fox-tail millet	Rich in vitamin B12, maintain healthy heart, smooth functioning of nervous system	Useful externally in rheumatic disorder. Used as remedy during labour pain.	(S <i>et al.</i> , 2019) ^[40]
5	Proso millet	High in lecithin, supports neural health system.	Used as food, as fodder, for making different beverages. The plant is used in cure of gonorrhoea.	(N. Gupta <i>et al.</i> , 2012) ^[12]
6	Barnyard millet	Low in calories, Rich in fiber, Gluten free	The grains are used as alternative of rice and other cereal. Useful in biliousness and constipation. The plant is used to check hemorrhage and is prescribed for disease of spleen	(Shobana Devi R, 2016) ^[45]
7	Kodo millet	Controls blood sugar level, high blood pressure, hydrate colon.	Used as food, fodder and beer making. Useful in inflammation disease of liver, causes constipation and heat the body. Plant along with some drugs work on treatment of scorpion sting.	(N. Gupta <i>et al.</i> , 2012) ^[12]
8	Little millet	Improve heart health, lowers cholesterol, body tissue repair.	As food and fodder. Used in beer making. The seeds are used as diuretic, blood purification and also in weight loss.	(P. Kaur <i>et al.</i> , 2019) ^[19]

Functional foods based on fruits

The application of whole fruits, minimum processed fruits which include juice and waste (pomace) are used in preparations of natural and healthy products like drink, yoghurt, ice-creams, smoothies, etc. There are some different physical parameters of fruits and fruit material which is been used to monitor satisfaction (Farajian *et al.*, 2010) ^[8]. To lower the total energy intake and utilization of dessert, the Dried fruits were used as snack before meals (Farajian *et al.*, 2010) ^[8]. The consumption of whole fruit shows more satisfaction than fruit juices or sauces which are processed by adding more fibre in comparison with whole fruits. (Flood-Obbagy & Rolls, 2009) ^[9]. In dried form fruits become more energy packed (Farajian *et al.*, 2010) ^[8]. Nowadays there is heavy usage of ingredients based on fruits, some natural fruit extracted colourants such as anthocyanin, fruit fillers, some natural sweeteners based on fruits having low glycaemic index and high amount of solid content along with fruit derived inulin and fructo-oligosaccharide (Abuajah 2017) ^[1].

The studies on consumption of apples have better the lipid and oxidative nature of the tissues and organs by building larger intestinal pool and higher stool secretion of bile acids in obese rats. The apple which contains high amount of dietary component helps to reduce the abdominal membrane and epididymal adipose tissue weights in rats (Nakazato & Song, 2006) ^[33].

Grapes and its products carry number of amount of polyphenols, flavanol, catechins, and anthocyanins which help to reduce diabetes, by enhancing B-cell function and protecting their loss (Zunino, 2009) ^[55].

The strawberry contains anthocyanin, anthocyanidin (pelargonidin sulfate), and anthocyanin cation (pelargonidin-3-O-glucoside) which helps to reduce postprandial swelling and increases insulin reactivity in obese adults (Edirisinghe *et*

al., 2011) ^[6]. The study shows that strawberry phenolics reduces postprandial LDL oxidation and fat metabolism after consuming high fat containing food by obese men and women. Pomegranates put forth (i) effects of hypoglycaemic, (ii) responsiveness to insulin is high, (iii) inhibit α -glucosidase, (iv) influence glucose transporter type 4 function, (v) lowers total cholesterol, (vi) improve blood lipid profiles, and (vii) delay inflammation by modulating PPAR pathways. Pomegranate is good source of polyphenols (ellagitannins), anthocyanins, fatty acids, phenolic acids and variety of volatile components.

Some study reveals that Watermelon helps to fight against diabetes, thyroid dysfunction and oxidation (V. Khan *et al.*, 2012) ^[22].

Within fruits, we can say that the berry fruits are the one with high amount of antioxidants. Some of the major studies shows that the berries contain a wide range of polyphenols, from which the important being flavonoids (anthocyanins), flavonols and catechins, tannins (proanthocyanidins & ellagitannins), phenolic acids (hydroxycinnamic acids). In some of the breakfast made from functional cereal products, the berry fruits are being used as sweetening agent to enhance aroma and also as colourant. Some of the major ingredients prepared from the berry fruits to use in functional foods are seed and berry oils, powders, berry fibre powders, berry extract.

These ingredients obtained from berries are used for preventions of many diseases like cancer, heart diseases, diabetes, early ageing, and also provide positive impact on brain and eyesight. Studies found that by consuming the mixture of special juice prepared from berry fruits has shown significant result in growth of antioxidant volume in blood due to which the activity of lipid was decreased. (S. Kaur & Das, 2011) ^[20] (Yildiz & Eydurhan, 2009) ^[53].

Table 2: Fruits, Compounds and their Utilization

Sr. No.	Fruits	Compound	Utilization	References
1	Apple	Dietary fiber	Reduce abdominal membrane	(Alongi <i>et al.</i> , 2019) ^[2]
2	Red Grapes	Polyphenol resveratrol	Cardioprotective, anticancer	(Shahidi, 2009) ^[42]
3	Cranberries	Anthocyanin	Treating urinary tract infections.	(Sun-Waterhouse, 2011) ^[50]
4	Pomegranate	Polyphenols (ellagitannins)	Lowers cholesterol, controls insulin level.	(Konstantinidi & Koutelidakis, 2019) ^[25]
5	Watermelon	Lycopene, beta-carotene	Fights against diabetes, thyroid dysfunction	(V. Khan <i>et al.</i> , 2012) ^[22]
6	Citrus fruits	Phytochemicals (Flavonones)	Inhibition of LDL oxidation, Improvement of vascular tone	(Sharma <i>et al.</i> , 2019) ^[43]
7	Amla	Rich in vitamin C, Tannins, phenols.	Hypoglycemic, antibacterial, antiulcerogenic, gastroprotective	(V. Khan <i>et al.</i> , 2012) ^[22]
8	Java Plum	Tannins, triterpenes, anthocyanin	Antidiabetic, antioxidant, hypoglycemic effect	(Science & Tripathi, 2015) ^[41]

Functional foods based on herbs & spices

Spices and Herbs are having abundant source of some of the most important antioxidants. The history of usage of spice and herbs for its colour, flavour and aroma is back from more than 2000 years. They have also been used for preservation of foods and beverages primarily due to their phytochemicals. Spices and herbs possess excellent antioxidant activity. They have been used in the form of ground or whole spices or herbs, in the extracted form or encapsulated form or also as emulsion of it. Beside from their efficacy as antioxidants, spices and herbs are classified as all natural, an attractive quality for consumers. Thus, spices and herbs may be used as a means to control lipid oxidation in foods. The first report of uses of spices was back to 5000 BC when the Sumerians were known to use thyme for its beneficial effects. (Viuda-Martos *et al.*, 2011) ^[52].

Spices and Herbs have a great traditional culture of use as preservatives, colorants, flavour enhancers and as therapeutic agents. The usage of spices and herbs in food as flavouring agents has become the major trend worldwide, showing the growth of around 20-30%. The trends in spices and herbs varies globally according the cuisines of particular places. There are many traditional cuisines of spice and herbs. For example, Turmeric used in Indian cuisine; basil, garlic and oregano used in Italian and Greek cuisines; and lemongrass, ginger, cilantro and chilli peppers used in Thai food shows the high uses of spices and herbs globally. The studies carried to identify the mostly used spice in some selected 36 countries globally were onion, garlic, ginger, and peppers (Kaefer & Milner, 2008) ^[18]. Some spices and their active principle are involved in lowering of cholesterol, like ginger, garlic, fenugreek, onion, curcumin, capsaicin, lemongrass, cinnamon

(Srinivasan, 2006) ^[48].

Garlic is involved for reducing the blood pressure (Rahman, 2007) ^[38]. Some studies shows that curcumin has some possibility to stop stroke and reduce the vascular swelling along with haemorrhagic stroke (Singletary, 2010) ^[47].

Spices and herbs show positive results to improve the diabetes symptoms by slowing down gastric emptying, enhancing insulin responsiveness and improving antioxidant defences. Cumin seeds, ginger, mustard, curry leaves, coriander, curcumin and fenugreek resulted to have some low blood sugar levels (Srinivasan, 2006) ^[48] (Kochhar, 2008) ^[24] (Singletary, 2010) ^[47]. The usage of cinnamon as a supplements for the treatment of diabetes mellitus is extremely encouraging but, along with other spices, there should be some well-controlled clinical trials before giving conclusive reports (Gruenwald *et al.*, 2010) ^[11].

The alcoholic extract from fenugreek seeds has shown beneficial effects on blood glucose level, body weight, and formation of cataract in aged group people. Fenugreek, garlic, gingers and red pepper shows beneficial result in lowering of cholesterol. Curcumin, fenugreek, capsaicin(chilli), and ginger also help to increase secretion of bile acids.

Oregano and Rosemary mint contain high amount of antioxidants and phenolics which are more than many other medicinal herbs (Patel *et al.*, 2011) ^[36]. Oregano is good source of rosmarinic acid, protocatechuic acid, quercetin, p-coumaric acid and protein (McCue *et al.*, 2004) ^[29].

Saffron helps to increase blood flow rate in particular tissues and it has antioxidant, antiinflammation, antihypertensive and relaxation properties (Srivastava *et al.*, 2010) ^[49], cardiovascular, lipids, insulin resistance, tissues oxygenation effects (Kianbakht & Hajiaghahae, 2011) ^[23].

Table 3: Spices and Herbs, Compound and their Utilization.

Sr. No	Spices	Part	Compound	Utilization	References
1	Ginger	Root	shogaol gingerol	Anti-inflammatory, anti-hyperglycemic	(Mohamed, 2014) ^[30]
2.	Turmeric	Root	Curcumin	Prevent strokes, Reduce vascular swelling	(Singletary, 2010) ^[47] , (Jiang, 2019) ^[17]
3.	Oregano	Leaves	Caffeic acid, p-coumaric acid,	Prevent lipid peroxidation and anti-inflammatory activity.	(Rodríguez-García <i>et al.</i> , 2016) ^[39]
4.	Clove	Flower/Bud	Eugenol, Eugenyl acetate	High in antioxidant, regulate blood sugar, reduce stomach ulcers.	(Hussain & Trak, 2019) ^[14]
5.	Thyme	Leaf	Phenolic acids (gallic acid, caffeic acid, rosmarinic acid), thymol, phenolic diterpenes, flavonoids	Anti-inflammatory activity and anti-obesity.	(Mueller <i>et al.</i> , 2010) ^[31]
6.	Garlic	Bud	Allicin	Reducing blood pressure, Anticancer	(Zong & Martirosyan, 2018) ^[54]
7.	Saffron	Stigma or Style	Crocins, Saffranal	Increase blood flow rate, antihypertensive, relaxant	(Srivastava <i>et al.</i> , 2010) ^[49]
8.	Cinnamon	Bark	Cinnamaldehyde	Anti-diabetic and Glucose Lowering	(Muhammad & Dewettinck, 2017) ^[32]

Conclusion

In this review, we have discussed about functional foods and their importance to human health. Functional foods have some compounds which are essential for human health and they have some major impact on various diseases. Functional foods are mainly plant based. They are rich in antioxidant, phytochemicals, have anti-inflammatory properties. Some studies has revealed that the food products prepared from these source are beneficial in treating various kind of diseases. Studies on functional foods has resulted in curing of diabetes, cancer, cardiovascular diseases, etc. The development of functional foods can be done by using various plant based components like some functional food based on millets, fruits, vegetables, herbs and spices and their compounds as they are good source of antioxidants, phytochemicals, flavanols, etc. More studies on these need to be carried out on development of food products based on functional foods for required aged group people. So nowadays it is highly recommended to utilize the “functional heritage”.

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