Chapter

Bioactive Molecules from Medicinal Plants as Functional Foods (Biscuits) for the Benefit of Human Health as Antidiabetic Potential

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Abstract

Functional foods defined as "similar in appearance to a conventional food, and is demonstrated to have physiological benefits or reduce the risk of chronic disease beyond basic nutritional functions." The leading role in food industry plays ultimately by the functional food. In recent days, the designing of a functional food with the incorporation of medicinal plants, which is the natural product is the familiar one. The medicinal plants are scientifically proven, lesser side effects, and eco-friendly in nature. Many food types are chosen for the development of functional food with the incorporation of medicinal plants. Diabetes mellitus is a major chronic disease which affects the basic metabolism of insulin secretion and insulin functioning on glucose clearance from the blood stream. The modern inactive life style of the population leads to obesity and ultimately results in the major risk of diabetes mellitus and other risk factors alongside. The therapeutic alteration for DM is to minimize the burden of disease, and the targeted people were advised to follow proper physical activity and nutrient intake with healthy weight gain. The disease targeted people were recommended with the proper diet intake which aims at consuming the functional food with the incorporation of medicinal plants.

Keywords: functional food, medicinal plants, bioactive molecules, diabetes mellitus, nutrient intake

1. Introduction

In the recent days, the world has a strong belief in the field of food, which directly contributes to the human health. Each and every individual is aware of the food intake and its effects to the benefit of the health. The food which contains all vital nutrients not only to subside the hunger but also to provide essential nourishment apart from usual benefits. This will improve the physical and mental state of the human health in a disease free condition leads to a diet related therapeutic model for the lifestyle diseases [1]. Nowadays science and technology has its wide arm in every field because of the scientific evidence that proves the benefits and harmfulness of certain thing. In food technology also, the consumers see to the scientific

evidence and proof for the beneficial effects of that food item to the health. Thus in the last few decades, the urge for the healthy combo of food demands the health promoting category in the food industry by the consumers [2]. Because of the modern life culture, the people are in hurry and fast, they were in need of fast foods and lead to change in their lifestyle. Thus, the emergence of lifestyle diseases started which is by the lack of physical activity, change in eating habits, taking unhealthy food in an unbalanced way and leads to hazardous health ill effects. The basic daily recommended dietary intake of macronutrients in gender wise is listed in **Table 1**.

Nutrients	Carbohydrates (g/d)	Fat (%K Cal)	Protein (g/d)	Total fiber (g/d)
Gender/category of age				
Male				
9–13 year	130		34	31
14–18 year	130		52	38
19–30 year	130	25–35	56	38
31–50 year	130		56	38
51–70 year	130		56	30
>70 year	130		56	30
Female				
9–13 year	130		34	26
14–18 year	130		46	26
19–30 year	130	20–35	46	25
31-50 year	130		46	25
51-70 year	130		46	21
>70 year	130		46	21

Table 1.
Recommended daily dietary intake of macronutrients for individuals – gender and age [3].

	Adult male	Adult female
Energy (kcal)	2400–3000	2200
Protein(g)	56	50
Vit. A (IU)	900	800
Vit. D (IU)	600	600
Vit. C (IU)	90	75
Vit. E (IU)	15	15
Folate (mcg)	400	400
Ca (mg)	1000	800–1000
Ph (mg)	700	700
Fe (mg)	18	8
Zn (mg)	11	8
I (mg)	18	8
Se (mg)	55	55

Table 2.
Daily nutritional requirement in gender based on recommended dietary intakes [7].

Nutrient is the term to be explained or mentioned before the definition of bioactive components in and as food. The food is a combination of vital components in a proper ratio called balanced diet. The nourishment provided by the food for the healthy functioning of the human body is said to be the nutrients [4]. About 2500 years ago, the tenet "Let food be thy medicine and medicine be thy food," espoused Hippocrates receives interest nowadays. Lifestyle and diet intake are common couple factors responsible for major chronic diseases. Major lifestyle diseases like cancer, diabetes, osteoporosis, respiratory diseases, cardiovascular diseases, gastrointestinal diseases, and obesity, account for 63% annual deaths [5]. Non-communicable diseases are coined as lifestyle diseases, which are linked with the people nature of living and behavior involved in diet, lifestyle, and environment [6]. Thus, the food not only helps to promote health, physical development, and growth but also to prevent or treat various disorders and diseases. Some of the daily recommended nutritional elements gender wise is listed in **Table 2**.

2. Diabetes mellitus

Diabetes mellitus is one of the most deadly chronic diseases with metabolic disorder which is associated with major life threatening complications. The diabetes is a growing global problem which affects the metabolism and results in many complications leads tom death at early stages of life. Diabetes is of three types: type 1 – non-insulin dependent diabetes, type 2 – insulin dependent diabetes, type 3 – gestational diabetes. According to international diabetic federation (IDF), type 2 diabetes is accounting 90% of worldwide diabetes. The prevalence of diabetes in 2030 is 1.2 billion, where as in 2045, it increases to 1.3 billion unconditionally shown in **Figure 1**. It is mainly because of insulin insufficient secretion to lower the blood glucose level because of impairment of pancreatic beta cells. The elevated blood glucose level in the body is because of insulin impairment termed as insulin resistance. The major cause of insulin impaired diabetes is due to improper physical activity, unhealthy food habits, and increase of obese condition [8]. As defined by WHO, the obese condition and overweight of body are the major risk factors for the cause of diabetes [5]. The risk factors are directly correlated to the food intake, physical inactivity, and modern lifestyle, thus the energy imbalance plays a vital role in the

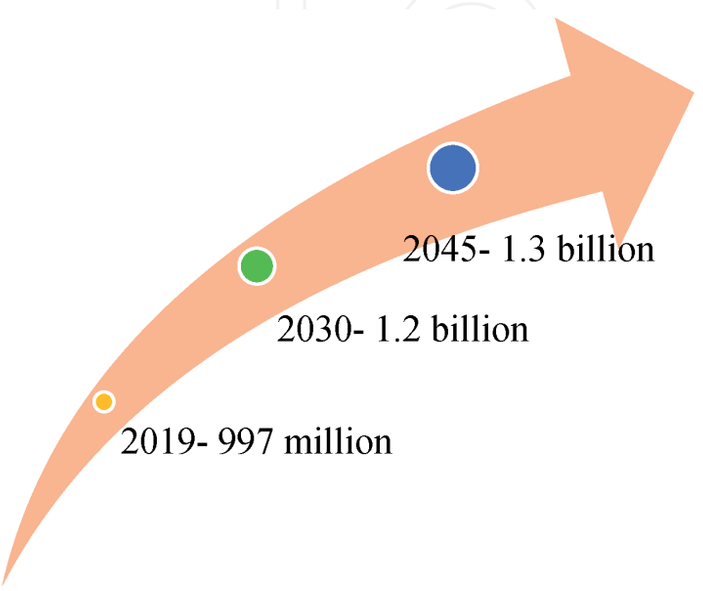

Figure 1.
Prevalence of diabetes worldwide, IDF.

prevalence of diabetes worldwide. Thus, the improper food habit and inactiveness of modern lifestyle inculcate the human life in a dangerous route where the people are unaware of diabetes emergence in their life. Prevalence of diabetes is estimated by sex among 65–99 years old adult population by IDF in **Figure 2** [9].

The major risk factors of type 2 diabetes mellitus are unhealthy eating, lack of physical exercise, obesity, and family epigenetics. Thus, the overeating of unhealthy food leads to increased body weight because of lack of exercise, results in obese condition. This obese condition portrays the beta cell destruction results in insulin impairment. It takes many years to exhibit the hyperglycemic condition in the body [10]. Various studies show that the high intake of fatty food gradually results in the lack of glucose resistant. The intake of unsaturated fatty acid is good for diabetic patients while the saturated and the Trans fats are associated with diabetic risk in a very high ratio. Reduced insulin secretion in the pancreas associated with decreased glucose uptake due to insulin excitation in muscles, also increased fundamental liver glucose production, thus glucose absorption in gastrointestinal tract is increased. This is the pathophysiological structure of type 2 diabetes mellitus. It is shown in **Figure 3**.

2.1 Medicinal plants and DM

As earlier defined by WHO, the cure for diabetes mellitus is possibly from the usage of medicinal plants in the form of herbal medicine whose remedies and proportion are involved in the control of the same. The scientific evidence and therapeutic application of the medicinal plants is the ultimate goal for the researchers and healthcare systems in the management of diabetes [11]. From the olden days, the management of severe diseases has its loophole in the potential of some medicinal plants which acts as drugs. These are having high belief that the drugs prepared from the medicinal plants are lesser side effects, and risk of toxicity is minimal and free from harmful effects [12]. Thus, World Health Organization recommends the usage of medicinal plants of traditional methods for the management of diabetes mellitus because of its lesser side effects when compared to the synthetic drugs. The usage of medicinal plants is extensively benefited worldwide for the management of various diseases in the pharmaceutical industry. Since plants are the rich source of phytochemicals whose benefits are countless and endless. In the pharma industries for most of the chronic diseases, the drugs are synthesized by using 50% of the medicinal plants from the historical origin [13].

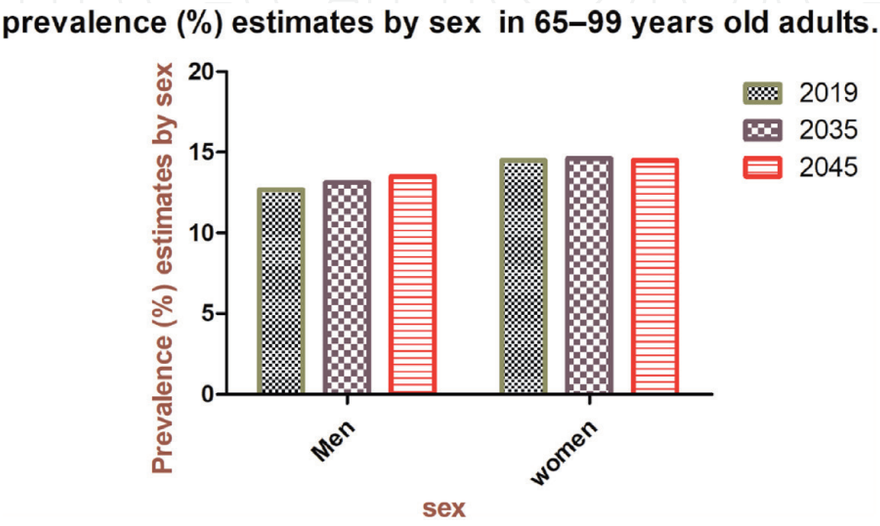

Figure 2.
Prevalence of diabetes estimated by sex among 65–99 years old adult population [7].

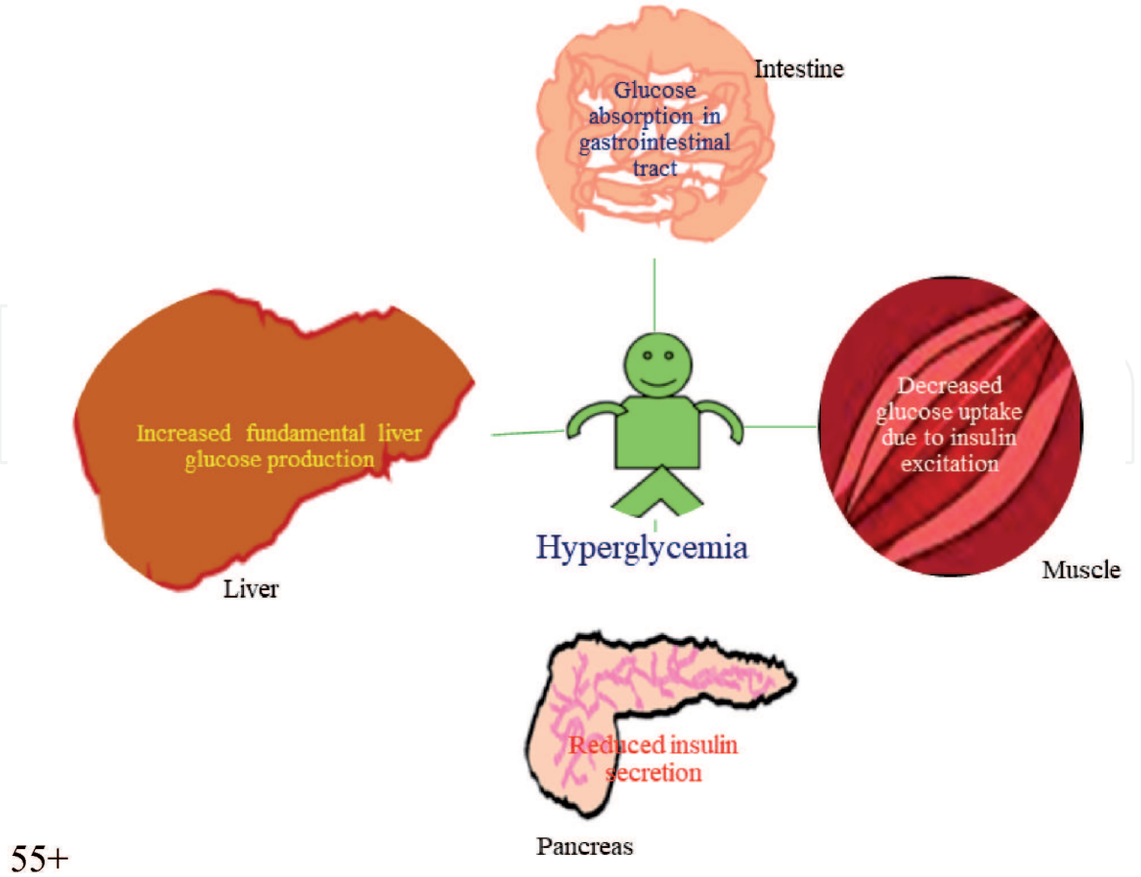

Figure 3.
Pathophysiology of type 2 diabetes mellitus.

The complications of diabetes mellitus are countless, which leads to gradual impairment of vital body parts one by one. The challenging part of diabetes is its management for maintaining the blood glucose level to normal range. The traditional usage of medicinal plants for the management of diabetes because of the bioactive molecules present in it which fight against the condition [14]. From the ancient history, the medicinal plants are having its main role for the curing of many diseases which paves the way for the utilization of the same to the management of diabetes mellitus. Thus, our ancestors commonly used the medicinal plants in the food itself, and the leaf, stem, fruits, flowers, and roots all are utilized in the management of various diseases. This enlightens the idea of using medicinal plants in the management of DM.

3. Bioactive molecules and functional food

The plants whose bioactive molecules are so called phytochemicals, which makes the plant to be said as medicinal plant. The medicinal plants contain some potential biological properties that help the human beings to get rid of some diseases and protect them from hazardous health issues [15]. The application of phytochemicals is in many fields such as food industry, health and nutrition, agriculture, and pharmaceuticals also. Thus, medicinal plants are having ancient origin for the home made treatment and desirable beneficial effects to human health. The bioactive molecules are called so because it is the biologically active compounds which give additional nutritional value than the primary nutrition. Thus the food contains some additional nutritional value because of the bioactive molecules present in it said to be known as functional food. The phytochemicals like alkaloids, phenols, flavonoids, terpenes and antioxidants, and polyunsaturated fatty acids like omega 3 fatty acids containing foods are called as functional foods [16].

According to American dietetic association, functional foods are said to be the food and its components which provide some additional nutrition than the basic nutrition. Examples for the functional food are the fortified food, enhanced or enriched foods which are having good health impact for the growth and development [17]. The pharmaceutical compounds than giving as drug form it can be provided as nutritional supplement with added advantage [12]. The functional food is similar to normal conventional food but beyond normal physiological role, it is having additional nutritional content that said to be as enhanced, enriched, or fortified food [18]. The functional properties are added in many food products like bread, biscuits, powders, mixes, decoction, suranams, also as various forms. The addition of nutrient rich food stuff in all the diets like legumes, grains, nuts, fruits, and vegetables will eventually result in less glycemic index foods and low fat substances which are good for type 2 DM [19]. Various probiotics, prebiotics, and also combination of both called symbiotic combo of functional foods are utilized [20]. The risk factors of DM and link to food habit are stated in **Figure 4**.

3.1 Functional food: biscuits

Among various functional foods, biscuits are of having wide range of advantages like a product with less moisture content, easily available, less cost, ready to consume at any time, can be prepared as varieties because of changing the proportion of the major ingredients. Biscuits can be made in wide functionality and nutritional value [21]. Biscuits are rich in cereal and best nutraceutical for delivery health benefits to the consumers in a right proportion. It can be used in the daily diet and improve the health state of human beings [22]. Biscuits can be available in different tastes, and variations also possess prolonged shelf life which suits all age group people [23]. In this review, especially biscuits are covered because of its efficacy and possess good functional properties in **Table 3**.

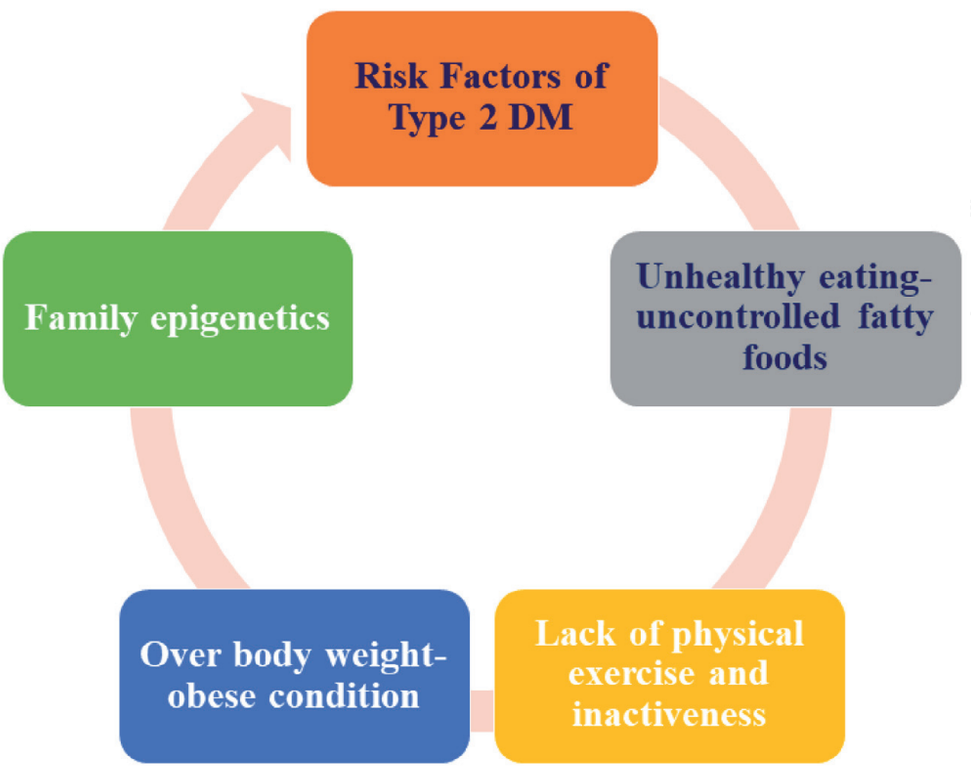

Figure 4.
Risk factors of DM and link of food intake.

S. No.	Medicinal plants	Common names	Bioactive molecules	Functional food	Reference
1	*Lupinus albus*	Sweet white lupin (SWL) grains	Dietary fiber and phenolic compounds	SWL biscuits	[24]
2	Cissus quadrangularis stem powder	Hadjor	Phytosterols, phenols, ascorbic acid, and calcite	Biscuits and cookies	[25]
3	*Musa paradisiaca*	Banana	Higher protein and phenol content	Biscuits products	[26]
4	Ipomoea batatas, Daucus carota, and *Musa paradisiaca*	Sweet potato, carrot and banana	Micro and macronutrients	Whey protein and banana incorporated biscuits	[27]
5	Hibiscus sabdariffa L. seed	Roselle seed	Protein content, dietary fiber and micronutrients	Biscuits and cookies	[28]
6	Ammannia baccifera L.	Monarch redstem	Phenols, flavonoids and terpenoids	Drug formulation	[29]
7	Lepidium sativum	Garden cress seed	Proteins, minerals and essential amino acids	Garden cress seed biscuit	[30]
8	(*Fragaria ananassa*) extract (Fisetin)	Strawberry	Fisetin – a flavonol	Biscuits	[31]
9	Beta vulgaris	Sugar beet molasses	Protein potassium, calcium, magnesium and iron content.	Ginger nut type biscuits	[21]
10	Phaseolus vulgaris	Common bean	Improved nutritional properties	Biscuits	[32]
11	Betifore-type	Egyptian butter cookie type	α-amylase added	Cookies	[21]
12	(Avena sativa), and maltitol	Oats	Inulin, a fructooligosachararide (FOS)	Biscuits	[33]
13	(*Musa species*), (Citrus sinensis), (Citrullus lanatus), (*Ananas cosmosus*) and (Carica papaya)	Banana, oranges, watermelon, pineapple, pawpaw	High fiber	Biscuits	[34]
14	Cinnamomum verum	Cinnamon powder	Protein and dietary fiber	Butter biscuits	[35]
15	De-oiled peanut meal flour (DPMF)		Nutritionally rich	Biscuits	[36]

S. No.	Medicinal plants	Common names	Bioactive molecules	Functional food	Reference
16	Amla (*Emblica officianalis*), (Moringa oleifera) and (Vitis vinifera)	Drumstick leaves, raisins.	Antioxidant effect	Biscuits	[37]
17	Hylocereus undatus	Pitaya	Nutritional quality	Biscuits	[38]
18	Fructo - ligosaccharide (FOS),	—	A prebiotic soluble fiber	Cookies	[39]
19	*Vitis*	Grape Seed Powder	Fatty acids and tocopherols	Iranian Sangak Bread	[40]
20	*Beta vulgaris* L.	Beetroot	Antioxidants	Mayonnaise	[41]
21	Curcuma longa L.	Turmeric flower	Formulating healthy cookie	Cookies	[42]
22	Brewer's spent grain (BSG)	—	Protein and fiber content	Cookies	[43]
23	*Carica papaya*	Papaya pulp flour (PPuF)	Protein and fiber content	Cookies	[44]
24	Sour cherry pomace extract		Polyphenols anthocyanins, antioxidant activity	Cookies	[45]
25	Linum usitatissimum flour	Flaxseed	Dietary fiber and linolenic acid	Cakes	[46]
26	Hordeum vulgare, Brassica nigra, *Linum usitatissimum*	Barley mustard, defatted mustard, flaxseed meal and flaxseed oil	Lowering blood lipids	Functional prebiotic biscuits	[47]
27	Citrus limetta	Sweet lime	Antioxidant potential	Herbal Juice	[48]
28	*Moringa olifera* leaves	Drumstick leaves	Beta-carotene	Biscuits	[49]
29	Holy Basil and *Moringa*	Thulasi	Protein and fiber enriched	Herbal biscuit	[50]
30	Inulin (Raftilin) (in combination with one of the following raw materials: soy flour, amaranth, carob apple fiber or oat fiber)	—	Essential mineral (Ca, Mg, Mn, Cu, and Fe) content and protein content	Biscuits	[51]

S. No.	Medicinal plants	Common names	Bioactive molecules	Functional food	Reference
31	Psyllium fiber content	—	Fiber incorporation	Biscuits	[23]
32	Green tea extract (GTE) was	—	Stability	Biscuits	[52]
33	(*Trigonella foenum graecum*) and (*Momorodica charantia*), Gudmar leaves	Fenugreek seeds, bitter gourd fruit.	Hypoglycemic properties	Idli and vegetable soup	[53]
34	*Moringa oleifera*	Drumstick	Nutritional value of food	Fortifying amala (stiff dough), ogi (maize gruel), bread, bis-cuits, yoghurt, cheese	[54]
35	Sesamum indicum powder	Black sesame	Antioxidant properties	Cookies	[55]
36	(*Musa species*), (*Citrus sinensis*), (*Citrullus lanatus*), (*Ananas cosmosus*), and (*Carica papaya*)	Banana, oranges, watermelon, pineapple, pawpaw	Dietary fiber, antidiabetic	Fiber-enriched cake	[56]
37	*Mangifera indica* L.	Mango	Phenolic content	Biscuits	[57]
38	Trigonella foenum graecum L	Fenugreek	Saponins	Biscuits	[58]
39	Soybean (*Glycine max*), Mushroom	Mushroom, soy bean	Protein supplemented cereal snack	Biscuits	[59]
40	Multigrain flour	Bengal gram flour (BGF),germinated pearl millet	Reduced -calorie	Biscuits	[60]
41	*Spinacia oleracea* L.	Spinach	Antioxidant properties	Biscuits	[61]
42	*Spirulina platensis*	Spirulina	Antioxidant activity	Biscuits	[62]

Table 3.
The incorporation of various bioactive molecules from the medicinal plants in the functional food – biscuits.

4. Conclusion

The functional food acts as a bridge between the nutritional diet and healthy living. The importance of medicinal plant incorporation is well known by the public from the ancient time but they were unaware of it. Nowadays its innovative way of incorporation in many kinds of food by means of scientific approach in order to avoid all kinds of queries and confusions is well understood. Overall, the maintenance of healthy living through nutritional approach is by the consumption of medicinal plant incorporated functional food also by having a physical activity to prevent the diseases from consuming life and have a healthy weight gain to avoid unnecessary health issues and sufferings. The potentiality and consequences of functional food suggest many inspiring opportunities on the whole. As a segment of a varied diet, on regular basis at effective levels, the consumption of functional food is recommended to major nutrition-related chronic diseases. For effective strategy in health claims, the functional food acts as one of the part of it, to maximize health and minimize the disease risk. The successful cyclic promo of functional food is depicted in **Figure 5**. From the novel idea in theory form have to cross many barriers like evidence, reviews, marketing, and publications results in the final destination the prototype, is product development.

Figure 5.
Functional food creation to success – a cyclic health promo. Source: https://www.slideshare.net/ektabelwal/development-of-nutraceuticals-functional-foods.

Acknowledgements

The authors wish to show their gratitude to the chancellor of Vellore Institute of Technology, Vellore, Tamilnadu, India for providing all the support to achieve the present research process.

Conflicts of interest

The authors declare no conflict of interest.

Funding

No external funding received for the research.

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