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Application of vegetables in development of healthy proprietary foods for diabetic management: A review

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Abstract
Diabetic patients must choose a food that can be digested slowly, high in fiber, low in carbohydrates and calories to maintain blood sugar levels and vegetables are universally promoted as healthy. Mixture of vegetables like Fenugreek leaves, Drumstick leaves, Carrot, Spinach, Tomato and Radish to develop proprietary food with respect to sensory quality and nutritional density is the main aim of this review. Development of healthy proprietary foods generally consumed in daily diet by using mixtures of vegetables (chopped, pulp or dried powders) incorporated into food to make them enriched in their nutritive quality generally for the management of blood glucose in diabetic patients. Developed products were evaluated for composition and functional properties. Sensory analysis and proximate analysis revealed that it is the perfect package of proteins and good source of dietary fiber needed as they slow the rate of sugar absorption in the body maintaining glycemic control. Other nutrients like vitamins, minerals in order to prevent deficiencies and maintain the health, also play an important role in glucose metabolism. Excellent source of bioactive compounds like antioxidants and phytochemicals, etc. which helps protect cells of body from damages that are caused by unstable molecules.

Keywords: diabetes, food enrichment, healthy food, phytochemicals, proprietary foods, vegetables

1. Introduction
Diabetes is a metabolic disease which is shown to cause high blood sugar levels over a prolonged period having pathogenic conditions including various complications such as micro and macro-vascular nephropathy, retinopathy, neuropathy, increased risk of stroke and coronary heart disease and decreased quality of life and an increased mortality rate. Around 3000 years ago it was first recognized as a disease illustrating some clinical features very similar to what we now know as diabetes by the ancient Indians and Egyptians. According to recent estimates, approximately 552 million people (9.9%) in the age of 20-79 years are prone to have diabetes by 2030. Major factors for rapidly rising Diabetes among developing countries that are commonly observed are dietary habits and sedentary lifestyles [7]. The basic requirement to prevent the key risk factors for diabetes, obesity, coronary heart disease is to change the unhealthy lifestyle and diet and practice daily physical activities. These changes are most likely to occur with implementation of a coordinated range of interventions to encourage people to maintain a healthy weight, participate in daily physical activity and consume a healthy diet [34].
India is a developing country with a large segment of population depending upon wheat, rice and maize as staple food which provides calories and proteins. These staple meals are meals eaten routinely and in such quantities that it constitutes a dominant portion of a standard diet in a given population, supplying a large fraction of the needs for energy rich materials and a significant proportion of the intake of other nutrients. There is presently much emphasis on reformulating processed foods to make them healthier. Dietary modification is one of the cornerstones of diabetes management. It is based on the principle of healthy eating in context of cultural, psychological and social influences of food choices. Healthy dietary habits and increasing level of physical activity should be the first steps in the management of newly diagnosed people with diabetes [9].
Foods similar in appearance to traditional food that is to be consumed as part of a normal diet, but has been modified to fulfill the nutritional limits beyond basic requirements are termed to be healthy proprietary foods [29]. More simply, proprietary foods can arise from a desire to provide consumers additional benefits in the way of enhanced nutrition in order to complete their daily nutritive requirement. They can also be useful by providing particular dietary components in foods that will increase their availability and palatability beyond that which might normally be consumed in making nutrients more available in normal food [1].

2. Vegetables used in Diabetes
Vegetables play a remarkable role in human nutrition and health as they contain phytochemicals, vitamins, dietary fiber, proteins and minerals. Until few years ago it was believed that 14 vitamins and 16 essential minerals were the key for human nutrition and health. Recently, with the developments in chemistry, it was found that vegetables contain thousands of beneficial phytochemicals in addition to the 14 vitamins and 16 minerals. Some phytochemicals are robust antioxidants and are believed to reduce the risk of some long standing or recurring ailments [43]. Phytochemicals are the key to best health as well as disease protection and regression. However, phytochemicals in freshly harvested vegetables may be thermal degraded and lost by processing techniques such as long steaming and cooking, which reduce their concentration, and may inactivate hydrolytic enzymes. Plant products are generally rich in natural antioxidants and functional components which have been suggested to reduce oxidation of foods.
Regular vegetable intake in the daily diet has been highly

correlated with improved gastrointestinal health, some types of cancer, chronic ailments such as diabetes and reduced risk of heart attack. Consumption of vegetable rich diet regularly has unquestionable positive effects on health and is likely to afford better protection against several chronic ailments. Addition of vegetables to the food also improves their oxidative stability and shelf life [18]. The mechanisms by which vegetables decrease risk of various chronic diseases are largely unknown. Different constituents present in the whole food may contribute to the overall health benefit. For example the dietary fiber in vegetables results in improving bowel transit, also help to manage blood glucose concentrations and by transporting through the human gut a remarkable amount of phytochemicals and minerals linked to the fiber matrix. Vegetables selection and amount of dietary fiber, vitamins, phytochemicals and minerals consumed can prevent diabetes [10]. This article highlights the health benefits in terms of nutritive requirement of different vegetables that should be consumed to prevent and reverse diabetes. Incorporating vegetables either fresh vegetables or in the form of dried powder to foods may also serve as an alternative route by which this important food group can be introduced into a population's diet. Thus the addition of vegetables into traditional foods may have both industrial and public health benefits [13].

Fenugreek (*Trigonella foenum graecum*) is an annual plant in the family Fabaceae. It is a very ancient spice used in human food. Fenugreek seeds are bitter in taste, when added to any recipe it titillates the taste bud. The seeds and green leaves of fenugreek are used in food as well as in medicinal application that is the old practice of human history. It has been used to increase the flavor and color and also modifies the texture of food materials. In addition to taste, it has numerous nutritional values as well. Fresh leaves are used as vegetables in the diets as a nutritional supplement [20]. It was observed and thus proved that there is a better retention of nutrients in the leaves of fenugreek. The reason why this herb is used since ages is because it is very effective in battling diseases and also has numerous health benefits. It is generally known for its medicinal qualities such as antioxidant, hypocholesterolemic, anticarcinogenic, antidiabetic and immunological activities. Beside its medicinal value, it is also used as a part of various food product developments as food stabilizer, adhesive and emulsifying agent [23]. Leaves as well seeds, are a rich source of dietary fiber and also protein content is high in them. The important vitamins and nutrients that fenugreek leaves contains are thiamine, folic acid, vitamin A, B6, C and K, riboflavin and niacin. Major ingredients present are potassium, calcium, iron and phosphorus.

Drumstick (*Moringa oleifera*) is the most widely cultivated belonging to the family of Moringaceae also known as horseradish tree. Many parts of moringa are edible like leaves, seeds, flowers, immature seed pods and roots and are a storehouse of nutrients and antinutrients. Moringa is rich in nutrition containing of a variety of essential phytochemicals, dietary fibers, proteins, vitamins and minerals present in its leaves, pods and seeds [16]. In fact, moringa is said to provide 17 times more calcium than milk, 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 9 times more protein than yoghurt, 25 times more iron than spinach and 15 times more potassium than bananas. The leaves of M. oleifera are rich in minerals like iron, calcium, potassium, magnesium, zinc and copper [22]. Vitamins like beta-carotene of vitamin A, folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also present in M. oleifera [4, 12]. It is an effective remedy for malnutrition. It is commonly used as anticancer, antidiabetic, antioxidant, antimicrobial and anti-inflammatory agent.

Carrot (*Daucus carota*) is one of the most important nutritious vegetable. It is an excellent source of phytonutrients such as phenolics, polyacetylenes and carotenoids [15]. The main physiological function of carotenoids is as precursors of vitamin A. Carotenoids are potent antioxidants present in carrots which help neutralize the effect of free radicals. Consumption of carrot and its products has gained wide acceptance as a result of its natural antioxidants properties coupled with the anticancer activities of β-carotene in it which is a precursor of vitamin A. Consumption of carrots on regular basis would help widely alleviating vitamin A deficiency in children in large scale which is very important in today's lifestyle [31]. Diet rich in carotenes may have a great impact against several types of cancer, lowers cholesterol levels and also useful in weight loss.

Spinach (*Spinacia oleracea*) is a cool season annual green leafy vegetable which is an active source of phytochemical like chlorophyll, beta-carotene and antioxidants. It is highly eaten raw as fresh while having food or boiled [8, 24] Spinach is an important dietary leafy vegetable loaded with high vitamin and mineral contents. Spinach are although underestimated are excellent source of nutrition which include minerals (iron, magnesium, calcium and potassium), vitamins (A, B1, B6, C, E, K) and dietary fiber [46] Spinach has very low glycaemic index. Spinach also contains several important plant compounds including lutein, nitrates, quercetin, kaempferol and zeaxanthin which are linked to improve eye health, heart health, also decrease the risk of cancer and chronic disease and ward off infection and inflammation.

Tomatoes (*Lycopersicon esculentum*) are the major dietary source generally categorized as vegetable. Tomatoes are also a great source of potassium, manganese, vitamin C and vitamin K. It is a plant chemical known for its antioxidant properties and low in glycemic index. They are rich source of antioxidant lycopene, which is linked with many health benefits, including reduced risk of heart disease, skin health and prevention of cancer. Tomato also contains ascorbic acid, β-carotene, flavonoids, tocopherol, folic acid and other small bioactive molecules in it. The several compositions in tomato is suggested to be favorable for fighting against various diseases [40, 47].

Radish (*Raphanus raphanistrum*) is amongst the rich source of dietary fiber, carbohydrates, potassium, magnesium, iron, calcium, vitamin (A, E, C B6 and K) and antioxidants like ascorbic acid, anthocyanins, folic acid and iodine. Leaves of radish are although underestimated but are excellent source of nutrition which also includes beta carotene, riboflavin and iron [41]. Radish is known to control the damage of red blood cells by increasing the oxygen supply to the blood. Radish micro greens are considered as a better source of bioactive compounds [33]. It improves digestion, regulates bile production, safeguards the liver and gall bladder and is the great root vegetable. Radish is also the good source of anthocyanins that keeps the heart functioning properly, reducing the risk of cardiovascular diseases.

Table 1: General uses of vegetables

Sr. No.	Vegetables	Utilization in foods
1.	Fenugreek	Bread (Losso J. N *et al*. 2009) [23], Paratha (M. L. Sudha *et al*. 2015)
2.	Drumstick leaves	Muffins (Sheetal Srinivasamurthy *et al*., 2017) Idli, dhokla, uthapam (Alka Gupta *et al*., 2017, Mamta Rani *et al*., 2014)
3.	Carrot	Biscuits, Cookies (Ibidapo Olubunmi Phebean, 2017; Mukhtar Ahmad *et al.*, 2016) Pan bread (M. A. Hussein *et al*., 2013)
4.	Spinach	Chapati (M. A. Khan *et al*., 2015) Idli (S. Uma Maheswari, 2014)
5.	Tomato	Soups, Puddings, Sweets, Biscuits, Baby foods, Confectionaries, Snacks (Nagamani, 2014; Ronanki Srivalli *et al*., 2017)
6.	Radish	Vegetable, raita, parotha, pakora (Seema and Neelam Khetarpaul, 2018)

3. Review of literature

Losso J. N *et al*. (2009) [23] developed bread by incorporating fenugreek in wheat flour using a proprietary process and evaluated for its taste acceptability and effect on carbohydrate metabolism compared with the normal bread. This study was stated that bread developed with the addition of fenugreek flour in wheat flour maintained fenugreek's functional property of reducing insulin resistance maintaining the blood glucose.

M. A. Khan and C. Mahesh (2015) studied effect of spinach powder by incorporating in chapati premixes on its physico-chemical, rheological, nutritional and sensory characteristics. Adding of spinach powder into chapatti to enhance daily intake of green leafy vegetables in order to serve the valuable source of calcium, iron, fibre, vitamin C and carotenoids in the diet is concluded in this research.

Mukhtar Ahmad and Touseef Ahmed Wani (2016) evaluated the study by incorporation of carrot pomace powder in wheat flour for the preparation of cookies and its effect on flour and dough characteristics. The cookies produced were low in gluten content and better antioxidant and sensory properties. It was evaluated that the fiber content was increased in the developed product.

M. A. Hussein and A. A. M. Yonis (2013) evaluated and studied the effect of physico-chemical, rheological and sensory properties of pan bread by incorporating various levels of carrot powder in wheat dough. Carrot powder was selected as it is found to be a good source of dietary fiber.

Pallavi Joshi and Beena Mathur (2015) analyzed and developed value added products from the leaf powders of dehydrated green leafy vegetables to study their nutritive value and acceptability of leafy vegetables in food. The mixtures of leaf powders were added into various foods with different levels of incorporation and thus sensory qualities were attributed. It was further found that the mixture of leafy vegetables had appreciable amount of proteins, fat, fiber, carbohydrates and calorific value.

Seema and Neelam Khetarpaul (2018) Organoleptic evaluation and proximate composition of products from chickpea leaves and other leaves like amla, drumstick leaves and raisins were used as sources of natural antioxidants.

Alessandra Lodi and Bettina Karsten *et al*. (2016) studied the effects and analyzed different high protein and low carbohydrates proprietary foods commonly used as daily meals in the diet on blood sugar. Case study was done and thus observed that ready-to-eat foods in low carbohydrate and high protein produces a significantly lower glycemic response and increased nutritional values makes them useful in weight control and diabetes management.

Ibidapo Olubunmi Phebean and *et al*. (2017) has developed and studied the quality evaluation of Carrot Powder and Cowpea Flour Enriched Biscuits that is capable of increasing the protein content which could serve as relief of malnutrition while on the other hand, the inclusion of carrot powder was found to significantly improve the carotenoid content, a potent antioxidants which helps in neutralizing the effects of free radicals.

S. Shukla *et al*. (2011) clearly indicates that radish is good for diabetes as it contains antidiabetic property. This review studies the effect of radish on diabetes. Variable doses of radish juice were administered orally and thus proved effective results against diabetes.

Ray Yu Yang *et al.* (2006) study implies that consumption of moringa greatly enhances nutritional qualities and also responds positively by strengthening the immune response of the body fighting against infectious diseases. Consumption of moringa also prevents iron and vitamin A deficiencies in children. It was also observed that moringa has highest amounts of fibers, β-carotene, Vitamin C, E and was the second highest in protein content.

Saleem A. Banihani (2018) studied that consumption of tomato (fresh or cooked) had certain compounds that exerts an antihyperglycemic effect which is always favorable for diabetes as it decreases diabetes induced oxidative stress.

4. Conclusion

It assessed after review that the efficacy of combination of the vegetables like Fenugreek leaves, Drumstick leaves, Carrot, Spinach, Tomato and Radish leaves powder incorporated to develop proprietary food, rich in proteins and fiber with acceptable functional and sensory characteristics, as well as excellent nutritional quality, helpful for controlling blood glucose level among diabetes. The full emphasis is on nutrition as it is the primary tool to combat the epidemic of diabetes.

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