STM JOURNALS

Research & Reviews: Journal of
Food Science & Technology

https://journals.stmjournals.com/rrjofst

ISSN: 2278-2249 (Online)
ISSN: 2321-6468 (Print)
Volume 13, Issue 1, 2024
January—April
DOI (Journal): 10.37591/RRJoFST

Research RRJoFST

Impact of Diet and Certain Functional Foods in Type-II Diabetes Management

Fathima Sabna Kainikkara[1], Amar Srivastava[2], Jyoti Rajput[3], Jeeban Prasad Gewali[4,*]

Abstract

Global health is greatly challenged by type 2 diabetes mellitus (T2DM), with its management largely dependent on dietary and lifestyle changes. This review study examines the importance of diet and certain functional foods in managing type 2 diabetes. It provides a comprehensive overview of current scientific discoveries and clinical investigations that highlight the role of dietary choices and functional foods in improving glycemic control, enhancing insulin sensitivity, and reducing the risk of diabetes-related complications. The study emphasizes the potential benefits of personalized dietary interventions and the inclusion of functional ingredients, such as oats (whole grain), fenugreek (legume), cinnamon (spice), and bitter gourd (vegetable), in the overall plan for managing diabetes. Understanding the synergistic effects of diet and functional foods is crucial for promoting more efficient and holistic approaches to type 2 diabetes care. Furthermore, the review explores how these functional foods can interact synergistically to enhance their effects on blood glucose regulation and overall metabolic health. By considering the complex interplay between diet, individual metabolism, and lifestyle factors, this study advocates for a tailored approach to dietary management. It suggests that future research should focus on understanding the mechanisms through which these foods exert their benefits and how they can be effectively incorporated into diverse dietary patterns. Promoting more efficient and comprehensive methods for managing type 2 diabetes requires an understanding of how these foods interact with metabolic processes, providing a foundation for more effective, individualized treatment strategies. In doing so, it aims to contribute to the development of more targeted and sustainable interventions that could significantly improve the quality of life for those living with T2DM.

Keywords: Diabetes mellitus, hyperglycemia, functional foods, diet, cinnamon

INTRODUCTION

The term Diabetes mellitus is coined by merging Greek word “diabetes” means "to pass through" and Latin word “mellitus” means “honey/sweetness” [1]. Hyperglycemic conditions, either during fasting or after eating, are known as diabetes mellitus [2]. The classification of diabetes types is based on variations in the mechanisms underlying [3, 4] the development of each type [1]. Common types include type I diabetes mellitus (T1 DM) or insulin-dependent diabetes mellitus (IDDM), sometimes referred to as juvenile-onset diabetes. Type-II diabetes mellitus (T2 DM), the most prevalent type of adult- onset diabetes. Gestational diabetes mellitus (GDM) is also known as maternal diabetes mellitus. Rare forms: maturity-onset diabetes of the young (MODY) and latent autoimmune diabetes (LADA).

Diabetes mellitus is characterized by persistent hyperglycemia, which leads to end-organ damage,

***Author for Correspondence**
Jeeban Prasad Gewali
E-mail: jpgewali@gmail.com

[1]Student, Department of Food Technology and Nutrition, Lovely Professional University, Jalandhar, Punjab, India.
[2-4]Assistant Professor, Department of Physics, School of Mechanical Engineering, Lovely Professional University, Jalandhar, Punjab, India

Received Date: April 10, 2024
Accepted Date: June 25, 2024
Published Date: June 28, 2024

Citation: Fathima Sabna Kainikkara, Amar Srivastava, Jyoti Rajput, Jeeban Prasad Gewali. Impact of Diet and Certain Functional Foods in Type-II Diabetes Management. Research & Reviews: Journal of Food Science & Technology. 2024; 13(1): 9–15p.

malfunction, and failure in several organs and tissues, such as the kidneys, eyes(retina), heart, neurons, and blood vessels [2].

There are two aspects of type 2 diabetes: relative insulin insufficiency and insulin resistance. Age, genetics, race, and ethnicity are examples of T2DM variables that cannot be modified. The variables included nutrition, exercise, and smoking [5].

According to the World Health Organization (WHO), there were 422 million diabetics worldwide in 2014, up from 108 million in 1980. It was projected that this medical condition directly led to the death of 1.5 million in 2019 and that high blood sugar killed 2.2 million individuals in 2012 – WHO, 2021. Based on the analysis, the illness is linked to additional fatal conditions, such as kidney failure, myocardial infarction, stroke, blindness, and lower limb amputation. Many experts in the field have discussed how dietary modifications and lifestyle choices can help reduce disease, and most of them concur that these two aspects can assist in lowering the elements that impact the onset of the disease. They contend that research has demonstrated how individualized diet and exercise can dramatically prevent or postpone disease, and that consistent moderate physical activity is crucial for both prevention and treatment, with prevention showing the greatest results. There are four key themes that can help lower the risk of developing diabetes: a properly controlled balanced diet, reaching the ideal weight for your size, increasing physical exercise, and cutting back on bad health habits such as [6].

Kaul et al. stated that the primary goal of managing diabetes is to keep blood glucose levels as close to normal as feasible while preventing hypoglycemia. Diabetes therapy involves five key tools: education, physical activity and/or exercise, food, oral drugs, and/or insulin, typically used in combination [1]. There have been numerous reviews on the role of diet in diabetes medical nutrition therapy, but few have focused on diabetes prevention. The risk of diabetes has been lowered in individuals with impaired glucose tolerance (IGT) with lifestyle therapies that combine nutrition and increased physical activity to cause weight loss [7].

Modest for significant weight loss may be beneficial for those who have diabetes and are overweight or obese. Glycemia and other intermediate cardiovascular risk variables improved, with comparatively minor weight loss (approximately 3–7% of the baseline weight). Greater advantages, including disease-modifying effects and the potential for type 2 diabetes remission, are typically associated with larger, longer-term weight decreases (>10%), which may also enhance long-term cardiovascular outcomes and mortality [8]. A combination of diet and moderate physical exercise targeted at achieving and maintaining a 5-7% body weight loss has been shown in four large randomized, controlled clinical trials to reduce the risk of type 2 diabetes by 29-58%. In conclusion, it is possible to prevent up to 90% of T2DM cases by eating a balanced diet, maintaining a BMI of less than 25 kg/m^2, exercising for at least half an hour each day, abstaining from smoking, and drinking alcohol sparingly. Moreover, certain dietary elements are linked, regardless of body weight, to a lower risk of type 2 diabetes mellitus (T2DM). These elements include fair consumption of alcohol; reduced intake of refined grains, red and processed meat, and sugar-sweetened beverages; and a higher intake of coffee, nuts, and green leafy vegetables [4].

Medical nutrition therapy (MNT) is a key component of the management of type 2 diabetes. This involves estimating energy and nutrient requirements, measuring carbohydrates, calculating glycemic index and load, recommending the intake of dietary fat, cholesterol, and proteins, explaining the food exchange list to patients, and making common but important recommendations for a healthy diet. To reduce blood sugar levels, the administration of multiple supplements has been suggested, such as fibers, ω3 fatty acids, antioxidant vitamins, multiple nutraceuticals, and herbs; however, there is insufficient evidence to support these suggestions for those with diabetes. Given their potential to improve well-being and lower the risk of chronic diseases, functional foods have received considerable attention in addition to their fundamental nutritional benefits. Several clinical trials have confirmed these benefits in individuals with diabetes. Recent studies have focused on the ability of the bioactive

components of functional foods to regulate many elements of diabetes mellitus. These substances and sources of different foods have been shown to have some preventive benefits, both in vitro and in vivo [9].

Impact of Diet in Type-II Diabetes Management

The evolution and management of type 2 diabetes mellitus are significantly influenced by diet. Diet has a direct effect on the development of type 2 diabetes mellitus. Type 2 diabetes mellitus is typically the outcome of a diet that is heavy in fat and simple carbohydrates later in life. In addition, many people with type 2 diabetes may manage their condition with diet alone, without the need for insulin or hypoglycemic medications. As a result, dietary restriction plays a crucial role in helping individuals with type 2 diabetes. Dietary restrictions included food distribution, timing, amount, and content. A diet that provides appropriate amounts of carbohydrates, fats, proteins, vitamins, and minerals is necessary for the optimal treatment of patients with diabetes.

To normalize body weight, the diet should be suitable and designed accordingly. The correct amount of calories should be included in a child's diet with diabetes to ensure proper growth and weight gain. [10]. When combined with physical activity to manage its high-energy content, the Mediterranean diet plan is a suitable option for individuals with type 2 diabetes. When treating type 2 diabetic patients, vegetarian and vegan diets should be considered. The ADA (American Dietetic Association) has also verified the advantages of vegetarian and vegan diets for treating chronic diseases and maintaining good nutrition [11].

Role of Macronutrients

Research including both healthy individuals and those at risk of developing diabetes indicates that the majority of a diabetic's daily intake of carbohydrates comes from whole grains, fruits, vegetables, and low-fat dairy products. It is commonly advised that 45–65% of energy comes from carbohydrates, with simple carbohydrates making up as much as one-third of the total. It has been shown that high-carbohydrate diets raise insulin and glucose levels by 9% and 12%, respectively. Consuming foods derived from less processed forms of carbohydrates can help limit this occurrence, whereas consuming monosaccharides, especially fructose, might make it worse. Refined and whole-wheat cereals can reduce blood glucose and insulin requirements, while providing protection against type 2 diabetes. Processed carbons can be substituted with these cereals [12]. Dietary fiber, which has other beneficial effects such as reducing HbA1c and improving postprandial glycemia results that would not be predicted in a diet so high in carbohydrates and helping to raise satiety levels, which in turn helps reduce calorie intake [11]. It is clear that individuals with type 2 diabetes benefit from dietary therapies such as dietary fiber and low-carbohydrate diets because they modulate gut microbial dysbiosis, promote SCFA synthesis, and improve glycemic control. However, further investigation is required to understand the process underlying how diets affect the gut microbiota, because this is still a developing field of study [13].

To maintain adequate renal function, the American Diabetes Association advises diabetics to ingest protein in amounts no greater than 15-20% of their total caloric consumption.

For each kilogram of body weight per day (or, on average, 10% of total calories), 0.8 g of high- quality protein is recommended. This was defined as providing all nine necessary amino acids and higher protein digestibility-corrected amino acid scoring pattern scores. One key strategy for managing renal function in patients with diabetes may be to restrict their protein consumption to no more than 20% of their total energy intake. Moreover, eating proteins can enhance insulin response without increasing blood glucose levels [11].

High-fat diets are associated with insulin resistance. This finding was unrelated to modifications in body composition. Among all lipids, trans fatty acids and saturated short-chain fatty acids seem to have

the most detrimental effects. High consumption of saturated fatty acids has been linked to a higher risk of insulin-related metabolic disorders (IGT), diabetes, and the development of diabetes. Trans-fatty acid consumption has been linked to a higher risk of type 2 diabetes by likely causing insulin resistance or impairing insulin action. Human experiments have shown that when a trans fatty acid-rich breakfast was consumed, insulin levels were greater than when it was consumed. However, an inverse relationship exists between the development of diabetes and unsaturated fatty acids. However, there is no evidence that omega-3 long-chain fatty acids have any impact on maintaining insulin sensitivity [12].

Role of Micronutrients

In general, it is a vital element of diet and life. They perform crucial tasks in numerous metabolic processes. A few minerals, particularly trace minerals, are actively involved in metabolism. Certain minerals are necessary for enzymes to perform their biological functions. As diabetes mellitus is a disease of faulty metabolism, minerals alone or as an ingredient in enzymes may be important in the onset and management of the condition. Cr is a mineral that plays an important role in the onset and management of diabetes mellitus. Numerous studies have been conducted on the role of Cr in development and regulation [10].

Intolerance to carbs can be worsened by deficiencies in certain minerals such as magnesium, potassium, and possibly zinc and chromium. According to several studies, supplementation with chromium may improve glycemia. More research is required because the benefits of Cr have not yet been proven. Increased consumption of antioxidants is considered crucial because diabetes appears to be a state of elevated oxidative stress [12].

Impact of Certain Common Functional Foods in Type-II Diabetes Management

According to the Academy of Nutrition and Dietetics (AND) position paper, "whole foods as well as fortified, enriched, or enhanced foods that have a potentially beneficial effect on health when consumed as part of a varied diet on a regular basis at effective levels based on significant standards of evidence" are considered functional foods. Foods or dietary elements that has much health benefit more than essential nutritional value and also may play a major role in reducing the risk of diseases and other health issues are indicated as functional foods by the International Food Information Council (IFIC) [14]. The potential of several popular herbs and super foods that lower blood sugar in clinical trials (particularly in light of the most recent meta-analysis) and show how they work in hypoglycemia in both *in vitro* and *in vivo* investigations [15].

Oats

Oat meal products are rich in antioxidants, bioactive compounds, soluble fiber (particularly β-glucan), phytic acid, phenolic acids (hydroxycinnamic acids, caffeic acid, and ferulic acid), flavonoids, and phytosterols. Patients with diabetes have also been studied and used as a good source of carbohydrates. Research indicates that oat products work as an active ingredient to reduce post-cecal glycemia and enhance glycemic, insulinemic, and lipidemic responses in diabetes patients. Oat products also reduce plasma free fatty acid levels and succinate dehydrogenase activity, stop pancreatic β-cell apoptosis, and enhance the quantity of glycogen in the liver in diabetic animal models. They also reduced the effects of hyperglycemia on retinal oxidative stress [9]. Whole grains, such as rye, barley, oats, and whole wheat, protect against metabolic syndrome, obesity, diabetes mellitus, hypertension, heart disease, and other malignancies. The following compounds are found in oats: beta-glucan, carotenoids, phytic acid, and phenolic acids (flavonoids, phytosterol, hydroxycinnamic acid, caffeic acid, and ferulic acid). Those with diabetes or prediabetes have lower postprandial glycemia, enhanced glycemic, insulinemic, and lipidemic responses, boost satiety, and ingest fewer calories [14].

Fenugreek

Legumes, such as fenugreek (*Trigonella foenum graecum*), are widely grown throughout the Mediterranean, North Africa, and India. It is a typical plant used in Ayurveda and as condiments in

Indian food. Early Greek and Latin pharmacopoeias have reported that defatted fenugreek seeds are rich in fiber, saponins, and proteins for the treatment of hyperglycemia. Delayed gastric emptying, sluggish absorption of carbohydrates, congestion of glucose transport from fiber content, improved erythrocyte insulin receptors, and utilization of altered peripheral glucose are some of the proposed processes [16].

Fenugreek seeds are frequently used in products such as different pickles, curry powder, and seasonings. In Asia, this plant, which is high in fiber, is frequently used to regulate blood sugar levels. Studies have indicated that polyphenolic compounds found in fenugreek seeds are responsible for their anti-inflammatory and antioxidant properties. Fenugreek seed steroidal saponins lower plasma total cholesterol levels and are linked to hyperinsulinemia. The oligosaccharides found in fenugreek seeds are believed to function as glucosidase inhibitors, slowing the absorption of monosaccharides and reducing blood sugar levels. Individuals with type 2 diabetes may benefit from a regular dosage of 5–100 g of powdered fenugreek seeds in terms of refined HbA1c, postprandial glucose, and fasting blood sugar. Fenugreek improves tissue insulin sensitivity by delaying stomach emptying and slowing carbohydrate absorption [14]. investigated the hypoglycemic effect of fenugreek seeds in 15 individuals with NIDDM. By increasing peripheral glucose consumption, the addition of fenugreek to the diet results in a significant reduction in fasting blood glucose levels and enhancement of glucose tolerance [10].

Cinnamon

The compounds trans- and cinnamaldehyde (Cin) found in cinnamon may help to reduce CVD and type 2 diabetes. Numerous trials have shown that cinnamon can deal with a number of conditions, including weight loss, inflammation, insulin resistance, hyperglycemia, hyperlipidemia, and a decrease in protein glycation. Cinnamon reduced hemoglobin A1c in 109 T2DM patients in a trial compared with standard management. The most desired topic of investigation at this time is cinnamon's value in type 2 diabetes mellitus (T2DM), although the current data are not sufficient to recommend cinnamon in treating any of the therapeutic conditions due to its inconsistent results [14].

Polyphenol type-A polymers found in cinnamon extracts have been shown to exhibit insulin-mimetic effects. Studies on animals, both *in vitro* and *in vivo*, have shown that cinnamon has powerful insulin-like or insulin-potentiating effects. An overview of current research using cinnamon extracts revealed that while some studies succeeded, others did not show any change in FBG or PPBG levels. Further research is required before cinnamon has been suggested as a treatment for type 2 diabetes [17]. However, from various clinical trials and placebo findings, Khan and Safdar concluded that, based on their findings, they advised type 2 diabetics to regularly incorporate 1-3 grams of cinnamon into their food preparations. Those with diabetes can sprinkle cinnamon powder over curries in a dish using cinnamon shakers. After meals, patients can make cinnamon tea without the addition of sugar. After eating, diabetics can chew cinnamon bark. This maintains blood sugar levels close to the typical ranges [10].

Bitter Gourd

Momordica charantia, sometimes called balsam pear, karela (karolla), or bitter melon, is a vegetable native to tropical areas of South America, Africa, Asia, and India. Increased insulin secretion, tissue glucose absorption, synthesis of liver muscle glycogen, glucose oxidation, and reduced hepatic gluconeogenesis are some theoretical mechanisms. Research on alloxan-induced diabetes in rabbits has indicated hypoglycemic effects (Yeh et al., 2003). According to a survey that expanded the list of natural ingredients that increase insulin activity, tea, fenugreek, bitter gourd, and jaman seed all have this property. It has been observed that a variety of culinary and medicinal plants can lower blood sugar levels in people with diabetes. Momordica charantia, cinnamon, cloves, bay leaves, and bitter melon [10].

Numerous academic publications have examined the beneficial effects of bitter gourd in animal models of diabetes. There are few poorly designed clinical investigations on the hypoglycemic effect of

bitter melon, which frequently produces inconsistent findings and insufficient data. Nonetheless, since no or very few negative effects were noted in these trials, more carefully planned investigations with a sizable sample size and statistical power are required to provide additional insight into the therapeutic potential of bitter melon, which is still one of the most promising candidates among FFs for diabetic patients (Figure 1). For age, components such as bitter melon have been used extensively in ethnomedicine and dietary supplements to treat diabetes-related ailments and symptoms [3].

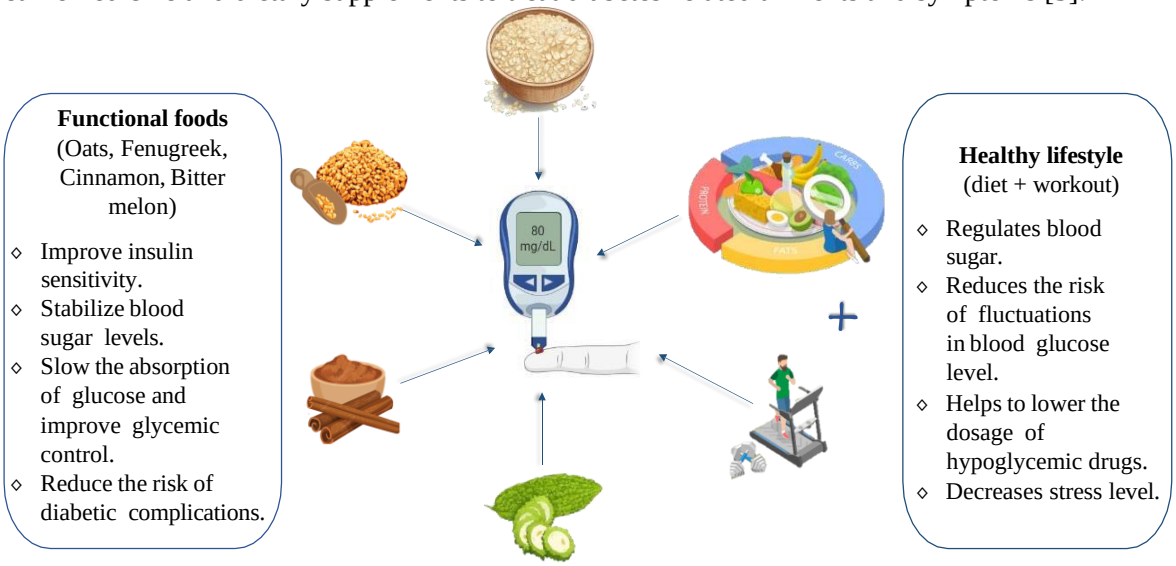

Figure 1. Certain functional foods and their dietary roles.

CONCLUSION

The review paper concludes by highlighting the critical role of diet and certain functional foods in managing type 2 diabetes mellitus. It highlights how crucial it is to follow dietary guidelines that prioritize whole, low-GI foods, lean proteins, and healthy fats because they all support stable blood sugar regulation and fewer issues. Furthermore, there is evidence that functional foods, such as oats, fenugreek, cinnamon, and bitter melon, can improve insulin sensitivity. Before suggesting these functional ingredients for the treatment of type 2 diabetes, further research is required, which requires continual engagement with healthcare specialists and the customization of food regimens. Therefore, there is a scope for future research on this topic. The thorough understanding emphasizes how important nutrition and functional foods are to helping people with diabetes live better lives.

REFERENCES

1. Kaul K, Tarr JM, Ahmad SI, Kohner EM, Chibber R. Introduction to diabetes mellitus. In: Diabetes: An old disease, a new insight. 2013. p. 1-11.
2. Alam U, Asghar O, Azmi S, Malik RA. General aspects of diabetes mellitus. Handb Clin Neurol. 2014;126:211-22. doi: 10.1016/B978-0-444-53480-4.00015-1. PubMed: 25410224.
3. Ballali S, Lanciai F. Functional food and diabetes: A natural way in diabetes prevention? Int J Food Sci Nutr. 2012;63(Suppl 1):51-61. doi: 10.3109/09637486.2011.637487. PubMed: 22107597.
4. DeFronzo RA, Ferrannini E, Groop L, Henry RR, Herman WH, Holst JJ, et al. Type 2 diabetes mellitus. Nat Rev Dis Primers. 2015;1:15019. doi: 10.1038/nrdp.2015.19. PubMed: 27189025.
5. Sami W, Ansari T, Butt NS, Hamid MRA. Effect of diet on type 2 diabetes mellitus: A review. Int J Health Sci (Qassim). 2017;11:65-71. PubMed: 28539866.
6. Suryasa IW, Rodríguez-Gámez M, Koldoris T. Health and treatment of diabetes mellitus. Int J Health Sci (Qassim). 2021;5. doi: 10.53730/ijhs.v5n1.2864.
7. Salas-Salvadó J, Martinez-González MÁ, Bulló M, Ros E. The role of diet in the prevention of type 2 diabetes. Nutr Metab Cardiovasc Dis. 2011;21(Suppl 2). doi: 10.1016/j.numecd.2011.03.009. PubMed: 21745730.

8. ElSayed NA, Aleppo G, Aroda VR, Bannuru RR, Brown FM, Bruemmer D, et al. 8. Obesity and weight management for the prevention and treatment of type 2 diabetes: Standards of care in diabetes-2023. Diabetes Care. 2023;46(Suppl 1). doi: 10.2337/dc23-S008. PubMed: 36507637.
9. Mirmiran P, Bahadoran Z, Azizi F. Functional foods-based diet as a novel dietary approach for management of type 2 diabetes and its complications: A review. World J Diabetes. 2014;5:267-81. doi: 10.4239/wjd.v5.i3.267. PubMed: 24936248.
10. Khan A, Safdar M. Role of diet, nutrients, spices and natural products in diabetes mellitus. Pak J Nutr. 2003;2:1-12.
11. Khazrai YM, Defeudis G, Pozzilli P. Effect of diet on type 2 diabetes mellitus: A review. Diabetes Metab Res Rev. 2014;30(Suppl 1):24-33. doi: 10.1002/dmrr.2515. PubMed: 24352832.
12. Lazarou C, Panagiotakos D, Matalas AL. The role of diet in prevention and management of type 2 diabetes: Implications for public health. Crit Rev Food Sci Nutr. 2012;52:382-89. doi: 10.1080/10408398.2010.500258. PubMed: 22369258.
13. Ojo O. Recent advances in nutrition and diabetes. Nutrients. 2021;13:1573. doi: 10.3390/nu13051573. PubMed: 34066662.
14. Sikand G, Kris-Etherton P, Boulos NM. Impact of functional foods on prevention of cardiovascular disease and diabetes. Curr Cardiol Rep. 2015 Jun;17(6):39. doi: 10.1007/s11886-015-0593-9.\
15. Venkatakrishnan K, Chiu HF, Wang CK. Popular functional foods and herbs for the management of type-2-diabetes mellitus: A comprehensive review with special reference to clinical trials and its proposed mechanism. J Funct Foods. 2019;57:425-38. doi: 10.1016/j.jff.2019.04.039.
16. Yeh GY, Eisenberg DM, Kaptchuk TJ, Phillips RS. Systematic review of herbs and dietary supplements for glycemic control in diabetes. Diabetes Care. 2003;26:1277-94. doi: 10.2337/diacare.26.4.1277. PubMed: 12663610.
17. Rudkowska I. Functional foods for health: Focus on diabetes. Maturitas. 2009;62:263-69. doi: 10.1016/j.maturitas.2009.01.011. PubMed: 19233576.

