Food Science and Technology
ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)
DOI: https://doi.org/10.1590/fst.03520

Ameliorative effects of fenugreek (*Trigonella foenum-graecum*) seed on type 2 diabetes

Muhammad Haseeb ur REHMAN[1], Asif AHMAD[1], Rai Muhammad AMIR[1]*, Kashif AMEER[1], Shinawar Wasim ALI[2], Farzana Siddique[3], Imran Hayat[4], Zaheer AHMAD[5], Farrukh Faiz[6]

Abstract

The hyperglycaemia defines features of type 2 diabetes (T2DM), which is a real time problem and poses a significant economic burden on the globe and is spreading like an epidemic. Currently it affects 384 million people on the globe and this number is expected to reach 592 million in 2035 as reiterated by International Diabetes Federation (IDF). By improving the quality of diet and decreasing the intake of sugary foods T2DM can be treated. Fenugreek seeds powder in sachet form of 20 g/day used to treat type 2 diabetes mellitus as a natural supplement. Anthropometric parameters of height, weight, age and BMI of T2DM patient was also calculated. In this study patients from Rawalpindi and Islamabad region were selected for study purpose. Blood sugar levels such as fasting blood glucose (FBG), random blood glucose (RBG), and HbA1c of both the groups (treated and control) were taken at baseline, after one month and at the end of study. When fenugreek seeds were given to T2DM patients significant decrease in their glucose levels were seen after 30 and then 60 days of treatment.

Keywords: fenugreek; *Trigonella foenum-graecum*; hyperglycaemia; diabetes; FBG; RBG.

Practical Application: Fenugreek could be exploited as diet-based antidiabetic remedy.

1 Introduction

Since ancient times, herbs are commonly used by the people for certain treatments due to their health benefits. Herbal supplementation like *Nigella sativa* or cinnamon or fenugreek, is also used to increase insulin production by keeping the cells and immune function healthy (Al-Rowais, 2002). Numerous herbs/plants are used to treat T2DM that but fenugreek seeds (FGS) are considered to be more effective. Fenugreek (*Trigonella foenum-graecum*) belongs to the family of fabacea and is generally known as "Methi Dana" which has been used in cooking and medicinal practices since antiquity. Fenugreek is a leguminous plant which is about thirty to sixty cm in length with leaves of about 2-2.5 cm and flowers of about 1-2 cm. There are many other names which are being called in different countries, such as Greek Hay Seed, Alholva. Medhika Methi, Trigonella, Birds Foot and fenugreek etc. (Hasan & Rahman, 2016). Fenugreek seeds help in lowering of glucose levels in blood. FGS contains chemicals which have anti-diabetic activity like fiber, saponins, amino acids etc. Fiber such as galactomannan helps to decrease the sugar levels in blood by delaying the carbohydrates absorption. 4-hydroxyisoleucine (4HIL) is present in the seeds which stimulates the secretion of insulin in pancreas that helps to lower the glucose absorption.

Diabetes mellitus is a metabolic disorder, where body cannot metabolize glucose, which accumulates in the body. Various factors contribute towards T2DM, but the main are lifestyle, i.e., sedentary, dietary i.e., consumption of carbohydrate rich foods, genetic, obesity and age. Deficiency of β-cells of islets of Langerhans causes defective production of insulin that affects the body's ability to metabolize glucose, which accumulates in the body, leading to its' cardinal features, i.e., polydipsia, polyurea, hyperglycaemia and glycosuria. It has long term effects, which can cause failure of different organs in the body. Currently diabetes affects 384 million people on the globe and this number is expected to reach 592 million in 2035 as reiterated by International Diabetes Federation (IDF) (Nanditha et al., 2016). South Asia faces the rapid rise and Pakistan is 4th on the list of diabetic countries (Naz et al., 2016). The hyperglycaemia defines features of T2DM, which is a real time problem and poses a significant economic burden on the globe and is spreading like an epidemic.

Hyperglycaemia is the most important diagnostic criteria for the diagnosis of fasting plasma glucose; 126 mg/dL or above, level of plasma glucose; 200 mg/dL or above and a random plasma glucose with the range of 200 mg/dL in hyperglycaemic persons, indicating the chance of diabetes. Also, the HbA1c of range 6.5% or above can be a major diagnostic criteria of diabetes mellitus but it's still controversial. Prevention of this disease is very much necessary. Keeping in view the recent scenario, the present study was designed to evaluate the effects of fenugreek seed on blood glucose level in the body along with prevention of obesity because obesity can lead to hyperglycaemia.

Received 24 Jan., 2020
Accepted 01 Mar., 2020
[1] *Institute of Food and Nutritional Sciences, PMAS-Arid Agriculture University, Rawalpindi, Punjab, Pakistan*
[2] *Institute of Agricultural Sciences, University of Punjab, Lahore, Pakistan*
[3] *Institute of Food Sciences & Nutritional, University of Sargodha, Sargodha, Pakistan*
[4] *Department of Food Science and Technology, University of Poonch Rawalakot, Azad Kashmir, Pakistan*
[5] *Department of Environmental Design, Health and Nutritional Sciences, Allama Iqbal Open University, Islamabad, Pakistan*
[6] *Department of Agriculture & Food Technology, Karakoram International University, Gilgit-Baltistan, Pakistan*
*Corresponding author: raiamir87@yahoo.com

2 Materials and methods

2.1 Number of patients, inclusion criteria & exclusion criteria

This research was conducted in diabetic department of Benazir Bhutto Hospital, Rawalpindi. Total number of patients was 60 with T2DM. Study period was of 2 months. The inclusion criteria include age ranging from 30-65 years old male and female type 2 diabetic patients. And those patients were selected who were willing to give informed consent. The exclusion criteria exclude those patients who were suffering from any chronic disease and patient other than inclusion criteria.

2.2 Treatments

Total number of patient's (n=60) were randomized into 2 treatment groups (T_1 & T_2) with 30 patients each named as treated and control group, respectively. Group T_1 remained as control group that will be on dietary modification. Group $T_{2,}$ received fenugreek seed powder of 10 g in sachet form before breakfast and 10 g of fenugreek seed powder before dinner. Their demographic profile along with fasting blood glucose FBG, random blood glucose RBG and HbA1c level was determined at baseline, after 1 month of trial and at the end of study. The Department and hospital permission were taken to conduct the proposed protocol. Written consent was taken from the patients agreed to the part of research.

2.3 Approach, permission and consent

The departmental and hospital permission were taken to conduct the proposed protocol. Written consent was taken from the patients agreed to the part of research.

2.4 Parameters

Following parameters evaluated the effect of fenugreek seed on type 2 diabetic patients.

Data collection tool

Questionnaire was used for dietary assessment of type 2 diabetic patients.

Anthropometric measurements

Height, weight and BMI was calculated by formulas given in published literature (Watson et al., 1980).

Socio economic status

Socio economic status was assessed through questionnaire, designed for data collection.

Diet history

Dietary history of T2DM patients was also assessed with the help of questionnaire.

Medical history

Medical history of the patient was evaluated through blood sugar tests, which are fasting blood glucose level FBG, random blood glucose level RBG and HbA1c.

2.5 Statistical analysis

Analysis was done using SPSS version 23 by the assistance of a statistician. Results were linked with the reference standards for calculating the outcome variables. Status of impact indicators i.e., for FBG, RBG, HbA1c, and insulin profile were studied. Frequency and Correlation tables were also developed to see the effect of FGS powder. The p values was calculated and a value of < 0.050 was considered significant (Steel et al., 1997).

3 Results and discussion

Fenugreek seeds are well known for their nutritional benefits. The present analysed the effect of fenugreek seed on type 2 diabetic patients. The results obtained has been briefly discuss below.

3.1 Human study design

This research was based on human study for 2 months. In current study patients in both treated and control group was counselled regarding dietary and lifestyle modification after giving fenugreek seeds powder. People were screened for eligibility within a period. Selected patients were placed in two treatment groups. First group was control group and termed as T_1 and selected patients in this group were taking no fenugreek seed powder with standard diet plan, this group was made for comparison with other group. In the second group termed as $T_{2,}$ in which T2DM patients were selected and given on fenugreek seed powder with standard diet plan.

3.2 Nutritional status of patients

The result regarding nutritional status of males and females was depicted in Table 1. According to these results over nourished males and females were 12 and 16 respectively in control group at baseline, while the number of over nourished males and females in treated group were 11 and 10 respectively. After 2 months of trial, the number of patients (males and females) in control group were 9 and 14 while in treated group the number of patients (males and females) were 4 and 9, which showed gradual decrease. Nutritional status of males and females was equated with Asian canons and most of the patients were overweight (Inzucchi et al., 2012). It is important to note that after the intervention process the number of overweight patients reduced. Improvement in nutritional status results in the management of diabetes. Because if the nutritional status is high than the normal these patients are more likely to be susceptible to diseases like CVD problems (Li et al., 2015).

3.3 BMI of the patients

Body mass index BMI of all the patients were calculated at baseline, after one month of trial and then after two months of

Table 1. Nutritional status at all phases.

		Type of the patient					
		Control		Treated		Total	
		M	F	M	F	M	F
Nutritional status at baseline	Undernourished	0	0	0	0	0	0
	Normally nourished	2	0	4	4	6	4
	Over nourished	12	16	11	10	23	26
Nutritional status after 1 month	Undernourished	0	0	0	0	0	0
	Normally nourished	4	0	7	4	11	4
	Over nourished	10	16	8	9	18	25
Nutritional status after 2 months	Undernourished	0	0	0	0	0	0
	Normally nourished	5	2	12	5	17	7
	Over nourished	9	14	4	9	13	23

M= Male; F= Female.

Table 2. MI status of patients.

	Type of the patient			
	Control		Treated	
	Male	Female	Male	Female
BMI kg/m^2 at baseline (mean ± SD)	26.34 ± 1.22	26.53 ± 0.83	25.65 ± 0.75	25.60 ± 0.83
BMI kg/m^2 after 1 month (mean ± SD)	25.03 ± 1.24	26.22 ± 0.90	25.14 ± 0.75	25.25 ± 0.85
BMI kg/m^2 after 2 months (mean ± SD)	25.58 ± 1.25	25.91 ± 0.99	24.62 ± 0.74	24.71 ± 0.85

SD= Standard Deviation.

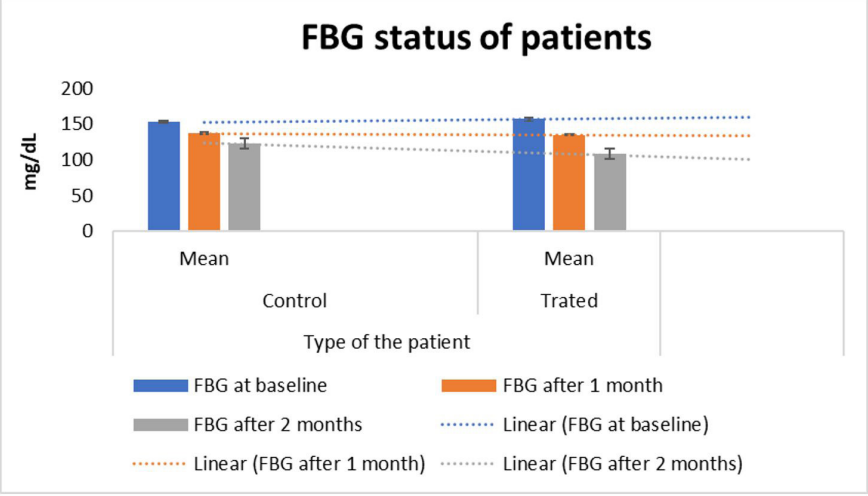

Figure 1. FBG status of patients.

trial. They showed a gradual decrease in BMI level. Their mean values were calculated see the Table 2. BMI scale is commonly used to check the nutritional status of person that either the person is over nourished or under nourished, but it is not a perfect tool in terms of clinical practices (Cook et al., 2005). After the intervention they showed positive improvement in maintaining weight.

3.4 Biochemical measurements

Effect on fasting blood glucose level

Data is presented in Figure 1 shows a significant difference between the treatment group T_1 and control group T2 at baseline, after 1 month and at the end of study. In the study, treated group showed highest fasting blood glucose level and the mean is 157.33 at baseline while in control group the mean is 153.23. Treated group was given by fenugreek powder along with dietary guidelines while the control group is only given by dietary interventions. At the end of study, the mean value of treated group is 108.2 while the control group showed the mean value of FBG status is 123.1.

As the result of this study it is concluded that fasting blood glucose level effectively decrease and showed beneficial effects in the treatment of type 2 diabetes mellitus. Similar results were found in a study which was conducted on T2DM patients

by Verma et al. (2016) in which it lowered FPG in 83% of Fenfuro-treated group as compared to 62% in the placebo group and this ratio was 89% & 72% in post prandial plasma glucose levels. Similar results were obtained for HbA1c. In another study conducted on 38 newly diagnosed T2DM patients by Nayak & Bhaktha (2005) with age range of 30-45 years which showed that adding fiber rich source like fenugreek seeds improve the FBG status of patients. In a study conducted by Roberts (2011), it is revealed that hypoglycaemic effect of fenugreek seeds is due to the rich components called dietary fiber that is 45.4% (13.3 soluble and 32% soluble) and galactose. The possible reason for declining tendency of FBG level could be due to dietary fiber (soluble). Fiber in form of viscous solution reduces or delays the absorption of glucose in the small intestine, which helps to lower the postprandial glucose level in the body (Gharib, 2016; Srinivasan, 2019). The FBG level and fiber intake of patients may vary depending on their age groups and weight to height ratio, basal metabolic rate and BMI. Body height has an adverse relationship with glucose tolerance of respective patients. Hence it is implied that BMI also has a contributory role in determining glucose tolerance in patients which might possibly exert an effect on FBG as well as macro and microvascular complications of diabetes in the patients (Anderwald et al., 2011; Janghorbani & Amini, 2008).

3.5 Effect on random blood glucose level

Data is presented in Figure 2 which shows a significant difference between the two groups treatment group T_1 and control group T_2. Test was conducted at baseline, after 1 month and at the end of study to check the health status of random blood glucose level. In the study, treated group mean value of RBG is 261.77 at baseline while in control group the mean value is 257.63 of FBG. Treated group was given by fenugreek powder along with dietary guidelines while the control group is not given by fenugreek seed powder and only given dietary interventions. At the end of two month of trial, the mean value of treated group is 178.63 while the control group showed the mean value of FBG status is 216.2.

After the trial when two groups were checked at baseline, after 1 month and then after two months it is cleared from the data that fenugreek seed reduces the random blood glucose level. Their mean values compared with each other which showed that treated group is more effective than the control one. Similar findings were found in the study conducted on meta-analysis of 12 RCTs has been done by Gong et al. (2016) to estimate its overall effect on T2DM subjects. Deficiency of insulin or resistivity to insulin may leads to T2DM. It is evident that weight reduction helps to decrease insulin resistivity which will help in lowering of RBG level. It is found that hyperglycaemia is due to insulin resistivity so glucose level can be controlled by addressing this problem of insulin resistivity (Jackness et al., 2013; Klein et al., 2019).

3.6 Effect on HbA1c level

HbA1c level is the average result of glucose level in the past three months. It gives the overall value and is an effective tool to check the glucose status. Data was taken from both the study groups to evaluate the health status and their values were compared to see the effective results. Mean value of treated and control group is shown in Figure 3, which reveals that treated group have mean value of HbA1c is 10.13 and the control group have mean value of HbA1c is 10.15. While it is noteworthy that the level of HbA1c decreases more after two months of trial than the first month. After two months of trial along with dietary guidelines treated group showed mean value 8.96 while control group showed 9.44.

As the results of this research which indicates the highest decrease in HbA1c levels of the group of participants which was having fenugreek seeds treatment. A study was conducted by Al-Rowais (2002), to check the effect fenugreek seeds which is used to increase insulin production by keeping the cells and immune function healthy. Fear of future hypoglycaemic events may be triggered due to hypoglycaemic experiences. This condition can be further worsened in case of changes induced by medications. It is reported that hypoglycaemia may lead to

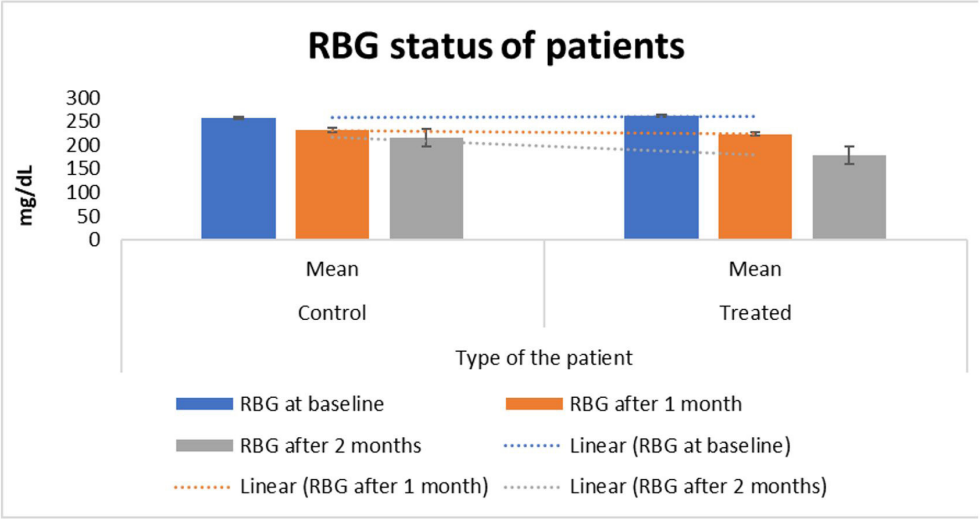

Figure 2. RBG status of patients.

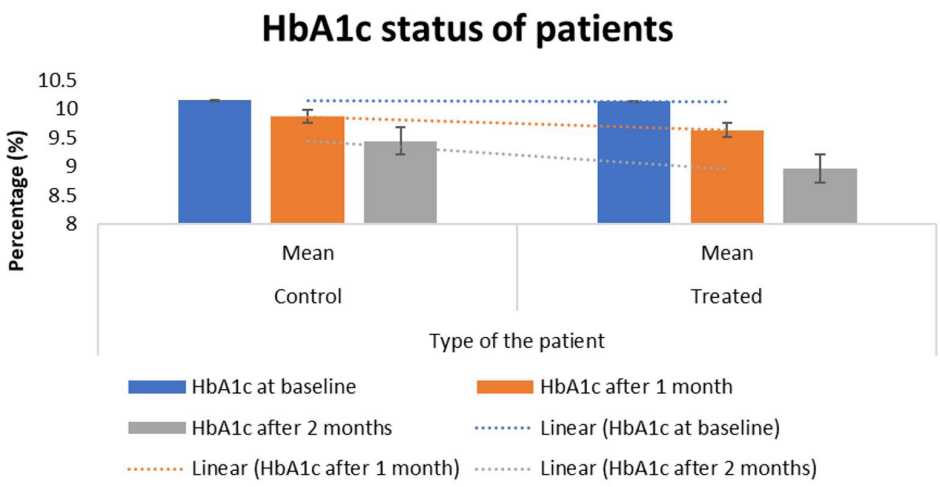

Figure 3. HbA1c status of patients.

lower incidence target HBA1c levels in patients who had not experiences any kind of hypoglycaemia in past. Moreover, risk of glycemia and target HbA1c have been reported to exhibit interlinked status. Reduction of 46% likelihood of target HbA1c results in increased risk of hypoglycaemia up to 17%. This might be explained by the fact that patients having attainments of target HbA1c found to be more prone to risk of hypoalgesia. However, insulin titration in intensive manner may also cause greater risk of hypoglycaemia in patients. Further research is needed to elucidate the mechanism of relationship of HbA1c with hypoglycaemia (Li et al., 2014).

4 Conclusion

Most common problem that is affecting billions of people worldwide is diabetes mellitus. It usually hits adults' people and is mainly type 2 diabetes. Type 2 diabetes mellitus caused by the accumulation of glucose in the body that cannot be metabolized. T2DM diagnosed on urine and blood tests. There is a need of more production of insulin in the body and also its action to metabolize glucose. Other than this there is a need for attaining a healthy lifestyle, a balanced diet with all essential nutrients are required to fulfill the body needs of a person. The most effective intervention to manage type 2 diabetes is to decrease the intake of sugary foods and also get physical activity to get a healthy weight as obesity is also a leading cause in the prevalence of T2DM. Herbal remedies are being used from ancient times to treat T2DM. One of the best herbal products is fenugreek seeds which are rich in fiber and other components that not only helps to lower the blood glucose level but also aid in different ailments.

In this study, fenugreek seeds were grinded and then filled in sachet form of 10 g each. These sachets were then given to T2DM patients which were divided into two groups T_1 (control group), T_2 (treated group). Their demographic profile and fasting blood glucose level, random blood glucose level and HbA1c level were measured at baseline, after one month and then at the end of study trial. When these sachet form of fenugreek seeds were given to the treated group of T2DM patients along with dietary guidelines they showed a gradual decrease in their FBG, RBG and HbA1c level. The result of this research showed that treated group gives significant results as compared to T_1 (control group). Since fenugreek seeds have hypoglycemic effect because of their nutritional value such as fiber, saponins and 4 HIL. It can be used to treat high cholesterol level as it contains saponins which have hypercholesteremic effect. There are other health benefits of fenugreek seeds including weight management as it contains fiber which is helpful in weight loss.

References

Al-Rowais, N. A. (2002). Herbal medicine in the treatment of diabetes mellitus. *Saudi Medical Journal*, 23(11), 1327-1331. PMid:12506289.

Anderwald, C., Gastaldelli, A., Tura, A., Krebs, M., Promintzer-Schifferl, M., Kautzky-Willer, A., Stadler, M., DeFronzo, R. A., Pacini, G., & Bischof, M. G. (2011). Mechanism and effects of glucose absorption during an oral glucose tolerance test among females and males. *The Journal of Clinical Endocrinology and Metabolism*, 96(2), 515-524. http://dx.doi.org/10.1210/jc.2010-1398. PMid:21147888.

Cook, Z., Kirk, S., Lawrenson, S., & Sandford, S. (2005). Use of BMI in the assessment of undernutrition in older subjects: reflecting on practice. *The Proceedings of the Nutrition Society*, 64(3), 313-317. http://dx.doi.org/10.1079/PNS2005437. PMid:16048662.

Gharib, M. A. (2016). Glycemic reaction of glimepiride combined with popular Egyptian antidiabetic drinks of fenugreek and coffee in diabetic rats. *Pakistan Journal of Nutrition*, 15(2), 194-202. http://dx.doi.org/10.3923/pjn.2016.194.202.

Gong, J., Fang, K., Dong, H., Wang, D., Hu, M., & Lu, F. (2016). Effect of fenugreek on hyperglycaemia and hyperlipidemia in diabetes and prediabetes: a meta-analysis. *Journal of Ethnopharmacology*, 194, 260-268. http://dx.doi.org/10.1016/j.jep.2016.08.003. PMid:27496582.

Hasan, M., & Rahman, M. (2016). Effect of fenugreek on type 2 diabetic patients. *International Journal of Scientific and Research Publications*, 6(1), 2250-3153.

Inzucchi, S. E., Bergenstal, R. M., Buse, J. B., Diamant, M., Ferrannini, E., Nauck, M., Peters, A. L., Tsapas, A., Wender, R., & Matthews, D. R. (2012). Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 25(3), 154-171.

Jackness, C., Karmally, W., Febres, G., Conwell, I. M., Ahmed, L., Bessler, M., McMahon, D. J., & Korner, J. (2013). Very low-calorie diet mimics the early beneficial effect of Roux-en-Y gastric bypass on insulin sensitivity and β-cell function in type 2 diabetic patients. *Diabetes*, 62(9), 3027-3032. http://dx.doi.org/10.2337/db12-1762. PMid:23610060.

Janghorbani, M., & Amini, M. (2008). Effects of gender and height on the oral glucose tolerance test: the Isfahan diabetes prevention study. *The Review of Diabetic Studies; RDS*, 5(3), 163-170. http://dx.doi.org/10.1900/RDS.2008.5.163. PMid:19099088.

Klein, P., Tyrlikova, I., Pirolli, N., Barber, A., Tyrlik, M., & Goldman, L. (2019). Pilot study of "classic" 3:1 ketogenic diet complete meal replacement treatment of obesity-related type 2 diabetes. *Journal of Obesity and Chronic Diseases*, 3(01), 19-27. http://dx.doi.org/10.17756/jocd.2019-024.

Li, L., Shen, J., Bala, M. M., Busse, J. W., Ebrahim, S., Vandvik, P. O., Rios, L. P., Malaga, G., Wong, E., Sohani, Z., Guyatt, G. H., & Sun, X. (2014). Incretin treatment and risk of pancreatitis in patients with type 2 diabetes mellitus: systematic review and meta-analysis of randomised and non-randomised studies. *BMJ*, 348(2), g2366. http://dx.doi.org/10.1136/bmj.g2366. PMid:24736555.

Li, W., Katzmarzyk, P. T., Horswell, R., Zhang, Y., Wang, Y., Johnson, J., & Hu, G. J. (2015). Body mass index and heart failure among patients with type 2 diabetes mellitus. *Circulation: Heart Failure*, 8(3), 455-463. http://dx.doi.org/10.1161/CIRCHEARTFAILURE.114.001837. PMid:25681435.

Nanditha, A., Ma, R. C. W., Ramachandran, A., Snehalatha, C., Chan, J. C. N., Chia, K. S., Shaw, J. E., & Zimmet, P. Z. (2016). Diabetes in Asia and the Pacific: implications for the global epidemic. *Diabetes Care*, 39(3), 472-485. http://dx.doi.org/10.2337/dc15-1536. PMid:26908931.

Nayak, S., & Bhaktha, G. (2005). Relationship between sialic acid and metabolic variables in Indian type 2 diabetic patients. *Lipids in Health and Disease*, 4(1), 15. http://dx.doi.org/10.1186/1476-511X-4-15. PMid:16092968.

Naz, R., Anjum, F. M., Butt, M. S., & Mahr-Un-Nisa, (2016). Dietary supplementation of bitter gourd reduces the risk of hypercholesterolemia in cholesterol fed sprague dawley rats. *Pakistan Journal of Pharmaceutical Sciences*, 29(5), 1565-1570. PMid:27731813.

Roberts, K. T. (2011). The potential of fenugreek (*Trigonella foenum-graecum*) as a functional food and nutraceutical and its effects on glycemia and lipidemia. *Journal of Medicinal Food*, 14(12), 1485-1489. http://dx.doi.org/10.1089/jmf.2011.0002. PMid:21861724.

Srinivasan, K. (2019). Fenugreek (*Trigonella foenum-graecum* L.) seeds used as functional food supplements to derive diverse health benefits. In S. M. Nabavi & A. S. Silva (Eds.), *Nonvitamin and nonmineral nutritional supplements* (Chap. 4, pp. 217-221). Massachusetts: Elsevier.

Steel, R., Torrie, J., & Dickey, D. J. I. (1997). *Principals and procedures of statistics: a biometrical approach* (3rd ed.). New York: McGraw Hill.

Verma, N., Usman, K., Patel, N., Jain, A., Dhakre, S., Swaroop, A., Bagchi, M., Kumar, P., Preuss, H. G., & Bagchi, D. (2016). A multicenter clinical study to determine the efficacy of a novel fenugreek seed (*Trigonella foenum-graecum*) extract (Fenfuro™) in patients with type 2 diabetes. *Food & Nutrition Research*, 60(1), 32382. http://dx.doi.org/10.3402/fnr.v60.32382. PMid:27733237.

Watson, P. E., Watson, I. D., & Batt, R. D. (1980). Total body water volumes for adult males and females estimated from simple anthropometric measurements. *The American Journal of Clinical Nutrition*, 33(1), 27-39. http://dx.doi.org/10.1093/ajcn/33.1.27. PMid:6986753.