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RESEARCH ARTICLE

EFFECT OF MORINGA AND OLIVE LEAVES POWDER CONSUMPTION ON HYPERGLYCEMIC STATE IN TYPE 2 DIABETES MELLITUS (A PILOT STUDY)

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Abstract

Study showed effects of *Moringa oleifera* (MO) and *Olea europaea* (OE) leaves powder on lowering blood sugar levels in diabetes patients. The aims of this study were to determine the effect of MO and OE leaves powder on blood glucose control in therapy type 2 diabetes mellitus (T2DM).

Diabetic patients (160 with diet-controlled type 2 diabetes and 250 non-diabetic) healthy volunteers were asked to fast for 13 hours on three occasions. Blood glucose was measured before and after eating 100g of white carbohydrates (bread) (at 30, 60, 90, 120, 150 and 180 minutes). On their second and third study visits, they were given 1g and 2g respectively, of *Moringa oleifera* and *Olea europaea* leaves powder for 30 minutes after eating the bread.

Ingestion of *Moringa oleifera* (MO) and *Olea europaea* (OE) leaves powder had no effect on blood glucose in non-diabetic participants, but in diabetic patients, *Moringa oleifera* and *Olea europaea* powder reduced post-prandial glycaemia in diabetic patients. A larger study is needed to define the optimal dose and to assess whether this translates into longer-term benefits.

Keywords: Moringa oleifera, Olea europaea, Type 2 diabetes, Clinical trial.

Introduction

Diabetes mellitus (DM) is the most common metabolic disorder affecting the people worldwide. Even though diabetes has been known since antiquity, only in the last few decades new discoveries have provided great hopes to minimize morbidity and mortality. It is estimated that for one diagnosed diabetes there is undetected diabetes. The diabetic ketoacidosis was major fatal complication of diabetes has virtually come down with advent of insulin [1].

The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction and disturbance in failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels [1].

Diabetes mellitus is a chronic, progressive and imperfect understood metabolic state that characterized by hyperglycemia (high blood sugar) which represents a major public health concern worldwide [2]. Mainly two types of diabetes mellitus are known; type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). Disturbances in insulin secretion, sensitivity to tissue actions of insulin, or both of them are supposed to be the commonest reasons leading to T2DM pathophysiology, diseases mainly arising from tissue insulin resistance which progress the complete loss of secretory activity of the pancreatic β-cells [2]**.** Hyperglycemia in T2DM can produce long-term complications such as cardiovascular and renal disorders, retinopathy and poor blood flow [3]

Moringa oleifera (MO) and *Olea europaea* (OE) leaves powder have been used as a folk remedy for combating diseases due to they are rich in polyphenolic compounds as their contents may reach up to 40 g per kg of dry tissue [4]. Several studies reported that, polyphenols from Olive and Moringa leaves represent natural anti-inflammatory agents and exhibit a wide range of interesting bioactivities such as antioxidant, antimicrobial, antiatherogenic, antitumoral, cytoprotective and cardioprotective properties [5]. Many herbal medicines are used for the treatment of diabetes, and the most widely-used modern antidiabetic medicine (metformin) is derived from guanidine and galegine, active compounds of the Western herbal remedy Galega officinalis [5]. Olive and Moringa leaves (Figure 1) are widely used in the tropics as a herbal remedy for diabetes [5-7].

Morgina (*Moringa oleifera*) and Olive (*Olea europaea*) are native to the western sub Himalayan regions of India, Pakistan, Bangladesh and Afghanistan, as well as Palestine, Lebanon, Syria and Tunisia but has been cultivated for food and medicine in tropical Asia, sub-Saharan Africa, Latin America and the Caribbean [8]. The consumption of the leaves, pods and flowers as food is very common. In West Africa, the leaves and sometimes the flowers, are eaten in a peanut sauce, whereas the immature pods are not frequently consumed but rather pressed for oil and used as medicine [8].

We aimed to conduct a pilot study of the effect of Morgina (Moringa oleifera), Olive (Olea europaea) leaves powder on postprandial blood glucose in diabetic patients. Also, we aimed in this study to use medical nutrition is to optimize metabolic control and decrease the risk factors for diabetic complications. This study was serial number of approving by the University of Science and Technology branch in Aden city, Yemen.

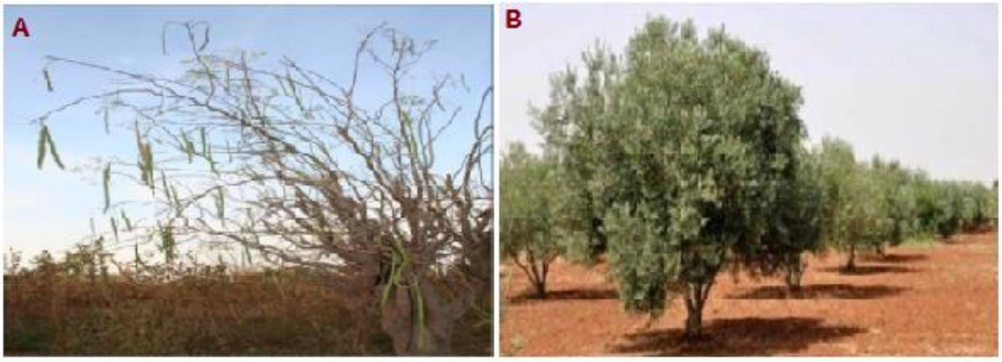

Fig (1): Moringa tree (A) and Olive tree (B)

Materials and Methods

Preparation of plant material

Olive and Moringa leaves were purchased from the local market in Sana'a city and send them to University of Science and Technology branch, Aden, Yemen in sealed polyethylene bags. The plants were identified by the Head Botanist of the Department of Plant, Faculty of Agriculture, Sana'a University, and a voucher specimen has been deposited in its herbarium (Number 139 and 140 MOE). The leaves were washed with tap water, dried in the shade, then pounded and sifted to give a fine powder. The powder was stored in hermetically sealed glass jars and kept in a dry area for used later.

Fig (2): Preparation of Moringa Powder (A) and Olive powder (B)

Participants

We recruited 410 participants (160 with diet-controlled type 2 diabetes, and 250 non-diabetic) from local communities in Aden city, Yemen. Diabetic patients were not excluded if they had pressure, cholesterol, heart, asthma diseases; if their fasting blood glucose was <7.0 mmol/l, if their post-prandial glucose was <11.0 mmol/l, or if they had any allergy to Moringa and Oliva leaves powder. Non-diabetic participants were recruited from among the relatives of the diabetic patients category that agreed to participate and from the staff of local schools.

The study Design

The study was carried out at community-dwelling adults in Aden city-Yemen. The samples were collected in February 2020 and we began to take the tests and apply the herbs and medicine (insulin) from 1 March to 31 March 2020.

Medical Nutrition Planning

There is no one meal that works for all [1]. It is tailored to personal needs and preferences. Daily requirement of macronutrients in adults (Carbohydrates, Protein and Fat) were estimated according to [1].

Study procedures.

Participants came on three occasions, at least 15 days apart. On all occasions, they were asked to fast for 13 hours [1] before the test. Participants were weighed, and body mass index was calculated. Fasting blood glucose was measured with a hand-held glucometer (Infopia Element, USA), on the first occasion, the patient ate 100 g of white bread, with water to check blood sugar level and blood glucose was measured again 30, 60, 90, 120, 150 and 180 minutes after eating the bread. On the second occasion, participants were given 1g of Moringa and Olive leaves powder with 75 ml water, 30 minutes after eating the bread (after the first post-prandial measurement of blood glucose). On the third occasion, they took 2 g of Moringa leaf powder with 75 ml water in addition we used herbs and medicine (insulin) together and herbs alone and medication alone. Patients were asked about any symptoms.

Biochemical analysis

Blood samples were collected from orbital sinus under anesthesia [9] as follows: about 3 ml in EDTA-coated tubes and about 2 ml in plain tubes, centrifuged at 3000 rpm for 10 min at 4 ^{o} C to get plasma and serum respectively.

Determination of glucose level

The estimation of glucose level was carried out as illustrated by Trinder [9].

Statistical analysis

Data was recorded on paper forms, and then entered into a database using Epi-info version 3.5.4 (CDC, Atlanta, USA). After completing data entry, data were exported and analyzed using SPSS 20 (IBM). A paired t-test was used to compare mean post-prandial blood glucose at different times, with and without different doses of Moringa and Olive leaves powder at the significant level P-Value 0.05. The results were analyzed separately for the patients with diabetes, and the healthy controls.

Results

Table (1): Comparison of the relationship between pre- and post-blood sugar levels with BMI.

Correlations				
		BMI	Sugar percentage after experiment	Sugar percentage before experiment
BMI	Pearson Correlation	1	0.072	0.053
	Sig. (2-tailed)		0.655	0.741
	N	410	410	410

The data in Table 1 was found through the experience that was during "one month" that there is no correlation between sugar and BMI before and after the experiment, as the value of the correlation coefficient was (0.072) between BMI and the main of sugar after experiment, and also the value of the correlation coefficient between sugar before experiment and BMI (0.053) which is very weak coefficients.

Table (2): Table showing Chi^2 value to test the relationship between blood sugar levels and comorbidities.

Diseases * sugar level				
			Low	High
Diseases	There is no	N	60	160
		%	27.3%	72.7%
	There is disease (pressure, cholesterol, heart, asthma)	N	40	150
		%	21.1%	78.9%
	Pearson Chi-Square		= 0.214	P-value =0.644

In Table 2 we notice through the table that there was no significant correlation at the level of significance 0.05 between the level of sugar and comorbidities, since the value of Chi^2 is as it is in the table 0.214 and it is less than its tabular value at the level of significance 0,05 and the degree of freedom (1) and The P-value of 0.644 is greater than the significance level of (0.05) .

Table (3): Results of the T-test for paired samples for the differences between the blood sugar levels before and after the experiment.

			Mean	N	Std. Deviation
Herbs	Pair 1	Sugar mean after experiment	131.2500	40	40.90130
		Sugar mean before experiment	183.2500	40	34.18942
Medicine (Insulin)	Pair 1	Sugar mean after experiment	238.0000	250	73.57706
		Sugar mean before experiment	281.9200	250	89.44687
Herbs and medicine	Pair 1	Sugar mean after experiment	136.4167	120	45.56206
		Sugar mean before adjustment	217.5000	120	69.95128
		Herbs	T = -3.562		P-Value = 0.038
		Medicine	T = -4.105		P-Value = 0.000
		Herbs and medicine	T = -6.813		P-Value = 0.000

The data in Table 3 showed there are differences between sugar levels before the experiment and after the experiment, as if the effect of experimenting with herbs and medicine together was more than trying herbs alone and medication alone, and the effect of the drug was more than the effect of herbs on Low blood sugar is very small, as shown in the table. Through the table, we note that there were differences between the glucose level before the start of the experiment and after the experiment at a significance level of (0.05).

Table (4): Table showing the Chi^2 value to test the relationship between blood sugar levels and Physical activity:

			Physical activity		
			High	Average	Low
Blood sugar level	Low	N	10	10	80
		%	10.0%	10.0%	80.0%
	High	N	30	80	200
		%	9.7%	25.8%	64.5%
		Person Chi-Square	1.127	P-value	= 0.569

The data in Table 4 showed no significant correlation at a significance level of 0.05 in the study group between blood sugar level and physical activity, as the Chi² value is as it is in Table 1.127 and it is less than its tabular value at the

degree of freedom (2) and the level of significance 0.05, {P-value = 0.569} which is greater than the significance level 0.05.

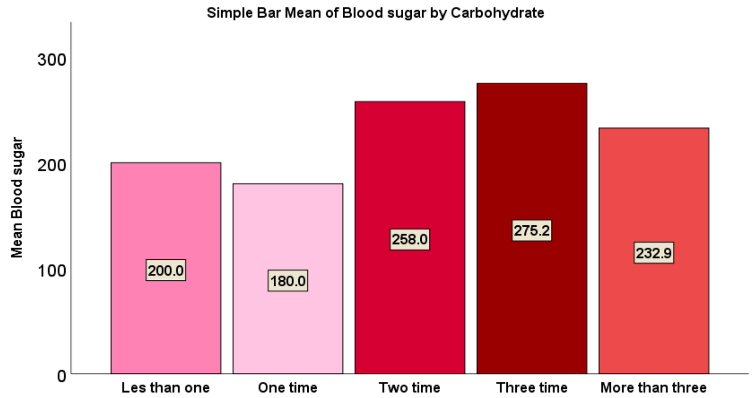

Fig. (3): The relationship between the amount of carbohydrates intake and the blood sugar levels.

The data in Figure 3 shown who consumed bread in large quantities had an average blood sugar level of no less than 232.9, while those who consumed small quantities did not exceed 200 mg/dl.

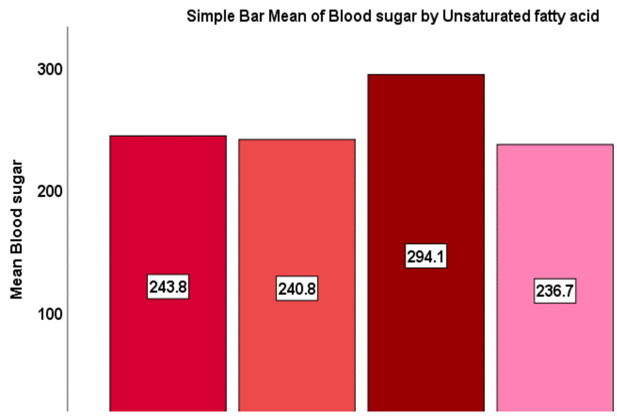

Fig. (4): The relationship between the amount of unsaturated fatty acid intake and the blood sugar levels

The Figure 4 showed slight change in the level of sugar in the blood of people who consumed unsaturated fatty acids, where the level of sugar decreased slightly in people who consumed in large quantities compared to those who consumed small quantities despite the high level Sugar when consumed twice a day.

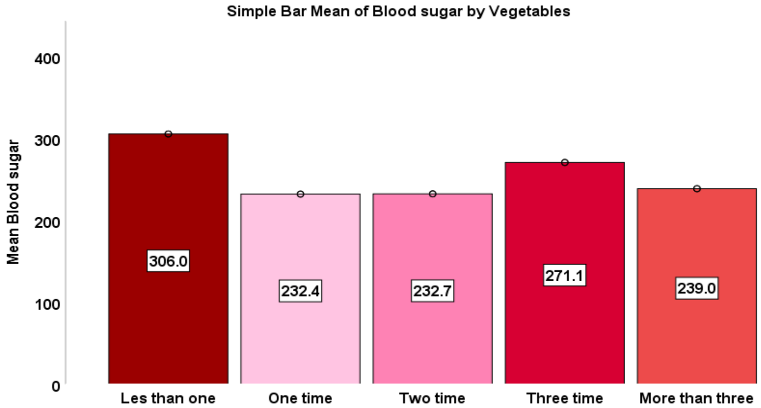

Fig. (5): The relationship between the amount of vegetable intake and the blood sugar levels:

The Figure 6 showed decrease in the level of blood sugar in people who consumed large amounts (239), compared to people who consumed small quantities (306).

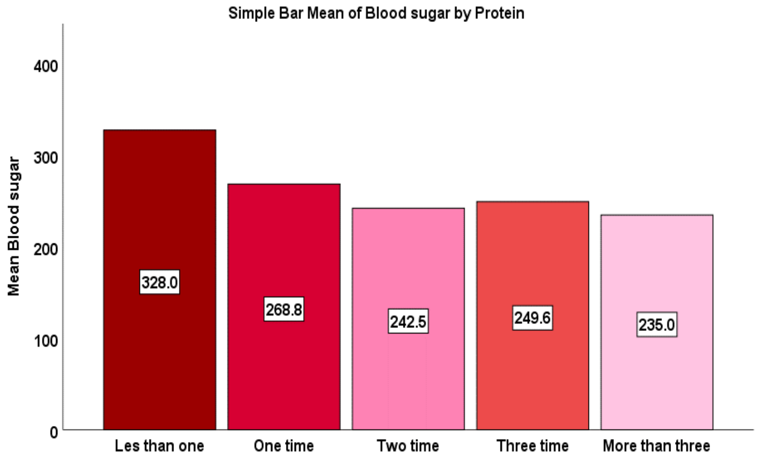

Fig. (6): The relationship between the amount of vegetable intake and the blood sugar levels.

The Figure 6 showed significant decrease in the level of sugar in people who consumed large quantities, with mean (235 g/dl) compared to people who consumed a small amount, with mean (328 g/dl).

Discussion

The data in Table 1 showed that there was no statistical significance between the blood glucose level and the blood BMI before and after the experiment, as half of the participants had a high body mass index and the other half had a normal body mass index. This gives two explanations. Studies have shown that the number one reason is that people with a high BMI are more likely to have diabetes and lipids.

The second explanation is that diabetics are at risk of losing weight due to disease burden and muscle weakness as a result of high blood sugar levels. This has also been demonstrated in a previous study conducted to help improve early assessment and management of risk factors Leading to Diabetes (SHIELD) 2004 screening questionnaire (mailed survey) and the National Health and Nutrition Examination Surveys (NHANES) 1999–2002 (interview, clinical and laboratory data) were conducted in nationally representative samples $\geq$ 18 years old. Responses were received from 127,420 of 200,000 households (64%, representing 211,097 adults) for SHIELD, and 4257 participants for NHANES. Prevalence of diabetes mellitus, hypertension and dyslipidaemia was estimated within BMI categories, as was distribution of BMI levels among individuals with these diseases. Mean BMI was 27.8 kg/m2 for SHIELD and 27.9 kg/m2 for NHANES. Increased BMI was associated with increased prevalence of diabetes mellitus, hypertension and dyslipidaemia in both studies ($p < 0.001$). For each condition, more than 75% of patients had BMI $\geq$ 25 kg/m2. Estimated prevalence of diabetes mellitus and hypertension was similar in both studies, while dyslipidaemia was substantially higher in NHANES than SHIELD. In both studies, prevalence of diabetes mellitus, hypertension and dyslipidaemia occurred across all ranges of BMI, but increased with higher BMI. However, not all overweight or obese patients had these metabolic diseases and not all with these conditions were overweight or obese. Except for dyslipidaemia prevalence, SHIELD was comparable with Nhanes [10].

The data in Table 2 showed that there is no statistical significance between diabetes and comorbidities, in contrast to what was proven by a previous study, which proved that the risks of a poorly managed blood sugar level are comorbidities that are often more dangerous than the actual diabetic disease itself. The cause of the various diabetic comorbidities is always excessively high blood sugar level of the affected persons. This means the breakdown of glucose in the cells is overloaded and oxygen radicals – more specifically: superoxide anion radicals – are released, which then trigger the additional complications. They damage the delicate blood vessels first and later the larger ones, thereby causing nerve damage, vision problems, and kidney failure in the long run. The heart attack and stroke risk increases considerably due to the risk of thrombosis and arteriosclerosis [11]**.** We think that the reason for the lack of statistical significance between diabetes and comorbidities is that half of the study participants had a normal body mass index, meaning that they were not obese.

The data in Table 3 high statistical significance in the group of patients who took the medicine and herbs together, because both herbs (Moringa and olive leaves) and anti-sugar medicines had been proven effective in reducing blood sugar levels, and this was consistent with the results of a previous study that *Moringa oleifera* (MO) caused a decrease significant in elevated blood sugar levels in alloxan diabetic mice. A previous report suggested that insulin deficiency occurs in mice with diabetes induced by alloxan which leads to changes in carbohydrate metabolism such as elevated blood sugar and decreased insulin level. In the study, it was observed that Moringa reversed these effects and tends to bring the parameters significantly towards the normal and comparable to the observation found with hypoglycemic drug (Metformin) in diabetic rats. Alloxan causes massive reduction in insulin release, through the destruction of ß-cells of the islets of Langerhans. The chemical constituents of the various plants containing carbohydrates, phenolics, flavonoids, alkaloids, saponins and glycosides gives recovery of islet which gives increasing the pancreatic secretion of insulin from islet of Langerhans [12, 13]**.**

The possible mechanism by which Moringa Oleifera pod brings about its hypoglycaemic action may be by potentiating the insulin effect by increasing either the pancreatic secretion of insulin from cells of islets of Langerhans or its release from the bound form. The study had registered a decrease in body weight in alloxan diabetic rats. When MOP was administered to animals treated with alloxan, the weight loss was reversed. The ability of Moringa oleifera Pod to protect body weight loss seems to be as a result of its ability to reduce hyperglycaemia [14, 15].

Also, in the past, a study was designed to test the antidiabetic and antioxidative activities of olive leaf oleuropein and hydroxytyrosol. Diabetes in Wistar rats was induced by intraperitoneal injections of alloxan. The serum glucose and cholesterol, hepatic glycogen, the thiobarbituric acid-reactive substances (TBARS), and the components of hepatic and serum antioxidant system were examined [15, 16]**.**

Diabetic rats showed hyperglycemia, hypercholesterolemia, increased lipid peroxidation, and depletion in the antioxidant enzymes activities. The administration, for 4 weeks, of oleuropein and hydroxytyrosol rich extracts, leading to 8 and 16 mg/kg body weight of each compound, significantly decreased the serum glucose and cholesterols levels and restored the antioxidant perturbations. These results suggested that the antidiabetic effect of oleuropein and hydroxytyrosol might be due to their antioxidant activities restraining the oxidative stress which is widely associated with diabetes pathologies and complications [17-20]. Antidiabetic Drugs Currently, 12 unique classes of drugs are available for the treatment of patients with T2DM in most countries of which 9 are oral agents. The glycaemic control in T2DM is achieved with some agents that predominantly lower the fasting plasma glucose level (metformin, sulfonylureas and basal insulins); with others that primarily lower postprandial plasma glucose excursions (meglitinides, α-glucosidase inhibitors, pramlintide, exenatide and prandial insulins); and with still others that do both (thiazolidinediones, dipeptidyl peptidase-4 inhibitors, liraglutide and premixed insulins) [21].

The glucose-lowering benefits of oral antidiabetic drugs (OAD) have been well established. But all the drugs are not absolutely safe in a patient having CV disease [22, 23]. The other two groups also showed slight statistical significance in the drug group more than the herbs, but when we followed the individual samples, the results showed a marked improvement in the herbs group more than the drug, and the reason for this is that the sample was very few compared to the sample of the drug, which was much larger.

The data in Table 4 showed that there is no difference significant in study group between blood glucose level and physical activity. This result showed no positive effect of physical activity to reduce blood glucose level in patients with diabetes.

This study is in disagreement with the previous studies showed as that Physical activity can improve glycemic control considerably and is therefore a central feature of disease management. A regular exercise program improves insulin sensitivity, which reduces insulin requirements. Other study showed that physical activity are critical foci for blood glucose management and overall health in individuals with diabetes and prediabetes. physical activity and exercise in people with type 1 diabetes, type 2 diabetes, gestational diabetes mellitus, and prediabetes [24].

Exercise improves blood glucose control in type 2 diabetes, contributes to weight loss, and improves well-being in type (1,2). Regular exercise may prevent or delay type 2 diabetes development. Regular exercise also has considerable health benefits for people with type 1 diabetes (e.g., improved cardiovascular fitness, muscle strength, insulin sensitivity [24, 25]. I think that the reason for the no statistically significant in study group between blood glucose level and physical activity is dues to this reason:

- some patients may be suffering excessive stress; stress has a remarkable effect on different hormones in the body, so Some patients may resort to eating more food to relieve this stress
- Excessive intake of carbohydrates because they directly affect the level of sugar in the blood
- Exposure to periods of stress and tension, push the body to release stress hormones, which cause high blood sugar, and if stress becomes chronic, hyperglycemia also becomes chronic.
- Excessive exercise may ultimately lead to more harm to the body than the benefits it reaps, because exercise may be very stressful, and it causes the production of greater amounts of the hormone cortisol (the stress hormone) [25], which is the hormone that also causes high blood sugar.

The data in Figure 3 showed a high correlation between carbohydrate intake and increased blood sugar levels, and this was consistent with a previous study that demonstrated that carbohydrate intake was associated with increased total mortality. Also the German website Apotheken-umschau advised to reduce or even stop eating foods that contain carbohydrates in the evening, which may help burn fats in the body better. Whoever consumes carbohydrates raises the level of sugar in the blood so that the body produces the hormone insulin, which in turn stimulates the formation of fats and prevents them from being burned [26].

The data in Figure 4 showed that there is as slight change in study group between blood sugar level and unsaturated fatty acids. This result showed a positive effect of unsaturated fatty acid to reduce blood glucose level in patients with diabetes. This study is consistent with previous studies showed that fat affect insulin sensitivity and hence, the risk of type 2 diabetes is high with intake of unsaturated fats, while a high intake of unsaturated fats reduces the risk whether unsaturated fats from marine or vegetable sources affect glycemic regulation differently in T2D.The study indicates that there is a good effect of fish, fish oils, vegetable oils, or nuts related to glycemic control in people with T2D [27, 28].

The data in Figure 5 showed that there was a slight change in the study group between the blood sugar level and the amount of vegetable servings. This result showed a positive effect of vegetables in lowering the blood sugar level in diabetic patients.

This study is consistent with previous studies that showed that an inverse relationship between vegetable intake and 2-hour glucose concentration in OGTT was found, but the analyses were only adjusted for cohort, age, BMI, and energy intake [29]. Also in a cross-sectional study of a Canadian native population a protective effect of vegetables on impaired glucose tolerance or T2D was reported [30].

The data in Figure 6 showed a high correlation among the study group between the blood sugar level and the amount of proteins. This result showed a positive effect of proteins in lowering the blood sugar level in diabetic patients. This study is consistent with previous study that have shown that it was the ingestion of egg white protein in a meal did not result in an increase in the blood glucose concentration in healthy persons [30]. A study found in which the metabolic effects of a high protein diet were compared with those of the prototypical healthy (control) diet, which is currently recommended by several scientific organizations [31]. The study is designed as follows: The metabolic effects of both regimens were studied in 12 cases with untreated type 2 diabetes. The ratio of protein to carbohydrates to fat was 30:40:30 on the high protein diet and 15:55: 30 on the control diet , the results showed under the curve, the high with the fasting glucose concentration used as the baseline to determine the area protein diet led to a 40% reduction in mean integrated glucose for 24 hours. Area response. Glycated hemoglobin decreased by 0.8% and 0.3% after 5 weeks of a high diet [31, 32].

Conclusions

The results showed that *Moringa oleifera* and *Olea europaea* powder reduced postprandial glycaemia in diabetic patients. The blood sugar levels in the sample of herbs with the drug decreased significantly compared to the samples of the herbs or the drug alone, at a significance level (0.05). In addition to that, the result of the drug was slightly better than the herbs at the level of significance (0.05), and the reason is that the sample of the participants in the herbs was very few.

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مقالة بحثية

تأثير استهلاك مسحوق أوراق المورينجا وأوراق الزيتون على حالة ارتفاع السكر في الدم في داء السكري من النوع 2 (دراسة تجريبية)

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المُلخّص

شيوع استخدام مسحوق مورجينا (*Moringa oleifera*) ومسحوق أوراق الزيتون (*Olea europaea*) لمعالجة مرضى السكري في اليمن. هدفت هذه الدراسة السريرية التجريبية إلى تقييم تأثيرها على نسبة السكر في الدم بعد الأكل.

طُلب من مرضى السكر المتطوعين وغير المصابين بالسكري الأصحاء (25 متطوع) الصوم لمدة 13 ساعة في ثلاث مناسبات، وتم قياس نسبة الجلوكوز في الدم قبل وبعد تناول 100 غرام من الخبز الأبيض (عند 30، 60، 90، 120، 150 و 180 دقيقة).

في زياراتهم الثانية والثالثة، تم إعطاؤهم 1 جرام و 2 جرام على التوالي من مسحوق أوراق نبات المورينجا ومسحوق نبات زيت الزيتون بعد 30 دقيقة من تناول الخبز.

لم يكن لتناول مسحوق أوراق زيت الزيتون ومسحوق أوراق المورينجا أي تأثير على نسبة السكر في الدم لدى غير المصابين بالسكري، ولكن في مرضى السكري أدى تناول مسحوق أوراق زيت الزيتون ومسحوق أوراق المورينجا إلى خفض نسبة الجلوكوز في الدم.

مسحوق أوراق زيت الزيتون ومسحوق أوراق المورينجا قلل من نسبة السكر في الدم بعد الأكل في مرضى السكري، وهناك حاجة إلى دراسة أكبر لتحديد الجرعة المثلى وتقييم ما إذا كان هذا يترجم إلى فوائد طويلة الأجل.

الكلمات المفتاحية: أوراق المورجينا، أوراق زيت الزيتون، داء السكري من النوع 2، تجربة سريرية.

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