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Effect of Bay Leaves (*Laurus nobilis, L*) and Cardamom Seeds (*Elettaria cardamomum, L.*) as Anti-diabetic Agents in Alloxan-Induced Diabetic Rats

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Abstract:
Herbs and spices are natural ingredients that have long been used to flavor and taste food and for their advantages in improving health and medical problems. The effects of various doses of 2.5 and 5% of Bay leaves and Cardamom seeds, as well as their mixture as powder, on glucose levels in diabetic rats, were investigated. Forty-eight rats in all, divided into eight groups of six each, were used in this experiment. Alloxan (150 mg/kg BW) induced diabetic rats. Glucose levels, total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-c), low-density lipoprotein cholesterol (LDL-c), very low-density lipoprotein cholesterol (VLDL-c), as well as liver (ALP, AST, and ALT) and kidney functions (urea, uric acid, and creatinine) were measured using biochemical testing. The findings demonstrated that rats fed on 5% mixed powder had the lowest glucose levels, with significant differences (P≤0.05) being 115.00 mg/dl, as well as lower liver, kidney, TC, TG, LDL, and VLDL levels in diabetic groups, and the and vice versa for HDL levels. While the group fed on 2.5 % Bay leaves powder had the highest value with a significant difference (P≤0.05). In conclusion, Consuming Bay leaves, Cardamom seeds, or both significantly (P≤0.05) improved HDL-c, kidney, liver, and serum glucose levels. Therefore, adding a 5% mixture of Bay leaves and Cardamom seeds to the food preparation process significantly improved all biochemical parameters in diabetic rats.

Keywords*: Spices, Rats, Hyperglycemic, Biochemical analysis*

Introduction

The most common endocrine illness in the world and one that is linked to higher rates of morbidity and mortality is diabetes. Long-term consequences of diabetes mellitus also include retinopathy, nephropathy, neuropathy, angiopathy, and several other conditions (1). A chronic endocrine condition with numerous etiologies, diabetes mellitus is characterized by hyperglycemia brought on by abnormalities in insulin secretion, insulin action, or both (2). (3) states that symptoms including polyuria, polydipsia, and unexplained weight loss typically

indicate the clinical diagnosis of diabetes, which is further supported by proven hyperglycemia. It is a clinical syndrome caused by a partial or absolute lack of insulin or by cellular resistance to insulin's action, which leads to hyperglycemia and glucosuria (4). The first step in preventing this complication is controlling blood sugar levels. Although the treatment for diabetes consists of oral antidiabetics like metformin drug and insulin injection, there was a greater movement to look for novel natural and active antidiabetic drugs, particularly in developing countries, due to the difficulty in producing conventional antidiabetic medications (5).

Microvascular problems of diabetes include damage to the nerve system (neuropathy), the kidneys (nephropathy), and the eyes (retinopathy), whereas macrovascular implications include cardiovascular disease, stroke, and peripheral vascular disease (6). Before the advent of modern medicine, traditional botanicals were utilized for a very long time to treat diabetes. Traditional herbal remedies have historically been found to have effective pharmacological activity, as was the case with metformin (7).

The occurrence of Bay leaf is widespread and accessible, which is expected to help with education and the introduction of bay leaf as an herbal alternative for health. Bay leaf is a plant that is frequently utilized in the community as an alternative medicine. It has several analgesic properties, is a diuretic, and has been used to treat eructation, epigastric bloating, poor digestion, and flatulence (8). In addition to its hypoglycemic effects, Bay leaf can help diabetes patients' blood glucose metabolism by enhancing their capillary function, lipid metabolism, liver and kidney function, and antioxidant status (9). According to (10), the phenolic compounds in Bay leaves have the capacity to inhibit the -glucosidase enzyme, which lowers blood sugar levels. The Bay leaf extract may have an action similar to insulin or may cause pancreatic cells to secrete more insulin (11). Additionally, these extracts may have a hypoglycemic impact because they decrease gluconeogenesis and glycogenolysis, reduce glucose absorption, and increase peripheral glucose utilization (12).

Cardamom is a member of the Zingiberaceae family and comes in two colors: black (*Amomum subulatum Roxburgh*) and green (*Elettaria cardamomum Maton*). It is widely utilized in traditional medicine and food across the world (13). The high fiber content of Cardamom is around 22%, along with moisture 8%, protein 6%, total ash 4%, and oils. Cardamom was found to have an anti-hypercholesteremic effect in rats on a high-fat diet (14). Cardamom enhanced the modulation of insulin, glucose, and lipid profiles in a human study; however, green Cardamon reduced blood pressure, glycemic indices, and serum cholesterol levels in a different investigation (15). According to (16), Cardamom leaf can restore body weight in alloxan-induced diabetic rats and lower blood glucose and total cholesterol levels. (17) indicated the potential use of these plants as a dietary supplement or in the manufacture of drugs for the control of increased blood glucose level in the body.

The purpose of this study was to see how diabetic rats responded to varying amounts of white mulberry and fig leaves, as well as their mixture powder.

Material and Methods

Materials

Bay leaves (*Laurus nobilis*) and Cardamom seeds (*Elettaria cardamomum*) were obtained from Haraz herbalist, Cairo Governorate, Egypt.

Diet ingredients

Morgan Company Cairo, Egypt provided casein, cellulose, choline chloride powder, and DL methionine powder.

Experimental animals

Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt provided a total of 48 adult normal male albino rats "Sprague Dawley" strain weighing 150±10 g.

The chemicals and kits

Morgan Co. Cairo, Egypt provided casein, cellulose, choline chloride powder, and DL methionine powder. Al-Gomhoria Company for Trading Drugs, Chemical and Medical Instruments, Cairo, Egypt, provided the chemical kits (TC, TG, HDL-c, ALT, AST, ALP, urea, uric acid, and creatinine) utilized in this examination.

Methods

Preparations of Bay leaves and Cardamom seeds

The Bay leaves and Cardamom seeds were ground to a fine powder in an air mill, then mixed with a high-speed mixer (Moulinex Egypt, ElAraby Co., Benha, Egypt) and served as powder seize. The material that passed through an 80-mesh sieve was retained for packing in polyethylene pages and storing at 4 °C until use.

Basal diet composition.

The basal diet was formulated according to AIN-93M diet (18) as follow: protein (10%), corn oil (10%), vitamin mixture (1%), mineral mixture (4%), choline chloride (0.2%), methionine (0.3%), cellulose (5%), and the remained is corn starch (69.5%). The vitamins and salts mixture were formulated according to (19) and (20) respectively.

Experimental design

The study was carried out at Animal House, Faculty of Home Economics, Menoufia University, Egypt**.** In this experiment, 48 adult male albino rats, "Sprague Dawley", weighing (150±10g), were used. All groups of rats were fed the (18) for 7 days prepared standard diet. After this adaptation period, rats were divided into 8 groups, six rats per each as follows: Group (1): A group rats fed on basal diet as negative control. Group (2): Rats fed on basal diet and injected by a single dose of freshly prepared solution of alloxan (150mg/kg) and was used as a positive control group according to the procedure described by (21). Group (3): A group diabetic rats fed on basal diet and Bay leaves as powder by 2.5% of the weight of basil diet. Group (4): A group diabetic rats fed on basal diet and Bay leaves as powder by 5% of the weight of basil diet. Group (5): A group diabetic rats fed on basal diet and Cardamom seeds as powder by 2.5% of the weight of basil diet. Group (6): A group diabetic rats fed on basal diet and Cardamom seeds as powder by 5% of the weight of basil diet. Group (7): A group obese rats fed on basal diet and mixture (1:1) as powder of Bay leaves and Cardamom seeds as powder by 2.5% of the weight of basil diet. Group (8): A group obese rats fed basal diet and mixture (1:1) as powder of Bay leaves and Cardamom seeds as powder by 5% of the weight of basil diet. The experiment continued for 28 days, at the end of the experimental period each rat weight separately, then slaughtered and blood samples were collected.

Blood sampling

At the end of each experiment, blood samples were taken from the hepatic portal vein after a 12-hour fast. Blood samples were collected into dry, clean centrifuge glass tubes and allowed to clot for 28 minutes in a water bath (37°C), after which they were centrifuged for 10 minutes at 4000 rpm to separate the serum, which was carefully aspirated and transferred into clean cuvette tubes and stored frozen at -20°C until analysis according to the method described by (22).

Biochemical analysis

Lipid profile

Serum total cholesterol was determined according to the colorimetric method described by (23). Serum triglyceride was determined by enzymatic method using kits according to the (24 and 25). HDL-c was determined according to the method described by (26 and 27). VLDL-c was calculated in mg/dl according to (28) was using the following formula:

VLDL-c (mg/dl) = Triglycerides / 5. LDL-c was calculated in mg/dl according to (28) as follows:

LDL-c (mg/dl) = Total cholesterol – HDL-c – VLDL-c

Liver functions

Determination of serum alanine amino transferase (ALT), serum aspartate amino transferase (AST), serum alkaline phosphatase (ALP) was carried out according to the method of (29, 30 and 31), respectively.

Kidney functions

Determination of serum urea and creatinine

Serum urea, uric acid and creatinine were determined by enzymatic method according to **(32, 33 and 34)**.

Determination of glucose level

Serum glucose was measured using the modified kinetic method according to **(35)** by using kit supplied by spin react. Spain.

Statistical analysis

The data were statically using a computerized COSTAT program by one way ANOVA. The results are presented as mean ± SD. Difference between treatments at (P≤0.05) were considered significant (36).

Results and Discussion

Data presented in table (1) show the effect of Bay leaves and Cardamom seeds and their combinations on glucose levels of diabetic rats. The obtained data revealed that the positive control group had a higher glucose level, whereas the negative control group had a lower level, with a significant difference (P≤0.05). The mean values were 280.00 and 91.00 mg/dl, respectively.

When compared to the control positive group, diabetic rats fed a 5 % mixture had the lowest glucose level with a significant difference (P≤0.05), the average level was 115.00 mg/dl. The highest glucose level in diabetic rats was reported for 2.5 % Bay leaves with a significant difference (P≤0.05) being 161.00 mg/dl. These results are in line with those of (37), which demonstrates that taking 2 g of bay leaves per day for 30 days reduces risk factors for

diabetes and cardiovascular disease and indicates that bay leaves may be beneficial for those with type 2 diabetes.

The regeneration of pancreatic beta cells and potentiation of insulin production from remaining beta cells were brought about by the methanolic extract of Bay leaves. As a result, the blood glucose level lowered (38).

Ahmed et al. indicated that cardamom supplementation by suppression of α-amylase and α-glucosidase enzymes has anti-diabetic effects and may regulate glucose metabolism [15]. (39) stated that supplementing with cardamom has anti-diabetic effects and may control glucose metabolism by inhibiting the enzymes -amylase and -glucosidase.

Table (1): Effect of Bay leaves, Cardamom seeds and their mixture as powder on glucose levels of diabetic rats

Treatment/Parameter	Glucose levels (mg/dl)
Control group (-)	91.00^{g}±0.10
Control group (+)	280.00^{a}±0.15
Diabetic rats with 2.5% Bay leaves powder	161.00^{b}±0.14
diabetic rats with 5% Bay leaves powder	151.50^{c}±0.13
Diabetic rats with 2.5% Cardamom seeds powder	154.00^{c}±0.12
Diabetic rats with 5% Cardamom seeds	135.00^{d}±1.10
Diabetic rats with 2.5% mixture powder	129.25^{e}±0.14
Diabetic rats with 5% mixture powder	115.00^{f}±0.10
LSD (P≤ 0.05)	4.820

Each value is represented as Values are expressed as mean ± SD; means in the same column with different letter are significantly different (P<0.05).

Data tabulated in table (2) show the effect of Bay leaves, Cardamom seeds and their mixtures on serum liver functions (ALT, AST, and ALP) of diabetic rats. It is clear to notice that the (ALT) of positive control group recorded the higher value when compared with negative control group with a significant difference (P≤0.05). The mean values were 75.15 and 37.00 U/L, respectively.

While the group fed 2.5% Bay leaves had the highest serum ALT, the group fed 5% mixture had the lowest, with a significant difference (P≤0.05), which were 71.70 and 59.20 U/L, respectively.

On the other hand, the serum AST of positive control group was significantly (P≤0.05) higher than that of negative control group. The average values were 90.00 and 40.50 U/L, respectively. While the group fed on 2.5% Bay leaves had highest serum AST. While 5% leaves mixture had the lowest with a significant difference (P≤0.05). The mean values were 81.00 and 61.00 U/L, respectively.

In the case of serum ALP, the positive control group had a significantly (P≤0.05) higher value when compared to the negative control group, which were 66.50 and 30.00 U/L, respectively. The group fed 5 % Bay leaves had the highest serum ALP, whereas the 5 % mixture had the lowest, with a significant difference (P≤0.05), which were 52.00 and 38.15 U/L, respectively. These results are in agree with (40) who mentioned that Cardamom extract

may lower high liver enzyme levels. Additionally, they might stop liver weight gain and enlargement, which lowers the risk of fatty liver disease. Rats treated with an oral dose of cardamom's aqueous extract has a remarkable hepatoprotective effect.

(41) demonstrated that diabetes mellitus (DM) damages blood vessels and the liver, the medical community often overlooks DM as the primary cause of chronic liver disease. This is because there are so many different clinical, metabolic, and hormonal problems. Due to the hepatoprotective effects of the bay leaf extract, ALT, AST, and ALP enzyme levels were lowered in response to bay leaf extract. This is most likely caused by the presence and combined action of the extract's phytocomponents, such as terpenes and terpenoids with antioxidative and antibacterial properties and terpenes and terpenoids of nonflavonoid origin.

Table (2): Effect of Bay leaves, Cardamom seeds and their mixture as powder on liver functions of diabetic rats

Treatment/Parameter	ALT (U/L)	AST (U/L)	ALP (U/L)
Control group (-)	37.00^{f}±0.03	40.50^{g}±0.20	30.00^{f}±0.20
Control group (+)	75.15^{a}±1.16	90.00^{a}±0.51	66.50^{a}±0.50
Diabetic rats with 2.5% Bay leaves powder	71.70^{b}±0.55	81.00^{b}±0.52	52.00^{b}±0.38
diabetic rats with 5% Bay leaves powder	67.55^{c}±0.35	78.60^{c}±0.37	46.60^{c} ±0.44
Diabetic rats with 2.5% Cardamom seeds powder	68.15^{c}±0.41	79.50^{c}±0.29	50.00^{b}±0.35
Diabetic rats with 5% Cardamom seeds	66.16^{c}±0.33	75.40^{d}±0.79	42.00^{d}±0.40
Diabetic rats with 2.5% mixture powder	64.30^{d}±0.28	70.45^{e}±0.50	41.35^{d}±0.20
Diabetic rats with 5% mixture powder	59.20^{e}±0.15	61.00^{f}±0.30	38.15^{e}±0.15
LSD (P≤ 0.05)	2.835	2.361	3.190

Each value is represented as Values are expressed as mean ± SD; means in the same column with different letter are significantly different (P<0.05).

The effect of Bay leaves, Cardamom seeds and their mixtures on serum total cholesterol and triglycerides in diabetic rats is shown in Table (3). The results showed that the total cholesterol levels of the positive control group were greater than those of the negative control group, with a significant difference (P≤0.05), which were 145.60 and 76.00 mg/dl, respectively. While the group fed the 2.5 % Bay leaves had the highest total cholesterol levels, while the 5 % mixture recorded the lowest level, with significant differences (P≤0.05), which were 79.50 and 110.50 mg/dl, respectively.

As for triglycerides, the positive control group recorded the higher value when compared with negative control group with a significant difference (P≤0.05). The mean values were 118.80 and 64.50 mg/dl, respectively. While the lowest triglycerides recorded for group fed 5% mixture, while the highest value recorded for 2.5% Bay leaves with a significant difference (P≤0.05). The mean values were 71.10 and 96.30 mg/dl, respectively. These results are in agree with (42) who found that a significant (p≤0.05) decreased in HDL-c whereas TC, TG and LDL-c were significantly elevated (p≤0.05) in alloxan group compared with the control group. The administration of two doses 250 and 500 mg / kg. BW. of Bay leaves extract after one

hour of injection of Alloxan lead to decrease in TC, TG and LDL-c and increased in HDL- c compared to control group.

Table (3): Effect of Bay leaves, Cardamom seeds and their mixture as powder on serum total cholesterol and triglycerides of diabetic rats

Treatment/Parameter	Total cholesterol (mg /dl)	Triglycerides (mg /dl)
Control group (-)	76.00^{e}±0.06	64.50^{f}±0.10
Control group (+)	145.60^{a}±0.12	118.80^{a}±0.70
Diabetic rats with 2.5% Bay leaves powder	110.50^{b}±0.40	96.30^{b}±0.13
diabetic rats with 5% Bay leaves powder	95.00^{c}±0.60	88.25^{c}±1.60
Diabetic rats with 2.5% Cardamom seeds powder	106.70^{b}±0.32	93.00^{b}±0.50
Diabetic rats with 5% Cardamom seeds	97.00^{c}±0.43	91.40^{c}±0.45
Diabetic rats with 2.5% mixture powder	84.50^{d}±0.30	78.60^{d}±0.40
Diabetic rats with 5% mixture powder	79.50^{e}±0.15	71.10^{e}±0.20
LSD (P≤ 0.05)	4.560	3.921

Each value is represented as Values are expressed as mean ± SD; means in the same column with different letter are significantly different (P<0.05).

Data presented in Table (4) show the effect of Bay leaves, Cardamom seeds and their mixtures on serum lipid profiles of diabetic rats. The results revealed that the HDL-c of negative control rats group recorded the higher value when compared with positive control group with significant difference (P≤0.05). The mean values were 52.00 and 28.00 mg/dl, respectively. While the highest HDL-c of treated group recorded for group fed on 5% mixture but, the lowest value recorded for group fed on 2.5 % Bay leaves with a significant difference (P≤0.05). The mean values were 46.00 and 36.25 mg/dl, respectively.

On the other hand, the LDL-c of positive control rats group recorded the higher value when compared with negative control group with a significant difference (P≤0.05). The mean values were 94.83 and 11.10 mg/dl, respectively. While the highest LDL-c of treated group recorded for group fed on 2.5% Bay leaves but, the lowest value recorded for group fed on 5% mixture with a significant difference (P≤0.05). The mean values were 54.99 and 19.28 mg/dl, respectively.

Table (4): Effect of Bay leaves, Cardamom seeds and their mixture as powder on lipid profile of diabetic rats

Treatment/Parameter	(HDL_{-C}) (g/dl)	LDL_{-C}) (g/dl)	($VLDL_{-C}$) (g/dl)
Control group (-)	52.00^{a}±0.36	11.10^{g}±0.04	12.90^{d}±0.42
Control group (+)	28.00^{e}±0.30	93.84^{a}±1.04	23.76^{a}±0.73
Diabetic rats with 2.5% Bay leaves powder	36.25^{d}±0.17	54.99^{b}±1.05	19.26^{b}±0.82
diabetic rats with 5% Bay leaves powder	39.60^{c}±0.46	37.75^{c}±0.93	17.65^{b}±0.36
Diabetic rats with 2.5% Cardamom seeds powder	38.50^{cd}±0.51	49.60^{d}±0.18	18.60^{b}±0.7
Diabetic rats with 5% Cardamom seeds	42.35^{c}±0.24	36.40^{c}±0.45	18.25^{b}±0.92
Diabetic rats with 2.5% mixture powder	44.50^{b}±0.30	24.28^{e}±0.6	15.72^{c}±0.19
Diabetic rats with 5% mixture powder	46.00^{b}±0.25	19.28^{f}±0.49	14.22^{c}±0.94
LSD (P≤ 0.05)	2.880	2.253	1.895

Each value is represented as Values are expressed as mean ± SD; means in the same column with different letter are significantly different (P<0.05).

HDL-c = High density lipoprotein cholesterol, LDL-c = Low density lipoprotein cholesterol, VLDL -c = Very low-density lipoprotein cholesterol.

In case of VLDL-c, the positive control rats group recorded the higher value when compared with negative control group with a significant difference (P≤0.05). The mean values were 23.76 and 12.90 mg/dl, respectively. While the highest VLDL-c of treated group recorded for group fed on 2.5% Bay leaves but, the lowest value recorded for group fed on 5% mixture with significant difference (P≤0.05). The mean values were 19.26 and 14.22 mg/dl, respectively. These findings are in accordance with those of (38) who found that treatment with Bay leaves decreased plasma cholesterol, TG, and LDL levels while increasing HDL levels. The hormone-sensitive lipase in adipose tissue will be blocked in the presence of insulin, and glucagon's ability to mobilize fatty acids from adipose tissue will likewise be impeded, resulting in the observed drop in plasma levels of free fatty acids.

Green cardamom supplementation may have a protective effect on HDL-C levels in pre-diabetic patients, according to findings of (43).

Data given in table (5) show the effect of Bay leaves, Cardamom seeds and their mixtures on kidney functions of diabetic rats. The obtained results indicated that the urea level of positive control rats group recorded the higher value when compared with negative control group with a significant difference (P≤0.05). The mean values were 35.50 and 11.47 mg/dl, respectively. While the highest urea level of treated group recorded for group fed on 2.5% Bay leaves but, the lowest value recorded for group fed on 5% mixture with a significant difference (P≤0.05). The mean values were 30.10 and 15.70 mg/dl, respectively.

On the other hand, the uric acid level of positive control rats group recorded the higher value when compared with negative control group with significant difference (P≤0.05). The mean values were 9.35 and 3.10 mg/dl, respectively. While the highest uric acid level of treated group recorded for group fed on 2.5% Bay leaves but, the lowest value recorded for group fed on 5% mixture with significant difference (P≤0.05). The mean values were 6.30 and 3.30 mg/dl, respectively.

Table (5): Effect of Bay leaves, Cardamom seeds and their mixture as powder on kidney functions of diabetic rats

Treatment/Parameter	Urea (mg/dl)	Uric acid (mg/dl)	Creatinine (mg/dl)
Control group (-)	11.47g±0.25	3.10d±0.70	0.57b±0.10
Control group (+)	35.50a±0.70	9.35a±0.20	1.25a±0.42
Diabetic rats with 2.5% Bay leaves powder	30.10b±0.50	6.30b±0.50	1.07a±0.30
diabetic rats with 5% Bay leaves powder	26.25c±0.42	5.25c±0.25	0.89b±0.25
Diabetic rats with 2.5% Cardamom seeds powder	27.30c±0.31	6.00b±0.38	0.95a±0.40
Diabetic rats with 5% Cardamom seeds	21.40d±0.15	4.60c±0.45	0.98a±0.11
Diabetic rats with 2.5% mixture powder	19.45e±0.43	4.45c±0.40	0.76b±0.24
Diabetic rats with 5% mixture powder	15.70f±0.25	3.30d±0.60	0.61b±0.15
LSD (P≤ 0.05)	1.402	1.170	0.355

Each value is represented as Values are expressed as mean ± SD; means in the same column with different letter are significantly different (P<0.05).

When it came to creatinine, the positive control rats had a greater value than the negative control rats, although there was significant difference (P≤0.05). The average values were 1.25 and 0.57 mg/dl. While the greatest creatinine level of the treated group was found in the group fed on 2.5% Bay leaves, the lowest value was found in the group fed on 5% mixture, with significant differences (P≤0.05), the mean values were 1.07 and 0.61 mg/dl, respectively. These results are in line with those of (44), who suggest that one of the hallmarks of diabetes is impaired kidney function. As a result, higher levels of urea, uric acid, and creatinine were found in diabetic rats, possibly because of renal failure.

These outcomes were consistent with (45) who discovered that giving alloxan to animals caused an increase in urea and creatinine levels. The Bay leaves reduced the elevations in these markers, indicating that the Bay leaves diet may be an essential component of a diet that is used to improve renal function that has been compromised.

Conclusion

Consumption of Bay leaves, Cardamom seeds, or their combination improves HDL-c, kidney, liver functions, and serum glucose levels significantly (P≤0.05). Therefore, all the biochemical parameters of diabetic rats were improved especially by the addition of a 5% mixture of Bay leaves and Cardamom seeds.

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تأثير أوراق الغار وبذور الحبهان كعوامل مضادة لمرض السكر فى الفئران المصابة بالسكر المستحث بالألوكسان

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الملخص العربي:

الأعشـــاب والتوابل هي أمثلة على المكونات الطبيعية التي اســـتخدمت منذ فترة طويلة ليس فقط لزيادة نكهة وطعم الأغذاية ولكن أيضًا لمزاياها في تحسين العديد المشاكل الصحية والطبية. تمت دراسة تأثير التركيزات المختلفة ٢,٥ ، ٥٪ من أوراق الغار وأوراق بذور الحبهان ومزيجها كمسحوق على مستويات الجلوكوز في الفئران المصابة بمرض السكر. تم اســـتخدام ٤٨ فأر في هذه التجربة ، وتم تقســـيمهم إلى ثماني مجموعات من ســـتة فئران لكل منها. تم اســـتخدام الألوكســـان للإصـــابة بمرض الســـكر لدى الفئران. تم إجراء الاختبارات البيوكيميائية لتقييم مســـتويات الجلوكوز والكوليســـترول الكلي (TC) والدهون الثلاثية (TG) والكوليســـترول عالي الكثافة (HDL-c) والكوليســـترول منخفض الكثافة (LDL-c) والكوليســـترول منخفض الكثافة جدًا (VLDL-c)) وكذلك وظائف الكبد (ALP ، AST ، ALT) والكلى (اليوريا وحمض البوليك والكرياتينين). أظهرت النتائج أن الفئران التي تم تغذيتها على مســـحوق الخليط بنســـبة ٥٪ سـجلت أقل مسـتوى من الجلوكوز حيث كانت القيمة ١١٥,٠٠ مجم/ديسـيلتر. ايضـا أقل مسـتوى من وظائف الكبد والكلى ، TC ، TG ، LDL-c ، VLDL-c للمجموعات المصـابة بمرض السـكر والعكس بالعكس مع HDL-c مع وجود فرق معنوى (P≤0.05) . بينما سـجلت أعلى قيمة للمجموعة التي تم تغذيتها على ٢,٥٪ مسـحوق أوراق الحبهان مع وجود فرق معنوي (P≤0.05). في الختام ، فإن استهلاك أوراق الغار ، وبذور الحبهان ، أو مزيجهما يحسن الكوليسترول عالي الكثافة ، وظائف الكلى ، الكبد ، ومسـتويات الجلوكوز في الدم بشـكل معنوى. لذلك ، فإن إضـافة خليط ٥٪ من أوراق الغار وبذور الحبهان إلى عملية تحضـــير الطعام أدى إلى تحســـن كبير في جميع التحاليل الكيميائية الحيوية في الفئران المصابة بمرض السكر.

الكلمات المفتاحية: التوابل، الفئران، ارتفاع سكر الدم،التحاليل الكيميائية الحيوية .