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Author Affiliation:
Department of Nutrition and Food Sciences, Faculty of Home Economics, Menoufia University, Shibin El Kom, Egypt

Corresponding author:
Eman Elnadry
emanelnadry77@gmail.com

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Possible Effects of Green and Brown Lentil on Alloxan-Induced Diabetic Rats

Authors
Hamdia Ahmed Helal, Seham Aziz Khedr, Eman Elnadry

Abstract:
This study aims to investigate the effect of green, brown, and their combination on diabetic rats. Eight groups of six adult male albino rats, each weighing (150±10g), were formed from the 48 rats used in this investigation. For 28 days, green, brown, and their powdered blends were gradually added to the main diet at a rate of 5 and 10 %, respectively. Alloxan (150 mg/kg body weight) was injected subcutaneously into diabetic rats. At the end of the experiments, serum glucose levels, lipid profiles of triglycerides (TG), total cholesterol (TC), low-density lipoprotein (LDL-c), very low-density lipoprotein (VLDL-c), and high-density lipoprotein (HDL-c), the activities of the liver enzymes ALT, AST, and ALP, and the kidney functions of creatinine, uric acid, and urea levels were evaluated. The results indicated that eating green and brown lentil powder or their mixture significantly (P≤0.05) improved the level of glucose in the serum blood of rats, increased HDL-c significantly and improved liver and kidney functions by decreasing ALT, AST, ALP, creatinine, uric acid and urea in the rats compared to the positive group. The best result was a mixture of 10% of green and brown lentils. As conclusion, Consequently, we might use a mixture of green and brown lentil powder in our daily dishes.

Keywords*: Legumes, Diabetic, Rats, Biochemical analysis*

Introduction

A dangerous metabolic condition occurs called diabetes mellitus (DM). Chronic hyperglycemia may result from inadequate insulin synthesis or from peripheral tissues' inability to respond to the presence of insulin (1). It spreads quickly. Diabetics composed 9.3% of the adult population worldwide in 2019 (2). It is the most prevalent endocrine condition in the world and is linked to a higher risk of morbidity and mortality. Among other long-term consequences, it is linked to retinopathy, nephropathy, neuropathy, and angiopathy (3). Impaired protein, carbohydrate, and lipid metabolism that is brought on by inadequate insulin production, insulin resistance, or both is what defines it. One of the most common and potentially fatal metabolic disorders nowadays is diabetes mellitus. It is predicted by numerous estimates that its incidence rate will increase even faster soon. (4).

However, among those who have not yet been identified, they may be the first symptom. It usually appears after several years (10–20). The most detrimental long-term effect is damage to blood vessels. Cardiovascular disease risk is increasing due to diabetes, and over 75% of deaths from diabetes are caused by coronary artery disease. Other "macrovascular" diseases include stroke and peripheral vascular disease (5). A number of pathologic disorders can cause it. These include anomalies that result in insulin resistance as well as autoimmune destruction of the panaceas' b-cells, which results in insulin insufficiency. Future research on diet therapy for the management of diabetes appears encouraging. There have been claims that the widely consumed cereal grains contain anti-diabetic properties. Numerous grains and grain-derived items can lessen insulin and glucose responses. Dietary fiber, polyphenols, vitamin E, magnesium, and other elements found in whole grains may all work in concert to lower the prevalence of type 2 diabetes mellitus (T2DM) (6). Three hundred fifty tow (352) million people were at risk for type 2 diabetes, according to a 2017 estimate by the International Diabetes Federation. By 2030, diabetes would have afflicted 439 million adults, according to health predictions (7). A meta-analysis of research carried out during the COVID-19 pandemic revealed that diabetes increased mortality in COVID-19 patients. Diabetes mortality in 2010 ranged from 6% of all deaths in Africa to 15.7% of all deaths documented in North America (8).

An annual native plant from Western Asia and various regions of the world, including North America, is lentil (*Lens culinaris*; Family: Fabaceae). Additionally, this species has now expanded beyond the Hindukush to Ethiopia, Afghanistan, and Mediterranean nations (9). It is well known for its edible seed, which is shaped like a lens and contains both macro- and micronutrients and has the most significant dietary components. Depending on the cultivar, the makeup of the seed coats, and the cotyledons, lentils can range in color from yellow to orange to red to green to brown to black (10). The cotyledon color, which can be yellow, red, or green, is the primary factor in determining the color of dehulled seeds. The seed coat determines the color of the undamaged seed, which might be tan, brown, green, grey, or even black (11). An abundant source of carbohydrates, lentils also contain a good number of proteins, minerals, vitamins, phytochemicals, and fiber. They are a very nutrient-dense legume. Despite being a staple food since antiquity, its consumption has been constrained in modern nations, particularly because of the reduced protein digestibility, the presence of anti-nutritional elements, flatulence, and poor cooking properties (12). According to (13), eating lentils significantly lowers the risk of developing degenerative illnesses like diabetes, cardiovascular disease (CVD), and cancer. The high nutritional composition, nutritive value, and existence of bioactive secondary metabolites in lentils have increased interest in the study of lentils as a functional food. These bioactive ingredients in lentils are essential for preventing degenerative disorders in people as well as having a substantial positive impact on health. According to (14), who found that adding 50g of cooked lentils to the diet of diabetic patients resulted in a substantial ($P \leq 0.05$) drop in fasting blood glucose levels. (15) noted that diets including lentils had a low glycemic index. Numerous studies have demonstrated that low GI, high fiber diets enhance levels of glycated proteins, which are indicators of glycemic management (both hemoglobin A1c (HbA1c) and fructosamine) (16).

Additionally, numerous studies have demonstrated that dietary fiber, especially the soluble kind, enhances glucose control and dramatically lowers post-prandial plasma glucose levels as well as the average daily blood glucose profile (17). Even though the amount of soluble dietary fiber was reduced, it's possible that cooked lentil was successful in lowering the glycemic response. After heating and cooling, a portion of the starch can be transformed into a non-digestible component known as resistant starch (RS), which develops from recrystallized amylose and amylopectin forms (18). According to (19), cooked lentils (whole or dehulled) were found to be more effective than raw lentils at lowering high blood glucose levels in diabetic rats. Additionally, in diabetic rats, it might raise HDL cholesterol levels. These findings imply that include lentils in human diets may aid in the prevention and treatment of diabetes and CHD.

The goal of this study was to study the effect of different levels of brown, green lentil, and their combination as powder influenced some biochemical and biological complications in diabetic rats. .

Material and Methods

Materials

Source of brown, and green lentil

The lentils (*Lens culinaris*, L.), both brown and green, were purchased at the local market in Cairo City, Cairo Governorate, Egypt.

Alloxan

Alloxan, also known as 5, 5-dihydroxyl pyrimidine-2, 4, 6-trione, is an organic molecule, urea derivative, carcinogen, and cytotoxic glucose derivative obtained by Al-Gomhoria Company for Trading Drugs, Chemicals, and Medical Instruments in Cairo, Egypt.

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

SIGMA Chemical Co., Egypt, provided pure white crystalline cholesterol powder. 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

Preparation of brown and green lentil powdered

The dried brown and green lentil were ground to a fine powder in an air mill, then mixed with a high-speed mixer (Molunix, Al-Araby Company, Benha, Egypt) and served as powder seize.

The induction of experimental diabetes:

According to (20) method, diabetes was induced in normal healthy male albino rats by injecting 150 mg/kg body weight of alloxan intraperitoneally.

Fasting blood samples were taken one week after alloxan injections to measure fasting serum glucose 200 mg/dl in diabetes rats NDDG, (21).

Experimental design:

The study was carried out and approved at Animal House, Department of Nutrition and Food Science, Faculty of Home Economics, Menoufia University, Egypt.

In this experiment, 48 adult male white albino rats, "Sprague Dawley" strain, 10 weeks old, weighing (150±10g), were used. For adaptation, all rats were fed a basal diet (casein diet) prepared according to (22) for 7 days. After this adaptation period, rats were divided into 8 groups, six rats per each as follows: group (1): rats fed on basal diet only as negative control. Group (2): Diabetic rats fed on basal diet only as a positive control group. Group (3): Diabetic rats fed on basal diet and green lentil as powder by 5% of kg/diet/day. Group (4): Diabetic rats fed on basal diet and green lentil as powder by 10 % of kg/diet/day. Group (5): Diabetic rats fed on basal diet and brown lentil 5% of kg/diet/day. Group (6): Diabetic rats fed on basal diet and brown lentil 10 % of kg/diet/day. Group (7): Diabetic rats fed on basal diet and mixture (1:1) of green and brown lentil 5% of kg/diet/day. Group (8): Diabetic rats fed on basal diet and mixture (1:1) of green and brown lentil 10% of kg/diet/day. 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 the experiment period (28 days), rats were fasted for 12-h then rats were scarified. Blood samples were collected from the portal vein into dry clean centrifuge tubes for serum separation, blood samples centrifuged for 10 minutes at 4000 rpm to separate, the serum (23). Serum samples were frozen at -18 ˚C until chemical analysis.

Biochemical analysis

Serum glucose was measured using the modified kinetic method (24) by using kit supplied by spin react. Spain.

The serum alanine aminotransferase (ALT), serum aspartate aminotransferase (AST), and serum alkaline phosphatase (ALP) were measured using the methods described by (25); (26) and (27), respectively.

Serum total cholesterol was determined according to the colorimetric method described by (28). Serum triglycerides was determined by enzymatic method using kits according to (29) and (30). HDL-c was determined according to the method described by (31) and (32). VLDL-c was calculated in mg/dl according to (33) using the following formula: VLDL-c (mg/dl) = Triglycerides / 5. LDL-c was calculated in mg/dl according to (33) as follows:

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

According to the method, serum urea and serum creatinine were determined using an enzymatic technique (34) and (35). While serum uric acid was measured using a calorimeter using the method of (36).

Statistical analysis

The data were analyzed using a completely randomized factorial design (37) when a significant main effect was detected; the means were separated with the Student-Newman-Keuls Test. Differences between treatments of ($P \leq 0.05$) were considered significant using Costat Program. Biological results were analyzed by One Way ANOVA.

Results and Discussion

Table (1) shows the effect of green and brown lentils, as well as their powdered combination, on diabetic rats' fasting blood glucose levels. There are significant differences (P≤0.05) between the negative control and positive control groups, with mean values of 93.00 and 277.50 mg/dl, respectively. The diabetic group rats fed on a 10% mixture powder had the lowest glucose level of any of the treated groups (diabetic). While the maximum value observed for diabetes group rats fed 5 percent brown lentil powder. The mean values were 115.10 and 145.00 mg/dl, respectively, with a significant difference (P≤0.05). These results are in line with those of (19), who found that giving lentils to diabetic rats resulted in a significant decrease in serum blood glucose (P<0.05) and an increase in HDL cholesterol (P<0.01). These findings imply that including lentils in human diets may aid in the prevention and treatment of diabetes and CHD. This might be caused by a decrease in lipoprotein lipase activity and an increase in adipose tissue lipolysis in the absence of insulin (38). Comparing lentil consumption to starchy control foods consistently reduces acute blood glucose and insulin response, according to (39). It is unclear how lentils lower postprandial blood glucose response (PBGR) and insulin levels, however research points to a possible relationship between the macronutrients a person consumes and/or the quantity of lentils they eat. Whether eating lentils can lower blood sugar levels in persons with or without type 2 diabetes. Lentils' advantageous effects are probably brought about by their complex macronutrient composition. Although the amount of protein and dietary fiber in lentils were suggested as potential influences on their glycemic response, there is currently insufficient direct evidence to support either claim (40)

Table (1): Effect of green, brown lentil, and their mixture on serum glucose level of diabetic rats

Parameters Groups	Glucose mg/dl
G_1 C (-)	$93.00^{f} \pm 0.40$
G_2 C (+)	$277.50^{a} \pm 0.50$
G_3 (5% green lentil powder)	$125.10^{d} \pm 0.40$
G_4 (10% green lentil powder)	$119.00^{e} \pm 0.10$
G_5 (5% brown lentil powder)	$145.00^{b} \pm 0.10$
G_6 (10% brown lentil powder)	$134.33^{c} \pm 0.11$
G_7 (5% mixture powder)	$127.50^{d} \pm 0.30$
G_8 (10% mixture powder)	$115.10^{e} \pm 0.20$
LSD (P ≤ 0.05)	4.260

Each value represents the mean ± SD of three replicates.
Means in the same column with different letter are significantly different (P<0.05).

Table (2) illustrates the effect of green, brown, and their combined powders on the ALT, AST, and ALP liver enzymes in diabetic rats. It is evident that there were significant ALT liver enzyme differences between the negative and positive control groups. The mean values were 83.60 and 155.20 U/L, respectively. The diabetic group rats fed on 10% combination powders had the lowest ALT liver enzyme of any treated group. While the diabetic group rats given 5 % brown lentil powder had the greatest value with a significant difference (P≤ 0.05), the mean values were100.20 and 137.30 U/L, respectively.

The data showed a significant difference (P≤ 0.05) between the negative and positive control groups for the liver enzyme AST. The mean values were 22.50 and 58.00 U/L, respectively. Diabetic rats fed a 10 percent powder mixture had the lowest AST enzyme of any treated group. While the greatest value was reported for diabetes group rats fed 5 % brown lentil powder with a significant difference (P≤ 0.05), the mean values were 18.80 and 41.10 U/L, respectively, with a significant difference (P≤0.05).

It is evident that ALP liver enzyme showed a significant difference between negative control group and positive control groups. The mean values were 14.70 and 38.87 IU/L, respectively. The lowest ALP enzyme of treated groups recorded for diabetic group rats fed on 10% mixture powder. While the highest value recorded was for diabetic group rats fed on 5 % brown lentil powder with significant difference (P≤0.05), the mean values were 15.80 and 24.20 U/L, respectively. This evidence supports the findings of (41), who demonstrated that diabetic rats had higher transaminase enzyme levels. An increase in their levels indicates that they are active in the absence of insulin. These factors improve the availability of amino acids in diabetics and increase glycogenesis and ketogenesis. Researchers are interested in the liver's participation in the etiology of type 2 diabetes because it plays a role in maintaining normal glucose levels during fasting and in the postprandial period. Lentil is a possible source of nutraceuticals with hepatoprotective benefits, (42) who suggest that lentil protects liver cells against oxidative stress, in part via triggering cellular antioxidant system. Additionally, they proposed that lentil might protect liver cells against the cytotoxicity brought on by oxidative stress.

Table (2): Effect different levels of green, brown lentil, and their mixture powder on some liver functions of diabetic rats

Parameters Groups	ALT (U/L)	AST (U/L)	ALP (U/L)
G_1 C (-)	83.60^{f} ±0.20	22.50^{e} ±1.11	14.70^{f}± 0.60
G_2 C (+)	155.20^{a} ± 1.20	58.00^{a} ±1.05	38.87^{a}± 0.10
G_3 (5% green lentil powder)	124.10^{c} ± 0.90	29.85^{d} ±1.10	21.80^{c} ± 0.30
G_4 (10% green lentil powder)	114.00^{d} ±0.70	19.91^{f} ± 0.92	19.95^{d} ± 0.11
G_5 (5% brown lentil powder)	137.30^{b} ± 1.10	41.10^{b} ± 1.45	24.20^{b} ± 0.50
G_6 (10% brown lentil powder)	126.40^{c} ± 1.00	33.70^{c} ± 0.80	21.93^{c}± 0.30
G_7 (5% mixture powder)	110.00^{e} ± 0.80	23.11^{e} ± 0.93	16.20^{e} ± 0.20
G_8 (10% mixture powder)	100.20^{e} ± 0.60	18.80^{f} ± 0.70	15.80^{e} ± 0.10
LSD (P ≤ 0.05)	3.120	1.790	1.170

Each value represents the mean ± SD of three replicates.
Means in the same column with different letter are significantly different (P<0.05).

Data tabulated in Table (3) showed the effect of different levels of green, brown lentil, and their mixture as powder on serum total cholesterol and triglycerides of diabetic rats. The obtained results indicated that there is a significant difference ($P\leq0.05$) between negative control group and positive control group in total cholesterol levels. The mean values were 70.00 and 120.00 mg/dl, respectively. While the lowest total cholesterol of treated groups recorded for diabetic group rats fed on 10% mixture powder. While the highest value recorded for diabetic group rats fed on 5% brown lentil powder with a significant difference ($P\leq0.05$), the mean values were 112.00 and 83.00 mg/dl, respectively.

Data showed that there is a significant difference between the negative control group and the positive control group in the case of triglycerides. The mean values were 130.00 and 60.00 mg/dl, respectively. The lowest triglycerides of treated groups were that recorded for diabetic group rats fed on 10% mixture powder. While the highest value was recorded for diabetic group rats fed on 5% brown lentil powder with significant difference ($P\leq 0.05$), the mean values were 66.00 and 96.50 mg/dl, respectively. The 10 % green and brown lentil mixture received the greatest results. These results are consistent with earlier research by (43) who state that there is little and conflicting data to support a potential impact of lentil on blood lipids in humans and animals.

Additionally, according to (44), different effects of lentil on blood lipid fractions have been shown in pigs and rats. According to (45) who observed that lentils given to type 2 diabetes patients have been shown to increase TC, HDL-c, and LDL-c, or reduce TC without changing other lipid fractions.

Table (3): Effect of different levels of green, brown lentil, and their mixture on some total cholesterol and triglycerides of diabetic rats

Treatments / Groups	Total cholesterol (mg/dl)	Triglycerides (mg/dl)
G_1 C (-)	$70.00^g \pm 0.21$	$60.00^f \pm 0.25$
G_2 C (+)	$120.00^a \pm 1.50$	$130.00^a \pm 1.71$
G_3 (5% green lentil powder)	$107.00^c \pm 0.90$	$84.50^c \pm 0.96$
G_4 (10% green lentil powder)	$98.00^d \pm 0.70$	$82.00^c \pm 1.05$
G_5 (5% brown lentil powder)	$112.00^b \pm 0.50$	$96.50^b \pm 1.10$
G_6 (10% brown lentil powder)	$103.00^c \pm 0.40$	$71.50^d \pm 0.70$
G_7 (5% mixture powder)	$90.00^e \pm 0.60$	$70.00^d \pm 0.40$
G_8 (10% mixture powder)	$83.00^f \pm 0.30$	$66.00^e \pm 0.30$
LSD ($P\leq0.05$)	4.350	3.711

Each value represents the mean ± SD of three replicates.
Means in the same column with different letter are significantly different (P<0.05).

The effect of different levels of green, brown lentil, and their powdered mixture on lipid profile {high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c), and very low-density lipoprotein cholesterol (VLDL-c)} in diabetic rats are shown in Table (4). It is clear to notice that the levels of high-density lipoprotein cholesterol (HDL-c) significantly different between the negative and positive control groups. The average concentrations were 47.00 and 29.15 mg/dl, respectively. The diabetic group rats fed a 10% powder mixture had the highest HDL-c of all the treated groups. While the lowest value recorded for diabetic rats fed 5% brown lentil powder, with a significant difference ($P \leq 0.05$) the mean values were 42.27 and 32.55 mg/dl, respectively.

According to the data, there are significant differences between the negative control group and the positive control group in terms of low-density lipoprotein cholesterol (LDL-c) levels. The average values were 11.00 and 64.85 mg/dl. The diabetic group rats fed a 10% mixture powder had the lowest LDL-c of all the treated groups. While the maximum value obtained for diabetes group rats fed 5 % brown lentil powder with a significant difference ($P \leq 0.05$), the mean values were 27.53 and 60.15 mg/dl, respectively.

In the case of very high-density lipoprotein cholesterol, however, there were significant differences between the negative and positive control groups (VLDL-c). The mean values were 26.00 and 12.00 mg/dl, respectively. The lowest VLDL-c of treated groups was recorded for diabetic group rats fed on 10% mixture powder. While the highest value was recorded for diabetic group rats fed on 5% brown lentil powder with a significant difference ($P \leq 0.05$), the mean values were 13.20 and 19.30 mg/dl, respectively. These results support earlier research (46), which contends that HDL-function c's in reverse cholesterol transfer makes it a preventative measure against atherosclerosis. The lipoprotein lipase enzyme, which is involved in the metabolism of triglyceride-rich lipoprotein, is stimulated by HDL-c.

Additionally, (47) observed that lentil significantly lowers the atherogenic index of plasma (AIP) and boosts TC/TG in rats when it is included in cholesterol-free and cholesterol-supplemented diets, likely due to its positive impact on TG and HDL-C. No matter how it is prepared, lentil has also had this effect. When compared to TG or HDL-C, the lentil's cardioprotective impact appears to be more pronounced when taking AIP and TC/TG into account. These findings imply that including lentils in daily meals may aid in preventing and treating cardiovascular disease (CVD) and other associated illnesses.

Table (4): Effect different levels of green lentil, brown lentil, and their mixture powder on lipid profile level of diabetic rats

Parameters **Groups**	**HDL-c** **mg/dl**	**LDL-c** **mg/dl**	**VLDL-c** **mg/dl**
G_1 C (-)	$47.00^{a} \pm 1.18$	$11.00^{h} \pm 0.21$	$12.00^{de} \pm 0.69$
G_2 C (+)	$29.15^{f} \pm 0.90$	$64.85^{a} \pm 1.20$	$26.00^{a} \pm 1.20$
G_3 (5% green lentil powder)	$35.40^{d} \pm 1.00$	$54.75^{c} \pm 1.72$	$16.90^{c} \pm 1.41$
G_4 (10% green lentil powder)	$39.20^{bc} \pm 0.80$	$42.40^{e} \pm 0.90$	$16.40^{c} \pm 0.30$
G_5 (5% brown lentil powder)	$32.55^{e} \pm 1.02$	$60.15^{b} \pm 1.60$	$19.30^{b} \pm 1.10$
G_6 (10% brown lentil powder)	$37.07^{d} \pm 1.21$	$51.63^{d} \pm 2.20$	$14.30^{d} \pm 1.20$
G_7 (5% mixture powder)	$40.34^{b} \pm 1.13$	$35.66^{f} \pm 2.20$	$14.00^{d} \pm 2.10$
G_8 (10% mixture powder)	$42.27^{b} \pm 1.15$	$27.53^{g} \pm 2.20$	$13.20^{d} \pm 1.30$
LSD ($P \leq 0.05$)	2.130	2.351	1.520

Each value represents the mean ± SD of three replicates.
Means in the same column with different letter are significantly different ($P<0.05$).

The effects of different levels of green, brown lentil, and their combination powder on diabetic rats' kidney functions (serum urea, urea, uric acid, and creatinine) are shown in Table (5) shows. It is clear to mention that serum urea of the positive control group was

much greater than the serum urea of the negative control group, which were 30.00 and 62.00 mg/dl, respectively. The diabetic group rats given 5 percent brown lentil powder had the highest serum urea level of all the treated groups. The lowest value recorded for diabetic rats fed a 10% powder mixture, while the highest recorded for brown lentil powder with a significant difference (P≤0.05), which was 58.13 and 44.20 mg/dl, respectively.
When it came to serum uric acid, the findings showed that the positive control group had a significantly greater value than the negative control group. The mean values were 3.80 and 1.75 mg/dl, respectively. On the other hand, diabetic rats fed 5 % brown lentil powder had the highest serum uric acid level of any treated group. While the lowest value obtained for diabetes group rats fed on 10 % combination powder with significant difference (P≤ 0.05), the mean values were 3.11 and 1.85 mg/dl, respectively.
In contrast, the positive control group's serum creatinine level was significantly greater than the negative control groups with significant differences (P≤ 0.05). The mean values were 1.15 and 0.70 mg/dl, respectively. The diabetic group rats given 5 % brown lentil powder had the highest serum creatinine level of the treatment group. While the lowest result was reported for diabetic rats fed a 10% powder mixture, the mean values were 1.11 and 0.78 mg/dl, respectively, with a significant difference (P≤ 0.05). These results agreed (48), who discovered that the positive control group's increase in blood urea, creatinine, uric acid, and urine albumin was prevented by the development of diabetes. This discovery lends credence to the hypothesis that diabetic nephropathy develops following streptozotocin-induced diabetes.

Table (5): Effect different levels of green, brown lentil, and their mixture on kidney functions level of diabetic rats

Parameters Groups	Urea mg/dl	Uric acid mg/dl	Creatinine mg/dl
G1 C (-)	30.20g ± 1.10	1.75c± 0.10	0.70bc+ 0.21
G2 C (+)	62.00a ±1.20	3.80a ± 0.90	1.15a+ 0.13
G3 (5% green lentil powder)	53.96c± 1.00	2.47b± 0.60	1.08a+ 0.01
G4 (10% green lentil powder)	50.27d ± 0.93	2.10b± 0.40	1.00b+ 0.14
G5 (5% brown lentil powder)	58.13b± 1.20	3.11a ± 0.60	1.11a+ 0.01
G6 (10% brown lentil powder)	55.40c± 0.45	2.75b± 1.20	1.04a+ 0.03
G7 (5% mixture powder)	48.25e± 0.60	2.00b± 1.30	0.91b+ 0.02
G8 (10% mixture powder)	44.20f± 0.70	1.85c± 1.10	0.78b+ 0.03
LSD (P≤0.05)	1.980	1.005	0.160

Each value represents the mean ± SD of three replicates.
Means in the same column with different letter are significantly different (P<0.05).

As the primary organ responsible for preserving body homeostasis, the kidney is a prominent target for numerous poisons. While some medications directly harm vascular, glomerular, tubular, and interstitial cells, others affect renal perfusion and decrease its capacity for filtration (49). Blood urea, uric acid, and creatinine levels in the serum are used as indicators of how well the kidneys are functioning (50). The findings of the current study are consistent with those of (51), who reported that the elevated serum levels of urea, uric acid, creatinine, sodium, calcium, and magnesium in rats were decreased when folic acid (FA) or lentil extract was administered along with diclofenac sodium (DS). In contrast, it caused a rise in serum potassium levels as compared to the DS group.

Conclusion

Green or brown lentils or their mixture enhanced significantly serum glucose level ($P \leq 0.05$), improved HDL-c, and decreased levels of liver, and kidney functions, thus, we might use a mixture of green and brown lentil powder in our daily dishes.

References

1. Geberemeskel, A.G.; Debebe, G.Y.; Abraha Nguse, A.N. Clinical study antidiabetic effect of fenugreek seed powder solution (*Trigonella foenum-graecum* L.) on hyperlipidemia in diabetic patients. *J. Diabetes Res.,* (2019): 8507453.
2. Statista Diabetics Percentage Worldwide. (2019);. https://www.statista.com/statistics/271464/percentage-ofdiabetics-orldwide/.
3. Sharma, U.; Sahu, R.; Roy, A. andGolwala, D. *In vivo* antidiabetic and antioxidant potential of *Stephania hernandifolia* in streptozotocin induced-diabetic rats. *J. Young Pharm.,* (2010); (2): 255-260.
4. Ogurtsova, K.; Fernandes, J.D.; Huang, Y.; Linnenkamp, U. IDF diabetes atlas: global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Res. Clin.,* Pract., (2017); 128: 40-50.
5. O'Gara, P.T.; Kushner, F.G.; Ascheim, D.D.; Casey, D.E. et al. ACCF/AHA guideline for the management of ST-elevation myocardial infarction: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines., *Circulation,* (2013); 127 (4): 362-425.
6. Singhal, G.K. and Prabhu, V.G. Antidiabetic Potential of Commonly Consumed Cereals. A Review. *JCMD,* (2011); 2 (2): 68-74.
7. Shaw, J.E.; Sicree, R.A.; Zimmet, P.Z. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res. Clin. Pract.,* (2010); 87: 4-14.
8. Wu, Z.; Tang, Y. and Cheng, Q. Diabetes increases the mortality of patients with COVID-19: A meta-analysis. *Acta Diabetol.* (2021); 58: 139-144.
9. Faris, M.A.E.; Takruri, H.R. and Issa, A.Y. Role of lentils (*Lens culinaris,* L.) in human health and nutrition: A review. *Mediterr. J. Nutr. Metab.,* (2013); 6:3-16.
10. Food and Agriculture Organization (FAO) *Traditional Food Plants.* FAO; Rome, Italy: 1988. http://www.fao.org/ docrep /W0078E/w0078e12.htm
11. Xu, B. and Chang, S.K. Phenolic substance characterization and chemical and cell-based antioxidant activities of 11 lentils grown in the Northern United States. *J. Agric. Food Chem.* (2010); 58:1509-1517.
12. Joshi, M.; Timilsena, Y. and Benu Adhikari, B. Global production, processing, and utilization of lentil: A review. *Journal of Integrative Agriculture* (2017); 16 (12): *2898*-2913.

13. Ganesan, I.D. and Baojun, X.U. Polyphenol-rich lentils and their health promoting effects. *Int. J. Mol. Sci.,* (2017); 18: 1-23.
14. Shams, H.; Tahbaz, F.; Entezari, M. and Abadi, A. (2008): Effects of cooked lentils on glycemic control and blood lipids of patients with type 2 diabetes. *ARYA, Athero, J.,* 3: 215-218.
15. Foster-Powell, K.; Holt S.H. and Brand-Miller, J.C. International table of glycemic index and glycemic load values: 2002. *Am. J. Clin. Nutr.,* (2002); 76: 5-56.
16. Kendall, C.W.; Esfahani, A. and Jenkins, D.J. (2010). The link between dietary fiber and human health. *Food Hydrocolloids,* 24: 42-48.
17. Giacco, R.; Clemente, G. and Riccardi, G. Dietary fiber in treatment of diabetes: myth or reality. Digest. *Liver Dis.,* (2002); 34: 140-144.
18. Kim, W.K.; Chung, M.K.; Kang, N.E.; Kim, M.H. et al. Effect of resistant starch from corn or rice on glucose control, colonic events, and blood lipid concentrations in streptozotocin induced diabetic rats. *J. Nutr. Biochem.,* (2003); 14: 166-172.
19. Al-Tibi, M.H.; Takruri, H.R. and Ahmad, M.N. Effect of dehulling and cooking of lentils (*Lens Culinaris,* L.) on serum glucose and lipoprotein levels in streptozotocin-induced diabetic rats. *Mal. J. Nutr.,* (2010); 16 (3): 409-418.
20. Desai, A. and Bhide, M. Hypoglycemic effect of *Hanikonia suavecolens*. *Idian. J. Med.,* (1985), 81: 86 - 91.
21. NDDG, Nation Diabetes Data Group. Classification and Diagnosis of Diabetes and other Calegories of Glucose. *Intolerance Diabetes,* (1979), 28:1039-1057.
22. Reeves, P.G.; Nielsen, F.H. and Fahmy, G.C. Reported of the American Institute of Nutrition adhocwriling committee on the reformulation of the AIN -76 a Rodent diet. *Journal Nutrition,* (1993),123:1939-19351.
23. Schermer, A. The Blood Morphology of Laboratory Animal. Longmans, Printed in Great Britain, *Green and Co. Ltd.,* (1967), pp.350.
24. Kaplan, L.A. Clinical Chemistry. The C.V. *Mosby Co. St Louis. Toronto. Princent.,* (1984), 1032-1036.
25. Hafkenscheid, J.C. Determination of GOT. *Clin. Chem.,* (1979), 25:155.
26. Henary, R.J. Clinical Chemist: Principals and Techniques. 2nd, Edition, *Hagerstoun (MD), Harcer, ROW,* (1974), P. 882.
27. Moss, D.W. Alkaline phosphatase isoenzymes. *Clin. Chem.,* (1982), 28: 2007-2016.
28. Thomas, L. Labor and diagnose, 4th Ed. Marburg: *Die Medizinischi Verlagsgesellschaft*, (1992), (Chemical Kits).
29. Young, D. Effects of drugs on clinical laboratory tests. *Pestaner, L. Clin. Chem.,* (1975), 21 (5): 14- 32. (Chemical Kits).
30. Fossati, P. and Pricipe, I. Determination of serum triglycerides. *Clin. Chem.,* (1982), 28: 2077.
31. Friedwaid, W.T. Determination of HDL. *Clin. Chem.,* (1972), 18: 499.
32. Grodon, T. and Amer, M. Determination of HDL. *Clin. Chem.,* (1977), 18: 707.
33. Lee, R. and Nieman, D. Nutrition Assessment. 2nd Ed. *Mosby, Missouri,* (1996), U.S.A.

34. Patton, C.J. and Crouch, S.R. Enzymatic determination of urea. *J. of Anal. Chem.,* (1977), 49: 464-469.
35. Henry, R.J. Clinical Chemist: Principles and Techniques, 2nd Edition, *Hagerstoun (MD), Harcer,* (1974), *ROW*, 882.
36. Barham, D. and Trinder, P. Determination of uric acid. *Analyst,* (1972), 97: 142.
37. SAS. SAS Users Guide: Statistics version 5th Ed. SAS. *Institute Inc.,* (1988), Cary N.C.
38. Eidi, A. and Eidi, M. Antidiabetic effects of sage (*Salvia officinalis,* L.) leaves in normal and streptozotocin-induced diabetic rats. Diabetes Metabolic Syndrome: *Clin. Res. Rev.,* (2009); 3: 40-44.
39. Clarke, S.T.; Sarfaraz, S.; Qi, X. and Ramdath, D.G. et al. A review of the relationship between lentil serving and acute postprandial blood glucose response: Effects of dietary fiber, protein and carbohydrates. *Nutrients,* (2022); 14, (849): 1-19.
40. Sievenpiper, J.L.; Kendall, C.W.C.; Esfahani, A.; Wong, J.M.W. et al. Effect of non-oil-seed pulses on glycaemic control: A systematic review and meta-analysis of randomized controlled experimental trials in people with and without diabetes. *Diabetologia,* (2009); 52: 1479-1495.
41. Marchesini, G.; Brizi, M.; Bianchi, G.; Tomassetti, S. et al. Nonalcoholic fatty liver disease: a feature of the metabolic syndrome. *Diabetes,* (2001); 50: 1844-1850.
42. Jung, Y.S.; Lee, S.H.; So Young Chun, S.Y. Kim, D.H. et al. In vitro and in vivo protective effects of lentil (*Lens culinaris*) extract against oxidative stress-induced hepatotoxicity. *Molecules,* (2022); 27 (1): 1-11.
43. Aslani, Z.; Alipour, B.; Mirmiran, P.; Bahadoran, Z. et al. Effect of lentil sprouts on lipid profile and blood fasting glucose in overweight and obese patients with type 2 Diabetes. *Iran J Endocrinol Metab*., (2015); 16 (5): 338-45.
44. Bazzano, L.A.; Thompson, A.M.; Tees, M.T.; Nguyen, C.H, et al. Non-soy legume consumption lowers cholesterol levels: a meta-analysis of randomized controlled trials. *Nutr. Metab. Cardiovasc. Dis.,* (2011); 21: 94-103.
45. Ahmad, M.N. The effect of dehulling and cooking of lentils (*Lens Culinaris,* L.) on serum glucose and lipid and lipoprotein concentrations in rats fed cholesterol- supplemented diets. *Life Sci. J.,* (2014); 11 (11): 924-931.
46. Ludvik, B.; Neuffer, B. and Pacini, G. Efficacy of *Ipomoea batatas* (Caiapo) on diabetes control in type 2 diabetic subjects treated with diet. *Diabetes Care,* (2004); 27 (2): 436-440.
47. Ahmad, M.N. The effect of lentil on cholesterol-induced changes of serum lipid cardiovascular indexes in rats. *Progress in Nutrition*, (2017); 19 (1): 48-56.
48. Sayed, A.A.R. Ferulsinaic acid modulates SOD, GSH, and antioxidant enzymes in diabetic kidney. *Evidence-Based Complementary and Alternative Medicine,* (2012); 2 (104): 1-9.
49. Choudhury, D. and Ahmed, Z. Drug associated renal dysfunction and injury. *Nature Clinical Practice Nephrology,* (2006); 2 (2): 80-91.
50. Gowda, S.; Desai, P.B., Kulkarni, S.S., Hull, V.V. et al. Markers of renal function. *North American Journal of Medical Sciences,* (2012); 2(4:) 170-173.

51. Abdel-Rahmana, O.N. and Abdel-Baky, E.S. Hematological and reno-protective effects of folic acid and lentil extract in diclofenac sodium exposed rats. Brazilian Journal of Biology, (2023); 83: 1-8

التأثيرات المحتملة للعدس الأخضر والبنى على الفئران المصابة بالسكر المستحث بالألوكسان

حمدية أحمد هلال ، سهام عزيز خضر ، إيمان عبد الفتاح النادرى
قسم التغذية وعلوم الأطعمة .كلية الاقتصاد المنزلي .جامعة المنوفية، شبين الكوم، مصر

الملخص العربي:
الهدف من هذه الدراسة هو تقييم تأثير العدس الأخضر والبنى ومخلوطهما على الفئران المصابة بمرض السكر. تم تقسيم ٤٨ من ذكور الفئران البالغة وزنها (١٥٠±١٠ جم) إلى ثماني مجموعات ، كل منها ستة فئران. تمت إضافة العدس الأخضر والبنى ومخلوطهما إلى الوجبة الرئيسية بمعدل ٥٪ ، ١٠٪ لمدة ٢٨ يومًا. تم حقن الألوكسان (١٥٠ مجم / كجم من وزن الجسم) تحت الجلد في الفئران لحدوث الأصابة بمرض السكر. تم قياس مستوي الجلوكوز ، صورة دهون الدم (TG، TC، LDL-c، VLDL-c، HDL-c) ، ونشاط إنزيمات الكبد (ALT ، AST ، ALP) ، ووظائف الكلى (الكرياتينين ، وحمض البوليك ، اليوريا). أشارت النتائج إلى أن تناول مسحوق العدس الأخضر والبنى أو خليطهما أدى إلى تحسين مستوى الجلوكوز في دم الفئران بصورة معنوية (P ≤0.05) وزيادة HDL-c بشكل ملحوظ وتحسين وظائف الكبد والكلى عن طريق خفض ALT, AST, ALP,الكرياتينين وحمض البوليك واليوريا في دم الفئران بالمقارنة بالمجموعة الموجبة. الخلاصة ، أدي التغذية على العدس الأخضر والبنى أو خليطهما للفئران إلى تقليل الآثار الغير مرغوبة لمرض السكر. كانت أفضل نتيجة هي تناول المخلوط بنسبة ١٠% من العدس الأخضر والبنى. لذلك ، يمكن استخدام مسحوق العدس الأخضر والبني وخليطهما في أطباقنا اليومية.

الكلمات المفتاحية: البقوليات ، مرض السكر, الفئران, التحاليل الكيميائية الحيوية.