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Effect of pomegranate peel and guar gum powders on diabetic rats induced by alloxan

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Abstract: Pomegranate peel (PP) and guar gum (GG) powder can be submitted many healthy benefits for Human. Therefore, the present study aims to investigate the effect of PP and GG powders and their mixture on diabetic rats induced by alloxan. Forty male Albino rats, weighing 140 ± 10g, were randomly divided into two main groups. The first main group (5 rats) fed on basal diet as a negative control group (healthy rats), while the second main group (35 rats) was diabetic induced by a single intraperitoneal injection of alloxan (150 mg/kg b.w.) then divided into seven sub groups. One of them fed on basal diet as positive control group (diabetic rats) and the other groups fed on basal diet containing 3 and 6% of PP, GG powders and their mixture for five weeks. The results revealed that feeding PP, GG powders and their mixture by diabetic rats improved kidney functions (uric acid and creatinine levels), liver functions (ALT and AST activities), serum glucose and serum lipid profile (cholesterol , triglycerides , LDL and HDL levels). Also, feeding 6% PP has achieved the best results followed by 6% PP + 6% GG when compared to the control group. Therefore, we recommended the using of PP and GG powders as food additives for their nutritional and healthy benefits.

Key words: Pomegranate peel, guar gum, kidney function, liver functions, serum lipid profile, serum glucose.

Introduction

Hypoglycemic drugs are either too expensive or have undesirable side effects. Coma and disturbances of liver and kidney functions limiting of diabetes without any side effects is still a challenge to the medical syst leads to exert effort to search for effective, safer and low cost antidiabetic prescriptions (Enas, 2004).

pp, a waste generated from fruit processing industry, is a potential source of active ingredients such as polyphenols that are known for their antioxidative properties (Ankita and Mahesh, 2015). PP constitutes a good source of fiber and antioxidant bioactive compounds. Total lipid, triglycerides, total cholesterol, LDL-C, liver enzymatic activities and uric acid and creatinine levels were decreased by increasing of PP level in pan bread while HDL-C was increased (Sayed, 2014). In another study, Sirekhatim *et al.,* (2015) reported that PP regulating blood glucose level in alloxan diabetic rats. Also, the study Ibrahium (2010) indicated that the lowest level of serum alanine aminotransferase (ALT), asparate aminotransferase (AST) and alkaline phosphatase (ALP), uric acid, urea and creatinine levels were found in hypercholesterolemic rat group fed on basal diet containing PP extract.

GG, also called guaran, is a substance made from guar beans which has thickening and stabilising properties useful in various industries, traditionally the food industry, but increasingly the hydraulic fracturing industry. The guar seeds are dehusked, milled and screened to obtain the guar gum (Tauseef and Sasi, 2011). GG is rich in a fiber that help decrease the amount of cholesterol and glucose that is absorbed in the stomach (www.webMd, 2017). GG with each meal significantly lowered the postprandial plasma glucose, low-density lipoprotein (LDL) whereas high – density lipoprotein (HDL) level was significantly ($p \leq 0.01$) increased (Mahendra *et al*., 2016). Also, Jayanta *et al*. (2014) found that the level of ALT and AST did not clarify any abnormal changes in serum after treatment by GG. Guar gum cold be used safety as an adjunct therapy to gliclazide in treatment of type 2 diabetes. In addition GG ameliorated its associated complications by reducing the oxidative stress and urea level (Nasry *et al*., 2013). Several studies have found significant decreases in human serum cholesterol levels following GG ingestion these decreases are through to be a function of its high soluble fiber content (Daumerie and Henquin, 2011). The present study aims to investigate the effect of PP and GG powders on diabetic rats induced by alloxan.

Material and Methods

Materials

PP and GG were purchased from the local market, Cairo, Egypt. Alloxan, solvents, and buffers were obtained from El Gomhoria Company

for trading Drugs, Chemicals and Medical Instruments., Cairo, Egypt. Forty male albino rats Sprague Dawley strain, weighing (140±10g), were obtained from the Research Institute of Ophthalmology, Medical Analysis Department, Giza, Egypt.

Methods

PP and GG were milled by high speed blender (Toshiba AlAraby Company, Benha, Egyt) and sieved through 20 mesh and kept at 4^0C until used.

Chemical analysis

Moisture content, total protein, crude fat, fiber and ash were determined in both of quinoa seeds and bread samples according to the methods of A.O.A.C. (1990). Carbohydrates content were calculated by the difference: Carbohydrates (%) = [100 – (moisture + fat + protein + crude fiber + ash)] .

Biological experiments

Rats were kept in individual stainless steel cages under hygienic conditions and fed one week on basal diet adlibitum for adaptation according to Reeves *et al*., (1993).

Induction of diabetes

Diabetes was induced in normal healthy male albino rats by intraperitoneal injection of alloxan (150 mg/kg BW) according to the method described by Desai and Bhide, (1985). After one week of injection, blood samples were collected from each rat to determined serum glucose in order to insure the induction of diabetes. Serum glucose more than 190 mg/dI , was considered diabetics (NDDG, 1994).

Experimental Design

The Rats were divided into two main groups, the first main group (5 rats) fed on basal diet and used as a negative control group. The second main group (35 rats) injected with alloxan 150 mg/kg BW to induce hyperglycemia, then divided into seven subgroups (n= 5) as follow:

- *group (2):* Fed on basal diet as a positive control group.
- *Group (3):* fed on basal diet containing GG powder (3%, w/w).
- *Group (4):* fed on basal diet containing PP powder (3%, w/w)**.**

- *Group (5):* fed on basal diet containing GG powder (6%, w/w).
- *Group (6):* fed on basal diet containing PP powder (6%, w/w)**.**
- *Group (7):* fed on basal diet containing GG (3%, w/w)+ PP powder (3%, w/w)**.**
- *Group (8):* fed on basal diet containing GG (6%, w/w)+ PP powder(6%, w/w)**.**

Biological Evaluation

During the experimental period (5weeks) the consumed feed was recorded every day, and body weight recorded weekly. The body weight gain (BWG,%), feed efficiency ratio (FER) and organs weight were determined according to Chapman *et al*., (1959) using the following equations.

$$\text{BWG (\%)} = \frac{\text{Final weight (g)} - \text{initial weight (g)} \times 100}{\text{Initial weight}}$$

$$\text{FER} = \frac{\text{Gain in body weight (g)}}{\text{Feed intake (g)}}$$

Blood Sampling

At the end of the experimental period blood samples were collected after 12 hours fasting from the portal vein; the rats were scarified after being ether anesthetized. Blood samples were received into clean dry centrifuge tubes, and left to clot at room temperature, then centrifuged for 10 minutes at 3000 rpm to separate the serum. Serum was carefully aspirated and transferred into clean curve t tubes and stored frozen at -20° C for analysis (Maihotra, 2003). Liver and kidneys , of the sacrificed rats were carefully removed, washed, in saline solution, dried with filter paper and weight as percentage of final body weight were calculated.

Biological Analysis

Serum glucose, ALT, AST, serum creatinine, uric acid, serum cholesterol, triglycerids, HDL-C and LDL-C were determined Trinder, (1969), Tietz, (1976), Yound, (1975), Larsen, (1972), Carawy, (1955),

Allain *et al.*, 1974), Foster and Dumns, (1973), Lopes-Virella *et al.*, (1977) and Fried Wald *et al.*, (1972), respectively.

Statistical Analysis

Statistical analysis were performed by using computer program, statistical package for social science (SPSS, 1998), and compared with each other using the suitable tests.

Results and Discussion

Data in Table (1) shows the chemical composition of PP and GG powders. The highest values for moisture, total protein, crude fat and crude fiber were recorded for GG while the ash and carbohydrates for PP. The selected plant parts i.e. PP and GG are good sources for the different food components including protein, fiber, ash and carbohydrates. Such data are in accordance with that obtained by Sayed, (2014) and Daumerie and Henquin, (2011).

Table 1. Proximate composition of pomegranate peel and guar gum powder

Component (%)	Pomegranate peel (PP)	Guar gum (GG)
Moisture	9.52± 2.43*	10.13±1.76
Total protein	6.75±1.09	28.22±3.42
Crude fat	1.47±0.21	2.25±0.87
Ash	6.13±1.11	3.61±0.94
Crude fiber	13.44±2.17	14.59±1.58
Carbohydrate	62.42±4.26	41.20±2.88

* Each value represents the mean of three replicates ±SD.

Data in Table (2) showed the mean ± SD values of body weight gain (BWG %) of the tested groups. The results indicated that diabetic rats recorded significant decreasing for BWG ($P \leq 0.001$), FI ($P \leq 0.05$) and FER ($P \leq 0.001$). Feeding of hyperglycemic rats with all levels from PP and GG powders (3% and 6%) and their mixtures caused significant ($P \leq 0.05$ to 0.01) increasing in BWG (%), as compared to the positive control group, respectively. The highest effect was recorded for the PP and its mixture followed by the GG mixture and GG alone treatment.

Such effects were increased with the increasing of the tested plants concentrations. The same behavior was recorded with FI and FER.

Table (2): Effect of feeding pomegranate peel and Guar gum powder on body weight gain, feed intake and feed efficiency ratio of diabetic rats (Mean ±SD)

Groups	Body weight gain (B WG, %)	Feed intake (FI, g/day/rat)	Feed efficiency ratio (FER, %)
Control (-)	0.24 ± 0.03	18.40 ± 0.55	1.92 ± 0.05
Control (+)	-0.07 ± 0.01 ***	15.80 ± 0.45 *	- 0.55 ± 0.01***
Guar gum (GG, 3% w/w)	0.10 ± 0.02 **	16.80 ± 0.84 *	0.94 ± 0.05***
Pomegranate peel (PP, 3% w/w)	0.12 ± 0.01 **	17.80 ± 1.09NS	1.09 ± 0.07***
GG (6%, w/w)	0.11 ± 0.01**	17.00 ± 0.71*	1.0 ± 0.04***
PP (6%, w/w)	0.14 ± 0.01**	17.80 ± 0.84NS	1.21 ± 0.05**
GG (3%, w/w) + PP (3%, w/w)	0.14 ± 0.01**	18.00 ± 1.00NS	1.22 ± 0.06**
GG (6%, w/w) + PP (6%, w/w)	0.12 ± 0.01**	18.00 ± 0.71NS	1.0 ± 0.04***

NS, no significant; * p≤0.05; ** p≤0.01; *** p≤0.001

Data in Table (3) showed the mean ± SD values of organs weight (kidney and liver) of the tested groups. The results indicated that diabetic rats recorded non significant increasing for kidney and liver. Feeding of hyperglycemic rats with all levels from PP and GG powders (3% and 6%) and their mixtures caused significant ($P \leq 0.05$ to 0.001) decreasing in kidney and liver weights [Organs weight / bodyweight (%)], as compared to the positive control group. The highest effect was recorded for the PP and its mixture followed by the GG mixture and GG alone treatment. Such effects were increased with the increasing of the tested plants concentrations.

Data in Table (4) showed the effect of feeding PP and GG powders on serum glucose and kidney functions of diabetic rats. The results indicated that diabetic rats recorded significant increasing for glucose ($P \leq 0.001$), uric acid ($P \leq 0.01$) and creatinine ($P \leq 0.01$). Feeding of hyperglycemic

rats with all levels from PP and GG powders (3% and 6%) and their mixtures caused significant ($P \leq 0.05$ to 0.001) decreasing in glucose, uric acid and creatinine, as compared to the positive control group. The highest effect was recorded for the PP and its mixture followed by the GG mixture and GG alone treatment. Such effects were increased with the increasing of the tested plants concentrations. In similar study, Mahendra *et al*., (2016) reported that GG with each meal significantly lowered the post prandial plasma glucose. Also, Hala *et al*., (2012) found that PP decreased glucose, while insulin level increased in diabetic rats. Furthermore, blood glucose level decreased significantly in all sub-groups feeding on PP compared to the control positive group, diabetic group (Sirekhatim *et al*., 2015). Some studies have found guar gum to improve dietary glucose tolerance. Research has revealed the water-soluble fiber in it may help people with diabetes by slowing the absorption of sugars by the small intestine. Although the rate of absorption is reduced, the amount of sugar absorbed is the same overall. This may help diabetic patients by moderating glucose "spikes" (*Daumerie and Henquin (1982)*.Uric acid and creatinine were decreased by increasing of PP level in pan bread (Sayed, 2014). Urea level was reduced after treatment by GG (Nasry *et al.*, 2013).

In general, urea is formed in the liver as the end product of protein metabolism. During ingestion, protein is broke down into amino acids. In the liver, these amino acids are catbolized and free ammonia is formed. The ammonia is combined to form urea (Pagana and pagana, 1997). Urea, the major product of protein catabolism measuring urea is the most popular laboratory procedure for assessing renal function (Pagana and pagana, 1997). Creatinine is a catabolic product of creatine phosphate, which is used in skeletal muscle concentration (Pagana and pagana, 1997). In the skeletal muscle serum creatinine levels are elevated by renal disease and dehydration. The decreasing in serum uric acid and creatinine as the result of feeding plant parts including PP and GG could be attributed to their higher content of phytochemicals such flavonols, phenolic acids, anthocyanins, alkaloids and organosulfur compounds (Tauseef and Sasi, 2011 and Ankita and Mahesh, 2015).

Data in Table (5) showed the effect of feeding PP and GG powders on liver functions of diabetic rats. The results indicated that diabetic rats recorded significant decreasing in ALT and AST ($P \leq 0.01$). Feeding of hyperglycemic rats with all levels from PP and GG powders (3% and 6%)

Table (3): Effect of feeding pomegranate peel and guar gum powder on organs weight/body weight of diabetic rats (Mean ±SD)

Groups	Organs weight / bodyweight (%)	
	Kidney	Liver
Control (-)	2.02 ± 0.11	5.6 ± 0.11
Control (+)	2.11 ± 0.17 ^{NS}	6.3 ± 0.27 ^{NS}
Guar gum (GG, 3% w/w)	1.96 ± 0.17^{NS}	6.80 ± 0.84 *
Pomegranate peel (PP, 3% w/w)	0.74 ± 0.011 ***	5.9 ± 0.26 ^{NS}
GG (6%, w/w)	1.98 ± 0.016 ^{NS}	5.9 ± 0.52 ^{NS}
PP (6%, w/w)	0.82 ± 0.08 **	5. 1 ± 0.13 *
GG (3%, w/w) + PP (3%, w/w)	0.76 ± 0.05 ***	6.0 ± 0.18 ^{NS}
GG (6%, w/w) + PP (6%, w/w)	0.90 ± 0.10 **	5.6 ± 0.16 ^{NS}

NS, no significant; * p≤0.05; ** p≤0.01; *** p≤0.001

Table (4): Effect of feeding pomegranate peel and guar gum powder on serum glucose and kidney functions of diabetic rats (Mean ±SD)

Groups	Glucose (mg / dI)	Uric Acid (mg/dI)	Creatinine (mg/dI)
Control (-)	77.00 ± 12.08	3.38 ± 0.28	0.59 ± 0.06
Control (+)	213.6 ± 11.97***	5.56 ± 0.46**	0.91 ± 0.11 **
Guar gum (GG, 3% w/w)	134.80 ± 8.47***	4.58 ± 0.36 **	0.76 ± 0.13 *
Pomegranate peel (PP, 3% w/w)	116.80 ± 7.12**	4.04 ± 0.36 *	0.67 ± 0.12 *
GG (6%, w/w)	134.60 ± 8.45***	4.30 ± 0.33 **	0.75 ± 0.11 *
PP (6%, w/w)	95.20 ± 6.30*	4.00 ± 0.68 *	0.65 ± 0.04 ^{NS}
GG (3%, w/w) + PP (3%, w/w)	116.40 ± 8.91**	4.24 ± 0.31 *	0.65 ± 0.06 ^{NS}
GG (6%, w/w) + PP (6%, w/w)	102.20 ± 8.41**	3.40 ± 0.31 ^{NS}	0.61 ± 0.07 ^{NS}

NS, no significant; * p≤0.05; ** p≤0.01; *** p≤0.001

and their mixtures caused significant ($P \leq 0.05$) decreasing in ALT and AST, as compared to the positive control group. The highest effect was recorded for the PP and its mixture followed by the GG mixture and GG alone treatment. Such effects were increased with the increasing of the

tested plants concentrations. In similar study, Jayanta *et al.,* (2014) reported that, the level of serum ALT and AST did not clarify any abnormal changes in the liver enzymes after treatment by GG. Liver functions were decreased by increasing of PPP level in pan bread (Sayed, 2014). Peel of pomegranate prevented these changes. After treatment with peel, AST and ALT levels decreased and become near to the control level especially ALT value (Hala *et al.,* 2012). Such as reviewed in many studies plant parts including PP and GG are a rich source of different classes of phytochemicals such flavonols, phenolic acids, anthocyanins, alkaloids and organosulfur compounds (Tauseef and Sasi, 2011 and Ankita and Mahesh, 2015). The present study with others reported that the effect of many plant parts on decreasing the serum liver function enzymes activity could be attributed to their high level content of that phytochemicals (Elhassaneen *et al.,* 2013).

Table (5): Effect of feeding pomegranate peel and guar gum powder on liver functions of diabetic rats (Mea ±SD)

Groups	ALT (U / I)	AST (U / I)
Control (-)	20.80 ± 4.15	31.60 ± 3.97
Control (+)	48.60 ± 4.16**	57.80 ± 8.26**
Guar gum (GG, 3% w/w)	28.40 ± 5.86^{NS}	46.80 ± 7.46*
Pomegranate peel (PP, 3% w/w)	33.20 ± 3.70*	34.60 ± 3.58^{NS}
GG (6%, w/w)	25.80 ± 6.49^{NS}	38.60 ± 7.96^{NS}
PP (6%, w/w)	22.40 ± 4.83^{NS}	31.80 ± 7.14^{NS}
GG (3%, w/w) + PP (3%, w/w)	32.40 ± 4.28*	37.60 ± 4.10^{NS}
GG (6%, w/w) + PP (6%, w/w)	21.40 ± 3.91^{NS}	32.00 ± 5.12^{NS}

NS, no significant; * p≤0.05; ** p≤0.01; *** p≤0.001

Data in Table (6) showed the effect of feeding pomegranate peel and guar gum powder on blood lipids profile of diabetic rats. The results indicated that diabetic rats recorded significant increasing for TC ($P \leq 0.001$), TG ($P \leq 0.01$) and LDL-c ($P \leq 0.01$). Feeding of hyperglycemic rats with all levels from PP and GG powders (3% and 6%) and their mixtures caused significant ($P \leq 0.05$ to 0.001) decreasing in TC, TG and LDL-c as compared to the positive control group. The highest effect was recorded for the PP and its mixture followed by the GG mixture and GG alone treatment. Such effects were increased with the increasing of the

tested plants concentrations. The opposite direction was recorded for HDL-c.

These results agree with that obtained by Daumerie and henquin, (2011) who reported that significant decreases in human serum cholesterol levels following GG ingestion.These decreases are through to be a function of its high soluble fiber content. GG may be effective hypolipiedemic agent and may prevent hyperlipidemic on the arthrosclerosis in both hyperlipidemic and normal rats (Hajzadeh *et al*., 2012). GG fiber helps in decreasing the levels of cholesterol in experimental animals (www.webMd, 2017). Also, GG with each meal significantly ($P \leq 0.05$) reduced TG levels, LDL as lower, whereas HDL level was significantly ($P \leq 0.01$) increased (Mahendra *et al*., 2016). Furthermore, the effect of GG on the glycidic metabolic control was inconclusive, but it was shown to be an effective dietetic strategy to reduce blood cholesterol levels (Mirela *et al*., 2006).

Table (6): Effect of feeding pomegranate peel and guar gum powder on blood lipids profile of diabetic rats (Mea ±SD)

Groups	Cholesterol (TC, mg / dI)	Triglycerides (TG, mg / dI)	HDL-c (mg / dI)	LDL-c (mg / dI)
Control (-)	127.40 ± 15.29	97.40 ± 11.23	42.4 ± 3.20	76.82 ± 11.86
Control (+)	$204.20 \pm 20.51^{***}$	$181.20 \pm 13.02^{**}$	$31.00 \pm 4.12^{**}$	$135.56 \pm 20.93^{**}$
Guar gum (GG, 3% w/w)	$162.60 \pm 6.02^{**}$	$128.40 \pm 10.01^{*}$	41.09 ± 3.4^{NS}	$103.92 \pm 8.28^{**}$
Pomegranate peel (PP, 3% w/w)	$143.40 \pm 13.81^{*}$	108.60 ± 14.26^{NS}	41.21 ± 1.9^{NS}	$88.48 \pm 10.99^{*}$
GG (6%, w/w)	$139.20 \pm 8.41^{*}$	$138.00 \pm 18.88^{**}$	41.42 ± 3.4^{NS}	79.80 ± 6.90^{NS}
PP (6%, w/w)	119.60 ± 6.80^{NS}	106.40 ± 13.90^{NS}	45.84 ± 3.3^{NS}	78.86 ± 8.80^{NS}
GG (3%, w/w) + PP (3%, w/w)	$159.20 \pm 13.18^{*}$	$116.80 \pm 8.70^{*}$	43.20 ± 4.2^{NS}	$96.64 \pm 15.25^{*}$
GG (6%, w/w) + PP (6%, w/w)	118.40 ± 4.28^{NS}	98.00 ± 6.32^{NS}	44.04 ± 3.7^{NS}	83.84 ± 9.45^{NS}

NS, no significant; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

In this context, coronary heart disease (CHD) is a major health problem in both industrial and developing countries including Egypt. Many studies have now shown that blood elevated concentrations of total

or low density lipoprotein (LDL) cholesterol in the blood are powerful risk factors for CHD, whereas high concentrations of high density lipoprotein (HDL) cholesterol or a low LDL (or total) to HDL (reviewed in Bedawy, 2008). The composition of the human diet plays an important role in the management of lipid and lipoprotein concentrations in the blood. Reduction in saturated fat and cholesterol intake has traditionally been the first goal of dietary therapy in lowering the risk for cardiovascular disease. In recent years, however, the possible hypocholesrerolemic effects of several dietary components, such as found in our selected plant parts (PP and GG) including, flavonols, phenolic acids, anthocyanins, alkaloids and organosulfur compounds etc have attracted much interest (Tauseef and Sasi, 2011 and Ankita and Mahesh, 2015)

Also, phenolic compounds found in such plant parts exerts its beneficial effects on cardiovascular health by antioxidant and anti-inflammatory activities *(*Anonymous, 1998*).* LDL oxidation and endothelial cell damage is believed to be involved in the early development of atherosclerosis *(*Kaneko *et al., 1994)*. Researchers found that presence of phenolics such quercetin significantly reduced LDL oxidation *in vitro* from various oxidases including 15-lipoxygenase, copper-ion, UV light, and linoleic acid hydroperoxide *(*Aviram *et al.*, 1999*).* Besides the direct antioxidant effect, quercetin also inhibited consumption of *alpha*-tocopherol *(*Kaneko *et al., 1994)* and protected human serum paraxonase (PON 1) activities *(*Aviram *et al., 1999).* Also, McAnlis *et al., 1999)* suggested that quercetin, having a high affinity for protein, was bound to albumin and never incorporated into the LDL particle.

Conclusion

The results of the present study indicated that PP and GG powders improved serum glucose, kidney functions, liver functions and serum lipid profile on diabetic rats. The highest effect was recorded for the PP and its mixture followed by the GG mixture and GG alone treatment. Such effects were increased with the increasing of the tested plants concentrations. Therefore, we recommended the using of PP and GG powders as food additives in our daily dishes and beverages for their nutritional and healthy benefits.

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تأثير مساحيق قشر الرمان وصمغ الغار على الفئران المصابة بمرض السكر المستحث بالألوكسان

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الملخص العربى:

يعد قشر الرمان وحبوب صمغ الغار من الأجزاء النباتية المفيدة غذائيا وصحياً للإنسان. لذلك أجريت الدراسة الحالية بهدف التعرف على تأثير مساحيق قشر الرمان وصمغ الغار على الفئران المصابة بمرض السكر المستحث بالألوكسان. لذلك أجريت الدراسة الحالية على عدد ٤٠ من ذكور الفئران (متوسط أوزانهم ١٤٠ ± ١٠ جم)، تم تقسيمهم عشوائياً إلى مجموعتين رئيسيتين، المجموعة الرئيسية الأولى (٥ فئران) تم تغذيتها على الغذاء الأساسي فقط كمجموعة ضابطة سالبة (فئران صحيحة)، أما المجموعة الرئيسية الثانية (٣٥ فأر) فقد تم إصابتهم بالسكرعن طريق حقنهم بمادة الألوكسان (١٥٠ ملجم / كجم وزن الجسم) ، ثم قسمت تلك المجموعة إلى سبعة مجموعات فرعية ، إحدى هذه المجموعات تم تغذيتهم على الغذاء الأساسي فقط واستخدمت كمجموعة ضابطة موجبة (الفئران المصابة بالسكرى)، وباقي المجموعات تم تغذيتهم على غذاء أساسي يحتوى على مساحيق قشر الرمان وحبوب صمغ الغار بالنسب التالية : ٣, ٦% ومخلوطهما، واستمرت التجربة لمدة خمسة أسابيع. ولقد أظهرت النتائج أن إضافة مساحيق قشر الرمان وحبوب صمغ الغار للفئران المصابة أدى إلى حدوث تحسن ملحوظ في وظائف الكلى (خفض مستويات حمض اليوريك والكرياتينين) وإنزيمات الكبد (ALT الانين امين ترانسفيريز – AST اسبارتات امين ترانسفيريز) ومستوى الجلوكوز ومستويات دهنيات الدم (الكوليسترول الكلى – الجليسريدات الثلاثية – الليبوبروتينات منخفضة الكثافة - الليبوبروتينات مرتفعة الكثافة). واستنتجت الدراسة أن نسبة ٦% من قشر الرمان قد حققت أفضل النتائج يليها مخلوط من ٦% قشر الرمان + ٦% صمغ الغار. لذلك تنصح الدراسة باستخدام مساحيق قشر الرمان وصمغ الغار كإضافات غذائية فى الأطباق الغذائية والمشروبات اليومية لفوائدها الصحية والغذائية العالية خاصة لمرضى السكرى.

الكلمات المفتاحية : قشر الرمان ، صمغ الغار ، وظائف الكلى ، وظائف الكبد ، صورة دهون الدم ، جلوكوز الدم.