Journal of Home Economics

Volume 24, Number (3), 2014

Journal of Home Economics

http://homeEcon.menofia.edu.eg **ISSN 1110-2578**

Effect of Mulberry, Marshmallow and Psyllium Leaves in Biological and Biochemical Changes on Hyperglycemic Rats

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Abstract: The effect of 5% mulberry (Morus alba), marshmallow (Althaea officinalis and psyllium (Plantago ovata) leaves powder in biological and biochemical changes on hyperglycemic rats were evaluated. Diabetic rats induced by injection with alloxan (150 mg/kg of rat's body weight). The results showed that group fed on 5% herbal mixtures showed the highest values of body weight gain, food intake and food efficiency ratio compared with other groups. The highest reduction with significant difference in glucose, alkaline phosphate and glutamic oxaloacetate transaminase (GOT) levels showed with group fed on 5% of mixtures herbals with values 109.1 ± 0.40 mg/dl, 90 ± 0.80 µ/l and 17.21 ± 0.90 µ/l, VS 197 ± 0.90 and 55.82 ± 1.35, µ/l respectively. A markedly reduction in glutamic pyruvate transaminase (GPT) levels by different rates in hyperglycemic rats fed on different herbs and its mixtures was observed. Group fed on 5% herbal mixtures showed the highest reduction with significant difference in serum triglycerides (TG) and total cholesterol values compared with other tested groups. The maximum reduction with significant difference in HDL, LDL and VLDLc values recorded with group fed on 5% herbal mixtures.

Key words: Herbal leaves, Biological and biochemical changes and Hyperglycemic rats,

Introduction

Diabetes mellitus (DM) is common endocrine disorder affecting more than 200 million people worldwide. According to the **International Diabetes Federation**, India has been declared as the diabetes capital of the world. Plant materials which are being used as traditional medicine for the treatment of diabetes are considered one of the good sources for a new drug or a lead to make a new drug **(Nadkarnim, and Nadkarni, 1995)**. Since, ancient times, plants have played an important role in the treatment of many diseases. Different

parts of medicinal plants such as leaf, root, flower and seed are used as extracts and chemical compounds to produce drugs **(Ozgen *et al.*, 2009)**. According to world Health Organization **(WHO)**, 80% of the World's population is dependent on the traditional medicine **(Maiyo *et al.*, 2010)**.

Morus alba (*Moraceae*) belongs to the genus *Morus* which is widely distributed in Asia, Europe, North and South America and Africa. Mulberry (genus *Morus*) is an economically important plant used for sericulture, as a feed for the domesticated silkworm, *Bombyx mori* **(Awasthi *et al.*, 2004)**, and has a long history of medicinal use in Chinese medicine as a herbal medicine called "Sang Bai-Pi". Anti-diabetic use of mulberry leaves had also been popular; moreover, this indication became part of the local traditional medicine wherever the tree has been naturalized. In additions, a large number of herbal preparations (including many food supplements) are worldwide available for diabetes treatment and easily accessible to everyone even via online shopping **(Singab *et al.*, 2005)**. This activity of mulberry leaves has been verified by a number of studies including several animal experiments and a few human trials as well, according to our knowledge, the active constituents and their role in the activity still remain to be fully described. Nevertheless, a complex cocktail of various bioactive constituents is thought to be responsible for this activity, among which the role of iminosugars and certain phenolics mainly chlorogenic acid and rutin might be the most significant (**Hunyadi *et al.*, 2012)**.

Although a more recent and carefully controlled study notice that reduced postprandial glucose and insulin concentrations with psyllium supplementation in type 2 diabetes, other studies found no effect on glycemic control or an effect only when psyllium was sprinkled onto or incorporated into a cereal meal. Psyllium has been shown to significantly reduce postprandial serum glucose and insulin concentrations in non diabetic individuals (**Anderson *et al.*, 1995)**. It is well known that type 2 of diabetes is associated with a significantly increased risk of macrovascular disease. Supplementation of the diet with soluble fiber or consumption of a high- fiber diet has been shown to lower total serum cholesterol and triacylglycerol in type 2 diabetic patients. psyllium *(P. ovate*) also reduced total cholesterol and LDL-cholesterol in animals and in human study, the efficacy and possible modes of action of hot-water extracts of husk of *P. ovata* were evaluated **(Terpstra *et al.*, 2000)**. Psyllium leaves and husk orally seems to significantly reduce postprandial serum glucose, insulin levels, serum total cholesterol, and low-density lipoprotein (LDL) cholesterol levels in patients with Type II diabetes and hypercholesterolemia Blond psyllium seems to reduce postprandial blood glucose levels about 14% to 20%, total cholesterol by about 9%, and LDL cholesterol by 13%. Blonde

psyllium also seems to lower postprandial glucose levels in patients with Type I diabetes. Blond psyllium's had maximum effect on the glucose levels occurs when it is mixed and consumed with foods. Blond psyllium does not lower postprandial glucose in people who do not have diabetes **(Jonathan, 2006)**.

Iauk *et al.*, (2003) reported that based on animal study, marshmallow may lower blood sugar levels. Caution is advised when using herbs or supplements that may also lower blood sugar. Blood glucose levels may require monitoring, and doses may need adjustment. A qualified healthcare professional should monitor patients taking drugs for diabetes by mouth or insulin closely. Medication adjustments may be necessary. Marshmallow may interfere with the absorption of other agents and therefore should be taken 1 hour before or 2 hours after other herbs and supplements. **Ali *et al.*, (2011)** mentioned that *Althaea officinalis* belongs to family Malvaceae. It is one of the medicinal plants used therapeutically since ancient time. The leaves of the *A. officinalis* plant as well as the root are used as medicine. Roots of *A. officinalis* contain mucilage, flavonoids and glycosides. Additionally the leaves contain the coumarin scopoletin. Due to having valuable secondary metabolites it exert potential therapeutic effect. *In vitro* and *in vivo* study of *A. officinalis* indicates significant pharmacological activity in the cough, irritation of the throat, gastric inflammation, anti-diabetic, anti-tumor, antiviral and immune stimulant.

This work was conducted to study the effect of 5% mulberry (*Morus alba*), marshmallow (*Althaea officinalis* and psyllium (*Plantago ovata*) leaves powder in biological and biochemical changes on hyperglycemic rats.

Material & Methods

Materials:

Mulberry (*Morus alba*), marshmallow (*Althaea officinalis*) and psyllium (*Plantago ovate*) leaves were obtained from local market, Menoufia Governorate, Egypt.

Cholesterol powder.

Pure white crystalline cholesterol powder and saline solutions were purchased from SIGMA Chemical Co., (USA).

Casein, cellulose, choline chloride, and DL Methionine.

Casein, cellulose, choline chloride powder, and DL methionine powder, were obtained from Morgan Co. Cairo, Egypt.

Experimental animals.

A total of 30 adult normal male albino rats Sprague Dawley strain weighing 140±10 g were obtained from Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt.

The chemical kits:

Chemical kits used for determination the (TC, TG, HDL-c, ALT, AST, ALP, bilirubin, urea, creatinin, albumin) were obtained from AlGomhoria Company, Cairo, Egypt.

Methods:

Preparations of herbs leaves:

To prepare the dried herbs, mulberry, marshmallows and psyllium leaves were obtained from herbalist. Plants were washed thoroughly under running tap water, shade dried, and ground to a fine powder using an air mill.

Experimental design:

Thirty adult male white albino rats, Sprague Dawley Strain, 10 weeks age, weighing (140±10g) were used in this experiment. All rats were fed on basal diet (casein diet) prepared according to **American Institute of Nutrition (AIN) (1993)** for 7 consecutive days. After this adaptation period, rats are divided into 5 groups, each group which consists of six rats as follows: group (I): rats fed on basal diet as negative control. Group (2): injected by alloxan a dose of 150 mg /kg of rat's body weight and used as a positive control group. Group (3): a group infected diabetic fed on the leaves of mulberry leaves as powder by 5% of the weight of the rat. Group (4): a group infected diabetic fed on the leaves of marshmallow leaves as powder by 5% of the weight of the rat. Group (5): a group infected diabetic fed on the leaves of psyllium leaves as powder by 5% of the weight of the rat. During the experimental period, the body weight and food intake were estimated weekly and the general behavior of rats was observed. The experiment will take 28 days, at the end of the experimental period each rat weight separately then, rats are slaughtered and collect blood samples. Blood samples were centrifuged at 4000 rpm for ten minute to separate blood serum, then kept in deep freezer till using.

3.2.4. Blood sampling:

After fasting for 12 hours, blood samples in initial times were obtained from retro orbital vein, while it obtained from hepatic portal vein at the end of each experiments. Two kind of blood samples were taken. The first parts of blood samples were collected into a dry clean centrifuge glass tubes and left to clot in water bath (37°C) for 30 minutes, then centrifuged for 10 minutes at 4000 rpm to separate the serum, which were carefully aspirated and transferred into clean cuvette tube and stored frozen in deep freezer till analysis.

Body weight gain (BWG), food intake (FI), and feed efficiency ratio (FER):

During the experimental period (28 days) the net food intake was daily recorded, while body weight was weekly recorded. The net food intake and gained body weight were used for the calculation of feed efficiency ratios (FER) as follow:

$$\text{FER \%} = \frac{\text{Body weight gain (g)}}{\text{Food intake (g)}} \times 100$$

Biochemical Analysis:

Lipids profile:

Serum total cholesterol was determined according to the colorimetric method described by **Thomas (1992)**.

2.3.1.3. Determination of serum triglycerides:

Serum triglycerides was determined by enzymatic method using kits according to the **Young, (1975) and Fossati, (1982)**.

2.3.1.4. Determination of high density lipoprotein (HDLc):

HDLc was determined according to the method described by **Fredewaid (1972) and Grodon and Amer (1977)**.

2.3.1.5. Calculation of very low density lipoprotein cholesterol (VLDLc):

VLDLc was calculated in mg/dl according to **Lee and Nieman (1996)** using the following formula:

VLDLc (mg/dl) = Triglycerides / 5

2.3.1.6. Calculation of low density lipoprotein cholesterol (LDLc):

LDLc was calculated in mg/dl according to **Lee and Nieman (1996)** as follows:

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

2.3.1.7. Determination of total lipids:

Determination of total lipids in serum was colorimetrically determined according to **Schmitt and Drevon (1964)**.

Liver functions:

Determination of serum alanine aminotransferase (ALT), serum asparatate aminotransferase (AST), serum alkaline phosphatase (ALP) were carried out according to the method of **(Clinica Chimica Acta 1980**, **Hafkenscheid 1979 and Moss 1982**),respectively.

Kidney functions:

Determination of serum urea:

Serum urea and serum creatinin were determinated by enzymatic method according to **(Patton and Crouch 1977** and **Henry 1974)**.

Determination of blood glucose:

Enzymatic determination of plasma glucose was carried out calorimetrically according to the method of **Tinder (1969).**

Statistical analysis:

The data were analyzed using a completely randomized factorial design **(SAS, 1988)** 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

Body weight gain, food intake and food efficiency Ratio

Data given in table (1) show the body weight gain, food intake and food efficiency ratio of control positive and different diabetic groups rats fed on 5% mulberry, marshmallow, psyllium and their mixtures. It's clear to notice that, body weight gain for control positive was lower than control negative. The values were 8.4± 0.20 and 28 ± 0.40 g, respectively. Concerning BWG % for group fed on 5% herbal mixtures showed highest value with significant differences as compared with control positive being (36.4 ±0.50, and 8.4 ± 0.20 g). While the lowest value recorded with group fed on 5% psyllium. The value was 16.8 ± 0.90 g. In case of food intake (FI), data indicated that food intake for control positive was lower than control negative. Group fed on 5% herbal mixtures showed highest value with significant differences as compared with other groups (5% mulberry, 5% marshmallow and 5% psyllium). The values were 509.6 ±0.70, 498.4 ±1.00, 495.6 ±0.20 and 492 ± 0.50 g/day, respectively). On the other hand, food efficiency ratio of control positive recorded the lowest value being, 0.019 ± 0.002 %. While the highest value of food efficiency ratio with significant difference recorded with group fed on 5% herbal mixtures. The value was 0.071 ±0.008 %. Finally, it could be concluded that group fed on 5% herbal mixtures showed the highest values of body weight gain, food intake and food efficiency ratio compared with other groups. These results are in agreement with those of **(Sahu, 2004)**.

Effect of mulberry, marshmallow, psyllium and herbal mixtures on glucose of hyperglycemic rats

Data presented in table (2) showed the effect of mulberry, marshmallow, psyllium and their mixtures on glucose of hyperglycemic rats. The highest reduction with significant difference in glucose levels recorded with group fed on 5% herbal mixtures with value 109.1 ± 0.40 mg/dl. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium recorded a moderate reduction with significant difference in glucose levels. The values were 111.7 ± 0.50, 115.2 ± 0.80 and 124.5 ± 0.90 mg/dl, respectively. Finally, it could be concluded that group fed on 5% mixtures herbal showed the highest reduction with significant difference in glucose levels compared with other tested groups. These results are in agreement with those of **(Shukla *et al.*, 2000)**, they found that mulberry leaves powder incorporated products had improved fasting blood sugar of the diabetic subjects studied.

Effect of mulberry, marshmallow, psyllium and herbal mixtures on(ALP), (GOT) and (GPT) of hyperglycemic rats:

Data given in table (3) show the effect of mulberry, marshmallow, psyllium and their mixtures on (ALP) of hyperglycemic rats. The highest reduction with significant difference in alkaline phosphate levels recorded with group fed on 5% herbal mixtures compared with positive control group. The values were 90± 0.80 VS 197 ± 0.90µ/l, respectively. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium recorded a moderate reduction with significant difference in alkaline phosphate levels. The values were 135 ± 2.10, 105 ± 1.10 and 123 ± 0.50µ/l, respectively. Finally, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in alkaline phosphate levels compared with other tested groups. These results are in agreement with those of **(Chaurasia *et al.* 2011)**.

The effect of 5% mulberry, marshmallow, psyllium and their mixtures on (GOT) of hyperglycemic rats is shown in table (3). It is obvious that a markedly reduction in (GOT) levels in hyperglycemic rats fed on different herbs and its mixtures was observed. The highest reduction with significant difference in (GOT) levels recorded with group fed on 5% herbal mixtures compared with positive control group. The values were 17.21± 0.90 and 55.82 ± 1.35, respectively. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium recorded a moderate reduction with significant difference in glutamic oxaloacetate transaminase levels. The values were 39.4 ± 2.05, 31± 0.60 and 27.15 ± 1.25, respectively. Finally, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in glutamic oxaloacetate transaminase levels compared with other tested

groups. These results are in agreement with those of **(Chaurasia *et al.* 2011)**. They reported that treatment with a mixture of white and black mulberry leaves produce a marked significant decrease of the elevated AST and ALT activities.

The effect of 5% mulberry, marshmallow, psyllium and herbal mixtures on (GPT) of hyperglycemic rats is shown in table (3). It is clear to notice that a markedly reduction in (GPT) levels by different rates in hyperglycemic rats fed on different herbs and its mixtures was observed. The highest reduction with significant difference in (GPT) levels recorded with group fed on 5% herbal mixtures compared with positive control group. The values were 6.0 ± 0.60 VS 20.70± 0.40 U/L, respectively. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium recorded a moderate reduction with significant difference in (GPT) levels. The values were 9.20± 1.20, 10.93±0.90 and 8.81 ± 0.50, respectively. Finally, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in (GPT) levels compared with other tested groups. These results are in agreement with those of **(Mahmoud *et al.*, 2014)**.

3.6. The effect of mulberry, marshmallow, psyllium and herbal mixture on Serum Triglycerides (T.G) and Serum Total cholesterol (TC) of hyperglycemic rats

The effect of 5% mulberry, marshmallow, psyllium and herbal mixtures on serum (T.G) and (T.C) of hyperglycemic rats is shown in table (4). It is clear to notice that the serum triglycerides level of control positive group was higher than control negative group. The values were 135.15 ±3.81and 55.81 ± 0.52 mg/dl, respectively. On the other hand, the maximum reduction with significant difference in serum triglycerides value recorded with group fed on 5% herbal mixtures. The values were 57.63± 2.66 mg/dl. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium showed high reduction with no significant difference in serum triglycerides when compared with vet. The values were 60.42 ± 0.70, 78.33 ± 1.10 and 70.14 ± 2.15 g/dl, respectively. From the obtained result, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in serum triglycerides value compared with other tested groups. These results are in agreement with those of **(Anderson *et al.*, 1999)**.

Concerning of total cholesterol, the obtained result indicated that the total cholesterol level of control positive group was higher than control negative group. The values were 140.00 ± 1.10 and 94.00 ± 0.70 mg/dl, respectively. On the other hand, the maximum reduction with significant difference in total cholesterol value recorded with group fed on 5% their mixtures, with value 103.00 ± 0.80 mg/dl. While other

groups fed on 5% mulberry, 5% marshmallow and 5% psyllium showed high reduction with significant difference in total cholesterol value. The values were $107.00^{d} \pm 0.60$, $128.00^{c} \pm 0.50$ and $130.00^{b} \pm 0.30$ g/dl, respectively. From the obtained result, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in total cholesterol value compared with other tested groups. These results are in agreement with those of **(Sonali *et al.*, 2013)**. They found that mulberry leaves powder incorporated products had improved lipid profile of the diabetic subjects studied. The data indicate that maximum improvement was observed in the value of experimental group, which shows the hypoglycemic and hypocholesteromic effects of mulberry leaves.

Effect of mulberry, marshmallow, psyllium and herbal mixtures on Very low density lipoprotein cholesterol and high density lipoprotein cholesterol and low density lipoprotein cholesterol of hyperglycemic rats:

Data presented in table (5) showed the effect of 5% mulberry, marshmallow, psyllium and herbal mixtures on serum of very low density lipoprotein cholesterol, high density lipoprotein cholesterol and low density lipoprotein cholesterol of hyperglycemic rats. It is clear to mention that the very low density lipoprotein cholesterol level of control positive group was higher than control negative group. The values were 27.03± 1.20 and 11.16± 0.69 mg/dl, respectively. On the other hand, the maximum reduction with significant difference in very low density lipoprotein cholesterol value recorded with group fed on 5% herbal mixtures. The value was 11.53±2.20 mg/dl, while other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium showed reduction with significant difference in very low density lipoprotein cholesterol value. The values were 12.08 ± 1.72, 15.67 ± 0.90 and 14.03± 1.60 g/dl, respectively. Finally, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in very low density lipoprotein cholesterol value compared with other tested groups. These results are in agreement with those of **(Andallu *et al.*, 2009)**. They found that a significant decrease in cholesterol, triglyceride, free fatty acid LDL cholesterol, VLDL Cholesterol levels and a significant rise in HDL Cholesterol levels in mulberry treated group. In case of high density lipoprotein cholesterol, the obtained result indicated that the high density lipoprotein cholesterol level of control positive group was lower than control negative group. The values were 27.67 ± 1.71and 43.05± 2.80 mg/dl, respectively. On the other hand, the maximum increment with significant difference in high density lipoprotein cholesterol value recorded with group fed on 5% herbal mixtures. The value was 45.51 ±1.9 mg /dl. While other groups fed on

5% mulberry, 5% marshmallow and 5% psyllium showed increment with significant difference in high density lipoprotein cholesterol value with vet. The values were 40.46 ±1.38, 37.61±0.50 and 39.94± 0.90 g/dl VS27.67, respectively. From the obtained result, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in high density lipoprotein cholesterol value compared with other tested groups. These results are in agreement with those of **(Rodríguez-Morán *et al.*, 1998)**. On the other hand, data from table (5) also, indicated that the low density lipoprotein cholesterol level of control positive group was higher than control negative group. The values were 85.30± 1.58 and 39.79± 0.93 mg/dl, respectively. The obtained results showed that, the maximum reduction with significant difference in low density lipoprotein cholesterol value recorded with group fed on 5% herbal mixtures. The value was 45.96±2.15 mg/dl. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium showed no significant difference between marshmallow and psyllium at level 5 % while there was significant difference between other all groups. Values of serum LDL-c were 54.46± 1.91, 74.72±0.83 and 76.03±2.41g/dl for G1, G2, G3 and G4, respectively. Finally, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in low density lipoprotein cholesterol value compared with other tested groups. These results are in agreement with those of **(Tsuduki, *et al.*, 2009)**. Also, **Aygustin and Dwyer (1999)** mentioned that soluble and insoluble psyllium fibers have their role in reducing total serum and LDL cholesterol and consequently reduce the risk of heart diseases**.**

Effect of mulberry, marshmallow, psyllium and herbal mixtures on serum urea and serum uric acid of hyperglycemic rats:

Data given in table (6) show the effect of 5% mulberry, marshmallow, psyllium and herbal mixtures on serum urea and serum uric acid of hyperglycemic rats. It is clear to notice that the urea level of control positive group was higher than control negative group. The values were 73.65 ±3.20 and 42.20 ± 2.10 mg/dl, respectively. On the other hand, the highest reduction with significant difference in serum urea value recorded with group fed on 5% herbal mixtures. The value was 46.25± 0.50 mg/dl. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium showed reduction with significant difference in serum urea value. The values were 50.96± 1.60, 58.27 ± 0.90 and 60.03± 1.30 g/dl, respectively. From the obtained result, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in urea value compared with other tested groups. These results are in agreement with those of **(Jarald *et al.* 2008)** they showed that diabetic rats had a significant

increase in creatinine and BUN levels as compared to the normal animals. In case of serum uric acid, in table (6) the serum uric acid level of control positive group was higher than control negative group. The values were 3.97 ± 0.90 and 2.11± 0.20 mg/dl, respectively. On the other hand, the maximum reduction with no significant difference in uric acid value recorded with group fed on 5% herbal mixtures. The value was 1.95± 1.10 mg/dl. While other groups fed on 5% mulberry, 5% marshmallow and 5% psyllium showed high reduction with no significant difference in uric acid value by different rates. The values were 2.27± 0.60, 2.60± 0.30 and 2.91 ± 0.70 g/dl, respectively. From the obtained result, it could be concluded that group fed on 5% herbal mixtures showed the highest reduction with significant difference in uric acid value compared with other tested groups. These results are in agreement with those of **(Dorothy, and Shahidul, (2015)**. They found that significantly increased serum ALT, as well as significantly decreased serum total protein and albumin and serum uric acid.

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Table (1): Effect of mulberry, marshmallow, psyllium and their mixtures on BWG, FI and FER of hyperglycemic rats

	Body Weight Gain (g)		**Food Intake (g/day)**		**Food Efficiency ratio (%)**	
	G/28 day	**% of Change**	**G /28 day**	**% of Change**	**G /28 day**	**% of Change**
G_1 control (-)	$28^{b} \pm 0.40$	+ 233.3	$504^{b} \pm 0.70$	+13.25	$0.056^{b} \pm 0.007$	+196.23
G_2 control (+)	$8.4^{f} \pm 0.20$	……	$445^{f} \pm 0.60$	……	$0.019^{e} \pm 0.002$	……
G_3 (5%Mulberry)	$21^{d} \pm 0.80$	+150	$498.4^{c} \pm 1.00$	+12	$0.042^{cd} \pm 0.005$	+122.64
G_4 (5%Marshmallow)	$25.2^{c} \pm 0.60$	+200	$495.6^{d} \pm 0.20$	+11.37	$0.051^{bc} \pm 0.003$	+169.81
G_5 (5%Psyllium)	$16.8^{e} \pm 0.90$	+100	$492^{e} \pm 0.50$	+10.56	$0.034^{d} \pm 0.004$	+79.25
G_6 (5%Herbal mixtures)	$36.4^{a} \pm 0.50$	+333.3	$509.6^{a} \pm 0.70$	+14.52	$0.071^{a} \pm 0.008$	249.1
LSD	**1.092**	**----**	**1.18**	**----**	**0.009**	**---**

Each value is represented as mean ± SD (n = 3).

Mean under the same line bearing different superscript letters are different significantly ($p < 0.05$).

Table (2) Effect of mulberry, marshmallow, psyllium and their mixtures on glucose of hyperglycemic rats

Groups	Glucose (mg/dl)	% Change compared with (vet)
G_1 control (-)	$108^{e} \pm 0.70$	-53.04
G_2 control (+)	$230^{a} \pm 1.10$	----
G_3 (5%Mulberry)	$111.7^{d} \pm 0.50$	- 51.43
G_4 (5%Marshmallow)	$115.2^{c} \pm 0.80$	-49.91
G_5 (5%Psyllium)	$124.5^{b} \pm 0.90$	- 45.87
G_6 (5%Herbal mixtures	$109.1^{e} \pm 0.40$	- 52.57
LSD	1.37	----

Each value is represented as mean ± SD (n = 3).

Mean under the same line bearing different superscript letters are different significantly ($p < 0.05$).

Table (3): Effect of mulberry, marshmallow, psyllium and their mixtures on (ALP), (GOT) and (GPT) of hyperglycemic rats

Groups	(ALT) U/L	% Change compared with (vet)	(GOT) U/L	% of Change	(GPT) U/L	% Change compared with (vet)
G_1 C (-)	$95^{e} \pm 1.70$	- 51.87	$9.22^{f} \pm 1.10$	- 83.48	$6.50^{d} \pm 0.80$	- 68.60
G_2 C (+)	$197^{a} \pm 0.90$	……	$55.82^{a} \pm 1.35$	----	$20.70^{a} \pm 0.40$	----
G_3 (5%Mulberry)	$135^{b} \pm 2.10$	-31.61	$39.4^{b} \pm 2.05$	-29	$9.20^{c} \pm 1.20$	- 55.56
G_4 (5%Marshmallow)	$105^{d} \pm 1.10$	-46.81	$31^{c} \pm 0.60$	-44.46	$10.93^{b} \pm 0.90$	- 47.20
G_5 (5% Psyllium)	$123^{c} \pm 0.50$	-37.69	$27.15^{d} \pm 1.25$	- 51.36	$8.81^{c} \pm 0.50$	- 57.49
G_6 (5% Herbal mixtures)	$90^{f} \pm 0.80$	-54.41	$17.21^{e} \pm 0.90$	- 69.16	$6.0^{d} \pm 0.60$	- 71.01
LSD	**2.32**	----	2.29	----	**1.39**	----

Each value is represented as mean ± SD (n = 3).

Mean under the same line bearing different superscript letters are different significantly ($p < 0.05$).

Table (4) Effect of mulberry, marshmallow, psyllium and their mixtures on Serum Triglycerides (T.G) and Serum Total cholesterol (TC) of hyperglycemic rats

Groups	Triglycerides (TG) mg/dl	% Change compared with (vet)	Total cholesterol (TC) mg/dl	% Change compared with (vet)
G_1 Control (-)	$55.81^{e} \pm 0.52$	- 58.70	$94.00^{f} \pm 0.70$	- 32.86
G_2 Control (+)	$135.15^{a} \pm 3.81$	----	$140.00^{a} \pm 1.10$	----
G_3 (5%Mulberry)	$60.42^{d} \pm 0.70$	-55.29	$107.00^{d} \pm 0.60$	- 23.57
G_4 (5%Marshmallow)	$78.33^{b} \pm 1.10$	- 42.04	$128.00^{c} \pm 0.50$	- 8.57
G_5 (5% Psyllium)	$70.14^{c} \pm 2.15$	- 48.30	$130.00^{b} \pm 0.30$	- 7.14
G_6 (5% Herbal mixtures)	$57.63^{de} \pm 2.66$	- 57.36	$103.00^{e} \pm 0.80$	- 26.43
LSD	**3.67**	**----**	**1.27**	----

Each value is represented as mean ± SD (n = 3).

Mean under the same line bearing different superscript letters are different significantly ($p < 0.05$).

Table (5): Effect of mulberry, marshmallow, psyllium and their mixtures on Very low density lipoprotein cholesterol ($VLDL_C$) and high density lipoprotein cholesterol(HDL_C) and low density lipoprotein cholesterol(LDL_C) of hyperglycemic rats

	Very low density lipoprotein		High density lipoprotein (mg/dl)		Low density lipoprotein (mg/dl)	
	($VLDL_C$) (mg/dl)	% Change compared with (vet)	(HDL_C) (mg/dl)	% Change compared with (vet)	(LDL_C) (mg/dl)	% Change compared with (vet)
G_1 C (-)	11.16^{d}± 0.69	- 57.08	43.05^{ab} ± 2.80	+ 55.58	39.79^{e}± 0.93	- 53.35
G_2 C (+)	27.03^{a}± 1.20	----	27.67^{d} ± 1.71	----	85.30^{a}± 1.58	----
G_3 (5%Mulberry)	12.08^{cd} ± 1.72	- 55.31	40.46^{bc} ±1.38	+ 46.22	54.46^{c}± 1.91	- 36.15
G_4 (5%Marshmallow)	15.67^{b} ± 0.90	- 42.03	37.61^{c}±0.50	+ 35.92	74.72^{b}±0.83	+ 12.43
G_5 (5%Psyllium)	14.03^{bc}± 1.60	- 48.09	39.94^{bc}± 0.90	+ 44.34	76.03^{b}±2.41	+ 10.86
G_6 (5%Herbal mixture)	11.53^{cd}±2.20	- 57.34	45.51^{a} ±1.9	+64.47	45.96^{d}±2.15	+ 46.12
LSD	**2.63**	**----**	**3.02**	**----**	**3.10**	**----**

Each value is represented as mean ± SD (n = 3).

Mean under the same line bearing different superscript letters are different significantly ($p < 0.05$).

Table (6): Effect of mulberry, marshmallow, psyllium and their mixtures on urea and uric acid of hyperglycemic rats

Groups	Serum urea (mg/dl)	% Change compared with (vet)	Serum uric acid (mg/dl)	% Change compared with (vet)
G_1 Control (-)	$42.20^{e} \pm 2.10$	- 42.70	$2.11^{b} \pm 0.20$	- 46.85
G_2 Control (+)	$73.65^{a} \pm 3.20$	----	$3.97^{a} \pm 0.90$	----
G_3 (5%Mulberry)	$50.96^{c} \pm 1.60$	- 30.81	$2.27^{b} \pm 0.60$	- 42.82
G_4 (5%Marshmallow)	$58.27^{b} \pm 0.90$	- 20.88	$2.60^{b} \pm 0.30$	- 34.51
G_5 (5%Psyllium)	$60.03^{b} \pm 1.30$	- 18.49	$2.91^{ab} \pm 0.70$	- 26.70
G_6 (5%Herbal mixtures)	$46.25^{d} \pm 0.50$	- 37.20	$1.95^{b} \pm 1.10$	- 50.88
LSD	3.24		1.26	

Each value is represented as mean ± SD (n = 3).

Mean under the same line bearing different superscript letters are different significantly ($p < 0.05$).

Journal of Home Economics, Volume 24, Number (3), 2014

تأثير أوراق التوت والخطمية ولسان الحمل على بعض التغيرات البيولوجية والكيموحيوية فى الفئران المصابة بمرض السكر

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الملخص

تم فى هذا البحث تقييم تأثير تركيز ٥٪ من كل من مسحوق أوراق التوت والخطمية ولسان الحمل بصفتها منفردة أو مجتمعة على التغيرات البيولوجية والبيوكيميائية فى الفئران المصابة بالسكر. حيث تم إصابة الفئران بمرض السكري عن طريق الحقن بواسطة آلوكسان (١٥٠ ملجم / كجم من وزن الجسم للفأر). وأظهرت النتائج المتحصل عليها أن مجموعة الفئران التى تغذت على مخلوط الأعشاب بتركيز ٥٪ قد أظهرت أعلى القيم من حيث الزيادة في وزن الجسم، وتناول الطعام ونسبة كفاءة الغذاء مقارنة مع المجموعات الأخرى المختبرة. بينما كان أكبر انخفاض مع وجود فرق معنوى كبير في مستويات السكر تم تسجيلها مع مجموعة الفئران التى تغذت على مخلوط الأعشاب بتركيز ٥٪, حيث كانت القيم ١٠٩,١ ± ٠,٤٠ ملجم / ديسيلتر. بينما كان أعلى انخفاض مع اختلاف كبير في درجة نشاط انزيم الفوسفاتيز القاعدى سجلت مع مجموعة الفئران التى تغذت على مخلوط الأعشاب بتركيز ٥٪ مقارنة مع المجموعة الضابطة الموجبة. وكانت القيم ٩٠ ± ٠,٨٠ و١٩٧ ± ٠,٩٠ميكروليتر/ لتر، على التوالي. ومن ناحية أخرى كان أعلى انخفاض مع اختلاف كبير في مستويات GOT سجلت مع مجموعة الفئران التى تغذت على مخلوط الأعشاب بتركيز ٥٪ مقارنة بالمجموعة الضابطة الموجبة. حيث كانت القيم ١٧,٢١ ± ٠,٩٠ و ٥٥,٨٢ ± ١,٣٥، على التوالي. كذلك لوحظ وجود انخفاض بشكل ملحوظ في مستويات GPT بنسب مختلفة في الفئران المصابة بسكر الدم والتى تغذت على الأعشاب مخلوطهم معا. وأظهرت مجموعة الفئران التى تغذت على مخلوط الأعشاب بتركيز ٥٪ أعلى انخفاض مع اختلاف كبير في كلا من الدهون الثلاثية في الدم والكوليسترول الكلى مقارنة مع المجموعات الأخرى المختبرة. وكان الحد الأقصى لانخفاض قيم كل من الكولستيرول منخفض الكثافة والكولستيرول مرتفع الكثافة ، ,الكولستيرول منخفض الكثافة جدا مع وجود فروق معنوية سجلت مع مجموعة الفئران التى تغذت على مخلوط الأعشاب بتركيز ٥٪.