Anti-diabetic Effect of Persimmon (*Diospyros kaki*) Fruits in Alloxan-Induced Diabetic Rats

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Abstract

The effect of different concentrations (5,7.5 and 10%) of persimmon fruits (*Diospyros kaki*) on diabetic rats were evaluated. Thirty rats were used in this study and divided into 5 groups, each group contain 6 rats. Rats were treated by aloxan (150mg/kg B.W) to induced diabetic. Results showed that the highest body weight gain, feed intake and feed efficiency ratio recorded for 10 % persimmon fruits, while the lowest recorded for 5 % persimmon fruits with no significant difference between persimmon treatments. Rat groups fed on 10% persimmon fruit recorded the highest liver, kidney and spleen weight. Rats fed on 10 % persimmon recorded the lowest glucose level with significant differences being, 97.53 mg/dl. The lower ALT and GOT liver enzyme of treated group which recorded for group fed on 10 % persimmon fruits, but the highest value recorded for group fed on 5 % persimmon fruits with significant difference. The highest GPT liver enzyme of treated group which recorded for group fed on 7.5 % persimmon fruits. Lowest value of triglyceride and cholesterol recorded for group fed on 10 % persimmon fruit. The highest HDL-c of treated group recorded for group fed on 10 % persimmon fruits. While, the highest LDL-c and VLDL-c of treated group recorded for rats fed on 5 % persimmon fruits. The highest urea and uric acid levels of treated group which recorded for group fed on 7.5 % persimmon fruits. While, the highest creatinine level of treated group which recorded for group fed on 5 % persimmon fruits.

Key words: Persimmon fruits, Rats, Anti-diabetic and Biochemical analysis.

Introduction

Diabetes mellitus (DM) is a chronic disease caused by inherited and/or acquired deficiency in production of insulin by the pancreas, or by the ineffectiveness of the insulin produced. Such a deficiency results in increased concentrations of glucose in the blood, which in turn damage many of the body's systems, in particular the blood vessels and nerves **(Nagappa *et al.,* 2003).**

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)**.

Diabetes is the world's largest endocrine disease associated with increased morbidity and mortality rate. Diabetes mellitus is also associated with long term complications including retinopathy, nephropathy, neuropathy and angiopathy and several others **(Sharma *et al.,* 2010)**.

A variety of ingredients present in medicinal plants are thought to act on a variety of targets by various modes and mechanisms. They have potential to impart therapeutic effect in complicated disorders like diabetes and its complications **(Tiwari and Rao, 2002)**.

Medicinal plants are gradually gaining global acceptability given their potential as bioactive agents to be used as pharmaceuticals. New hypoglycemic agents derived from plants have shown both hypoglycemic action and the ability to improve some of the secondary complications of diabetes such as kidney damage, fatty liver, and oxidative stress. In addition, some tropical herbs offer both benefits as it has been recently informed in experimental models **(Fonseca *et al.,* 2012).**

Among the fruits, persimmon (*Diospyros kaki*) is a popular and widespread fruit that is enriched with many bioactive compounds, including polyphenols, terpenoids, steroids, flavonoids, carotenoids, minerals, and dietary fiber. Some components like phenolics, antioxidants, sterols, and flavonoids have a beneficial effect on human health owing to their ability to prevent or control various ailments (**Karaman *et al.,* 2014).**

Persimmon (*Diospyros kaki* L.) is an important horticultural crop which has many cultivated varieties. Based on the statistics of FAO , the annual production of persimmon in China is about 2.68 million tons, accounting for about 70.0% of the total world production (**FAO, 2010).**

Persimmon fruit contains different nutrients and phytochemicals such as carbohydrates, organic acids, vitamins, tannins, polyphenols, dietary fibers and carotenoids etc., which play important roles in the flavor, color, nutritive and pharmaceutical value of the fruit (**Celik *et al.*, 2007**).

Persimmons revealed considerable health and medicinal benefits, which are considered to be related to the various hydrophilic and lipophilic antioxidants including phenolic compounds, vitamin C and carotenoids, contained in the fruit (**George and Redpath, 2008**).

Traditionally, persimmon fruit have been used for their medicinal properties, such as their blood pressure-lowering and diuretic effects. A persimmon supplemented diet had a lipid-lowering effect and positively influenced organ functions in streptozotocin induced diabetic rats. Persimmon fruit improved also lipid metabolism in rats fed diets containing cholesterol and showed antigenotoxic effect . Furthermore, persimmon has been shown to have antitumor properties on several tumor cell lines in vitro and has been associated with an inhibitory effect on human lymphoid leukemia cells (**Quan *et al.*, 2012**).

Azadbakhta *et al.*, (2010) demonstrate that aqueous fruits extracts of *D. kaki, L.* possesses antidiabetic properties suggesting the presence of biologically active components which may be worth further investigation and elucidation. The effective anti-diabetic dose was also found to be 1000 mg/kg body weight. These results suggest that the product of *D. kaki, L.* may provide a new therapeutic avenue against diabetes and diabetes-related complications a global burden.

Material and Methods
Materials:
Persimmon (*Diospyros kaki*) fruits was obtained from local market, Shibin El-Kom City, Menoufia Governorate, Egypt.
Cholesterol powder:
Alloxan, it waspure chemical fine product (DBH) were purchased from SIGMA Chemical Co., (USA), and was used for induction of diabetes among rats.
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, urea, uric acid and creatinine) were obtained from Al-Gomhoria Company, Cairo, Egypt.

Methods:

Preparations of herb leaves:

To prepare the dried persimmon fruit was obtained from local market. Fruits was 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 **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 persimmon fruit as powder by 5% of the weight of basal diet. Group (4): A group infected diabetic fed on persimmon fruit as powder by 7.5% of basal diet. Group (5): A group infected diabetic fed on persimmon fruit as powder by 10 % of basal diet. During the experimental period, the body weight and feed intake were estimated weekly and the general behavior of rats was observed. The experiment period was 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, and then kept in deep freezer till using.

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 according to method described by **Schermer (1967)**.

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

During the experimental period (28 days) the net feed intake was daily recorded, while body weight was weekly recorded. The net feed intake and gained body weight were used for the calculation of feed efficiency ratios (FER) according to **Chapman *et al.,* (1959)** as follow:

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

Biochemical analysis:
Lipids profile:
Determination of total cholesterol:

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

Determination of serum triglycerides:

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

Determination of high density lipoprotein (HDL-c):

HDL-c was determined according to the method described by **Friedewaid (1972) and Grodon and Amer (1977)**.

Calculation of very low density lipoprotein cholesterol (VLDL-c):

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

VLDL-c (mg/dl) = Triglycerides / 5

Calculation of low density lipoprotein cholesterol (LDL-c):

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

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

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

Kidney functions:
Determination of serum urea:
Serum urea and serum creatinin were determinated by enzymatic method according to **(Henry (1974)** and **Patton & Crouch 1977)**.
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
Data given in Table (1) show the changes of body weight, feed intake and feed efficiency ratio of diabetic rats fed diet supplemented with persimmon fruits. The obtained results showed that the body weight gain (BWG) g/28 day of positive control recorded the highest value when compared with negative control with significant difference. The mean values were 69.7 and 50.8 g/28 day, respectively.

From diabetic rat groups, it is clear to notice that the highest (BWG) % recorded for 10 % persimmon fruit, while the lowest BWG% recorded for 5 % persimmon fruit with non significant difference. The mean values were 55.3, 54.6 and 53.1 g/28 day, respectively.

In case of feed intake, it could be notice that the feed intake (FI) g/ day of positive control recorded the highest value when compared with negative control with significant difference. The mean values were 14.48 and 13.0 g/ day, respectively. While, 10 % persimmon fruit recorded the highest FI while the lowest value recorded for 5 % persimmon fruit with significant difference. The mean values were 14.40 and 13.98 g/ day, respectively.

On the other hand, feed efficiency ratio (FER) of negative positive control recorded the highest value when compared with positive control with significant difference. The mean values were 0.194 and 0.172 %, respectively. In case of treated rat groups, it clear to mention that 10 % persimmon fruits recorded the highest FER while, the lowest value recorded for 5 and 7.5% persimmon fruits. The mean values were 0.137, 0.136 and 0.136 %, respectively. These results are in agreement with **Chen and Ianuzzo (1982),** they found that a significant weight loss was observed in

the diabetic group and significant improvement in weight was observed in the groups treated with *D. lotus,* L. This may be due to the ability of *D. lotus L.* to reduce hyperglycemia.

Data presented in Table (2) show the changes of organs weight in the diabetic rats fed diet supplemented with persimmon fruit.

It is clear to notice that the liver weight of positive control group recorded the highest value when compared with negative control group with significant difference. The mean values were 7.12 and 6.10 g, respectively. While, group fed on 10% persimmon fruits recorded the highest liver weight while the lowest value recorded for 7.5%. The mean values were 6.62 and 6.22g, respectively.

On the other hand, kidney weight of positive and negative control groups recorded the same values being, 1.25 g. While, group fed on 5 and 10% persimmon fruit recorded the highest kidney weight while the lowest value recorded for 7.5%. The mean values were 1.125 and 0.975 g, respectively.

In case of spleen weight, the positive and negative control groups recorded the same values being, 0.825 g. While, group fed on 10% persimmon fruits recorded the highest spleen weight while the lowest value recorded for 7.5%. The mean values were 0.850 and 0.775g, respectively. These results are in agreement with **Ahn *et al.,* (2002).**

Data presented in Table (3) show the effect of persimmon on glucose of diabetic rats. The obtained results indicated that the highest glucose level recorded for positive control group, while the lowest level recorded for negative control group with significant differences. The mean values were 198 and 96 mg/dl, respectively.

On the other hand, rats fed on 10 % persimmon recorded the lowest glucose level with significant differences being, 97.53 mg/dl. While, the higher glucose level in diabetic rats recorded for 5 % persimmon with significant differences. The value was 117 mg/dl. It could be concluded that increasing persimmon levels showed highest reduction in glucose level. These results are in agreement with **Azadbakhta *et al.,* (2010)**, they reported that oral administration of *D. lotus, L.* fruits extract for 16 days effectively controlled hyperglycemia, due to the presence of biologically active components. The product of *D. lotus, L.* may provide a new therapeutic avenue against diabetes and diabetes-related complications a global burden.

Data given in Table (4) show the effect of persimmon on (ALP), (GOT) and (GPT) of diabetic rats. The obtained results indicated that the

ALT liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 197.0 and 95.0 U/L, respectively. While, the highest ALT liver enzyme of treated group recorded for group fed on 5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 135.0 and 90.0 U/L, respectively.

On the other hand, GOT liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 55.82 and 9.22 U/L, respectively. While, the highest GOT liver enzyme of treated group recorded for group fed on 5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 39.4 and 17.21 U/L, respectively.

In case of GPT liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 20.7 and 6.5 U/L, respectively. While, the highest GPT liver enzyme of treated group recorded for group fed on 7.5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 10.93 and 6.0 U/L, respectively. These results are in agreement with **Sochar et al., (1985)**, they reported that the persimmon fruits extract maintains the blood glucose to normoglycemia during diabetes, which acts as an essential trigger for both liver and kidney to revert to their normal metabolic homeostasis. The liver and kidney exhibits numerous morpho-logical and functional alterations during diabetes.

The effect of persimmon fruits on the serum lipid profiles of diabetic rats are shown in Table (5). The obtained results indicated that the triglyceride of positive control group recorded the highest value when compared with negative control group with significant difference. The mean values were 223.2 and 81.3 mg/dl, respectively. While, the lowest triglyceride recorded for group fed on 10 % persimmon fruit while the highest value recorded for 5% persimmon fruit with significant difference. The mean values were 145.9 and 169.1 mg/dl, respectively.

In the other hand, the cholesterol levels of positive control group recorded the highest value when compared with negative control group with significant difference. The mean values were 97.0 and 63.5 mg/dl, respectively. While, the lowest cholesterol levels recorded for group fed on 10 % persimmon fruit while the highest value recorded for 5% persimmon

fruit with significant difference. The mean values were 64.6 and 72.6 mg/dl, respectively. These results are in agreement with **Gorinstein *et al.,* (2000)**, they mention that persimmon is one of nutritious entities that hold hypocholesterolemic effects. The reasons include presence of bioactive compounds that possess the plasma lipid lowering and antioxidant properties. Also, **Kim and Yoozawa (2009)**, they reported that the whole persimmon or its parts hold lipid lowering effects in hypercholesterolemic rats.

Data presented in Table (6) show the effect of persimmon fruit on the serum lipid profiles of diabetic rats. The results indicated that the HDL-c of negative control rats group recorded the highest value when compared with positive control group with significant difference. The mean values were 33.3 and 23.3 mg/dl, respectively. While, the highest HDL-c of treated group recorded for group fed on 10 % persimmon fruits but, the lowest value recorded for group fed on 5% persimmon fruits with significant difference. The mean values were 29.7 and 27.3 mg/dl, respectively.

On the other hand, the LDL-c of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 29.05 and 13.94 mg/dl, respectively. While, the highest LDL-c of treated group recorded for group fed on 5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 11.98 and 5.72 mg/dl, respectively.

In case of VLDL-c, the positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 44.64 and 16.26 mg/dl, respectively. While, the highest VLDL-c of treated group recorded for group fed on 5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 33.82 and 29.18 mg/dl, respectively. **Matsumoto *et al.,* (2006)** supplemented diet with young persimmon fruit (10 %) that resulted in similar results i.e. lowering of total & LDL cholesterol and triglyceride. They reported that the improvement lipid profile might be due to increase the expression of cholesterol 7 alpha-hydroxylase (CYP7A1) gene's expression. CYP7A1 regulates bile acid synthesis thus holds imperative role in balancing cholesterol homeostasis.

Data presented in Table (7) show the effect of persimmon fruits on urea, uric acid and creatinine of diabetic rats. The obtained results indicated that the urea level of positive control rats group recorded the highest value

when compared with negative control group with significant difference. The mean values were 73.65 and 42.2 mg/dl, respectively. While, the highest urea level of treated group recorded for group fed on 7.5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 58.27 and 46.25 mg/dl, respectively.

On the other hand, the uric acid level of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 3.97 and 2.11 mg/dl, respectively. While, the highest uric acid level of treated group recorded for group fed on 7.5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with non significant difference. The mean values were 2.6 and 1.95 mg/dl, respectively.

In case of creatinine, the level of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 1.13 and 0.87 mg/dl, respectively. While, the highest creatinine level of treated group recorded for group fed on 5 % persimmon fruits but, the lowest value recorded for group fed on 10% persimmon fruits with significant difference. The mean values were 0.99 and 0.89 mg/dl, respectively. These results are in agreement with **Almdal and Vilstrup (1988**), reported that diabetic hyperglycemia fed on persimmon fruits also induces an elevation in the plasma level of creatinine, and its level is considered to be a significant marker of renal dysfunction.

Table (1): Changes of body weight, feed intake and feed efficiency ratio of diabetic rats fed diet supplemented with persimmon fruit

Groups	BWG (g/28 day) Mean ± SD	FI (g/day) Mean ± SD	FER (%) Mean ± SD
G1 control (-)	50.8 ± 2.00^c	13.00 ± 0.84^b	0.194 ± 0.25^a
G2 Control (+)	69.7 ± 2.61^a	14.48 ± 0.24^a	0.172 ± 0.04^b
G3+5% persimmon fruit	53.1 ± 2.28^{bc}	13.98 ± 0.53^{ab}	0.136 ± 0.13^c
G4+7.5% persimmon fruit	54.6 ± 2.28^b	14.32 ± 0.26^a	0.136 ± 0.08^c
G5+10% persimmon fruit	55.3 ± 3.69^b	14.4 ± 0.22^a	0.137 ± 0.05^c
LSD P≤0.05	**1.092**	**1.18**	**0.009**

BWG=Body weight gain, FI=Feed intake, FER =Feed efficiency ratio.
Each value is represented as mean ± standard deviation (*n* = 6).
Mean with the same letters in the same horizontal column are not significantly different at P≤0.05.

Table (2): Changes of organs weight in the diabetic rats fed diet supplemented with persimmon fruit

Groups	Liver (g)	Kidney (g)	Spleen (g)
	Mean ± SD	Mean ± SD	Mean ± SD
G1 control (-)	6.10 ± 0.67^{b}	1.25 ± 0.190^{a}	0.825 ± 0.09^{a}
G2 (+)	7.12 ± 0.91^{a}	1.25 ± 0.170^{a}	0.83 ± 0.05^{a}
G3+5% persimmon fruit	6.42 ± 0.92^{a}	1.125 ± 0.26^{a}	0.80 ± 0.41^{a}
G4+7.5% persimmon fruit	6.22 ± 0.45^{a}	0.98 ± 0.15^{a}	0.78 ± 0.05^{a}
G5+10% persimmon fruit	6.62 ± 0.96^{a}	1.13 ± 0.45^{a}	0.85 ± 0.01^{a}
LSD P≤0.05	**1.02**	**0.86**	**1.02**

Each value is represented as mean ± standard deviation ($n = 6$).
Mean with the same letters in the same horizontal column are not significantly different at P≤0.05.

Table (3): Effect of persimmon on glucose of diabetic rats

Groups	Glucose (mg/dl)
G_1 C (-)	$96^{e} \pm 0.70$
G_2 C (+)	$198^{a} \pm 1.10$
G_3 (5% persimmon)	$117.30^{b} \pm 0.50$
G_4 (7.5% persimmon)	$109.21^{c} \pm 0.80$
G_5 (10% persimmon)	$97.53^{d}\pm 0.90$
LSD P≤0.05	1.53

Each value is represented as mean ± standard deviation ($n = 6$).
Mean under the same column bearing different superscript letters are different significantly ($p \leq 0.05$).

Table (4): Effect of persimmon on (ALP), (GOT) and (GPT) of diabetic rats

Groups	(ALT) U/L	(GOT) U/L	(GPT) U/L
G$_1$ C (-)	95 ± 1.70[d]	9.22 ± 1.10 [e]	6.50± 0.80[d]
G$_2$ C (+)	197± 0.90 [a]	55.82 ± 1.35[a]	20.70± 0.40[a]
G$_3$ +5% persimmon fruit	135 ± 2.10[b]	39.4 ± 2.05[b]	9.20 ± 1.20[c]
G$_4$ + 7.5% persimmon fruit	105 ± 1.10[c]	31.0± 0.60[c]	10.93± 0.90[b]
G$_5$ +10% persimmon fruit	90 ± 0.80[d]	17.21 ± 0.90 [e]	6.0± 0.60[d]
LSD P≤0.05	5.0	2.29	1.39

Each value is represented as mean ± standard deviation ($n = 6$).

Mean under the same column bearing different superscript letters are different significantly ($p \le 0.05$).

Table (5): Effect of persimmon fruit on the serum cholesterol and triglyceride of diabetic rats

Groups	TG (mg/dl) Mean ± SD	TC (mg/dl) Mean ± SD
G1 control (-)	81.3±2.61[e]	63.5±2.28[c]
G2 control (+)	223.2±2.83 [a]	97.0±3.69[a]
G3+5% persimmon fruit	169.1±2.83[b]	72.6±3.41[b]
G4 +7.5% persimmon fruit	153.5±3.16[c]	67.5±2.61[c]
G5 +10% persimmon fruit	145.9±3.22[d]	64.6±3.35[c]
LSD P≤0.05	3.67	1.27

Each value is represented as mean ± standard deviation ($n = 6$).

TG= Triglyceride.   TC= Total Cholesterol,

Mean with the same letters in the same horizontal column are not significantly different at P≤0.05

Table (6): Effect of persimmon fruit on the serum lipid profiles of diabetic rats

Groups	HDL-C (mg/dl)	LDL-C (mg/dl)	(VLDL$_C$) (mg/dl)
	Mean ± SD	Mean ± SD	Mean ± SD
G1 control (-)	33.3±2.61[a]	13.94±3.16[f]	16.26[a]± 0.69
G2 control (+)	23.3±3.16[c]	29.06±2.28 [a]	44.64[a]± 1.20
G3+5%persimmon fruit	27.3±2.99 [b]	11.48±2.98 [b]	33.82[a] ± 1.72
G4+7.5% persimmon fruit	28.5±3.42 [b]	8.30±2.28 [b]	30.70[a] ± 0.90
G5+10% persimmon fruit	29.7±2.61[b]	5.72±2.28[c]	29.18[a]±2.20
LSD P≤0.05	**2.63**	**3.02**	**3.01**

HDL-C= High density lipoprotein Cholesterol. LDL =Low density lipoprotein Cholesterol
Each value is represented as mean ± standard deviation (*n* = 6).
Mean with the same letters in the same horizontal column are not significantly different at P≤0.05

Table (7): Effect of persimmon on serum urea and serum uric acid of diabetic rats

Groups	Urea (mg/dl)	Uric acid (mg/dl)	Serum Creatinine (mg/dl)
G$_1$ C (-)	42.20[e] ± 2.10	2.11[b]± 0.20	0.87[d]± 0.577
G$_2$ C (+)	73.65[a] ±3.20	3.97[a] ± 0.90	1.13[a]± 0.115
G$_3$ (5% persimmon)	50.96[c]± 1.60	2.27[b]± 0.60	0.99[b]± 0.025
G$_4$ (7.5% persimmon)	58.27[b] ± 0.90	2.60[b]± 0.30	0.94[b]± 0.177
G$_5$ (10% persimmon) mixtures)	46.25[d]± 0.50	1.95[b]± 1.10	0.89[c]± 0.030
LSD P≤0.05	**3.24**	**1.26**	**2.14**

Each value is represented as mean ± standard deviation (*n* = 6).
Mean under the same column bearing different superscript letters are different significantly (p ≤ 0.05).

References

Ahn, H.S.; Jeon, T.I.; Lee, J.Y.; Hwang, S.G.; Lim, Y. and Park, D.K. (2002): Antioxidative activity of persimmon and grape seed extract: *in vitro* and *in vivo*. Nutr Res., 22:1265-73.

AIN (1993): American institute of nutrition purified diet for laboratory Rodent, Final Report. J. Nutrition, 123: 1939-1951 and O. Compactum Benth. J. Essential Oil Res. 8 (6): 657-664.

Almdal, T.P. and Vilstrup, H. (1988): Strict insulin therapy normalizes organ nitrogen contents and the capacity of urea nitrogen synthesis in experimental diabetes in rats. Diabetologia, 31: 114–118.

Azadbakhta, M.; Safapour, S.; Ahmadi, A.; Ghasemi, M. and Shokrzadeh, M. (2010): Anti-diabetic effects of aqueous fruits extract of *Diospyros lotus, L.* on streptozotocin-induced diabetic rats and the possible morphologic changes in the liver, kidney and heart. Journal of Pharmacognosy and Phytotherapy, 2 (2): 10-16.

Celik, A. and Ercisli, S. (2007): Persimmon cv. Hachiya *(Diospyros kaki* Thunb.) fruit: Some physical, chemical and nutritional properties. Int. J. Food Sci. Nutr., 18: 1-8.

Chapman, D.G.; Castilla,R. and Campbell, J.A. (1959): Evaluation of protein in food. LA. Method for the determination of protein efficiency ratio.Can. J. Biochem. Physiol., 37: 679 – 686.

Chen, V. and Ianuzzo, C.D. (1982): Dosage effect of streptozotocin on rat tissue enzyme activities and glycogen concentration. Can. J. Physiol. Pharmacol., 60: 1251-1256.

Clinica Chimica Acta (1980): 105, 147-172, (Chemical kits).

FAO, (2010): FAOSTAT, FAO Statiscal Databases. Downloaded from http://faostat.fao.org on 15/4/2012.

Fonseca, V.A.; Kirkman, M.S.; Darsow, T. and Ratner, R.E. (2012): The american diabetes association diabetes research perspective. Diabetes, 6:1338–1345.

Fossati, P. (1982): Pricipe l. Clin. Chem., 28: 2077 (Chemical Kits).

Friedwaid, W.T. (1972): Determination of HDL. Clin. Chem., 18: 499. (Chemical Kits).

George, A. P. and Redpath, S. (2008): Health and medicinal benefits of persimmon fruit: A review. Adv. Hort. Sci., 22: 244-249.

Gorinstein, S.; Kulasek, G.W.; Bartnikowska, E.; Leontowicz, M.; Zemser, M. and Morawiec, M. (2000): The effects of diets, supplemented with either whole persimmon or phenol-free persimmon, on rats fed cholesterol. Food Chem., 70: 303-8.

Grodon, T. and Amer, M. (1977): Determination of HDL. Clin. Chem., 18: 707. (Chemical Kits).

Hafkenscheid, J.C. (1979): Determination of GOT. Clin. Chem., 25:155.

Henry, R.J. (1974): Clinical Chemist: Principles and Techniques, 2nd Edition, Hagerstoun (MD), Harcer, ROW, 882.

Karaman, S.; Toker, Ö. S. ; Yüksel, F.; Çam, M.; Kayacier, A. and Dogan M. (2014): Physicochemical, bioactive, and sensory properties of persimmon-based ice cream: technique for order preference by similarity to ideal solution to determine optimum concentration. Journal of Dairy Science, 97 1: 97-110,

Kim, Y.J. and Yokozawa, T. (2009): Modulation of Oxidative Stress and Melanogenesis by Proanthocyanidins. Biol. Pharm. Bull., 32: 1155-9.

Lee, R. and Nieman, D. (1996): Nutrition Assessment. 2nd Ed. Mosby, Missouri, U.S.A.

Maiyo, Z.C. ; Ngure, R.M. ; Matasyoh, J.C. and Chepkorir, R. (2010): Phytochemical constituents and antimicrobial activity of leaf extracts of three *Amaranthus* plant species. African Journal of Biotechnology, 9 (21): 3178-3182.

Matsumoto, K.; Watanabe, Y.; Ohya, M.A. and Yokoyama, S. (2006): Young Persimmon Fruits Prevent the Rise in Plasma Lipids in a Diet-induced Marine Obesity Model. Biol. Pharm. Bull., 29: 2532-5.

Moss, D.W. (1982): Alkaline phosphatase isoenzymes. Clin. Chem. 28: 2007-2016.

Nagappa, A.N.; Thakurdesai, P.A.; VenkatRao, N. and Jiwan, S. (2003): Antidiabeticactivity of *Terminalia catappa*, Linn fruits. J. Ethnopharmacol., 88 (1): 45-50.

Ozgen, M. ; Serce, S. and Kaya, C. (2009): Phytochemical and antioxidant properties of anthocyanin-rich *Morus nigra* and *Morus rubra* fruits. Sci, Horticult. Amsterdam, 119: 275-279.

Patton, C.J. and Crouch, S.R. (1977): Enzymatic determination of urea. J. of Anal. Chem., 49: 464-469.

Quan, N.; Kobayashi, K.; Matsunami, Y.; Ide, M.; Makarova, M.; Shen, L.; Ohno, S.; Zheng, Y.; Kobayashi, H.; Lopez, L. R. and Matsuura, E. (2012): Persimmon *(Diospyros Kaki* Thunb 'Saijo') peel improved dyslipidemia and its related production of atherogenic autoantigen complexes in low density lipoprotein receptor-deficient mice. *Open Nutr. J.*, **6**: 12-20.

SAS (1988): SAS Users Guide: Statistics version 5th Ed. SAS. Institute Inc., Cary N.C.

Schermer (1967): The Blood Morphology of Laboratory Animal. Longmans, Printed in Great Britain, Green and Co. Ltd., pp.350.

Schmitt, J.M. and Drevon, B. (1964): Determination of Total Lipids. Bull. Trav. Soc. Pharm. Lyon., 8:173.

Sharma, U.;Sahu, R.; Roy, A. andGolwala, D. (2010): *In vivo* antidiabetic and antioxidant potential of *Stephania hernandifolia* in streptozotocin induced-diabetic rats. J. Young Pharm., (2): 255-260.

Sochar, M.; Baquer, N.Z. and Mclean, P. (1985): Glucose under utilization in diabetes: Comparative studies on the changes in the activities of enzymes of glucose metabolism in rat kidney and liver. Mol. Physiol., 7: 51-68.

Thomas, L. (1992): Labor and Diagnose, 4th Ed. Marburg: Die Medizinischi Verlagsgesellschaft. (Chemical Kits).

Tinder, P. (1969): Determination of triglycerides, Ann. Clin. Biochem., 6: 24 – 27.

Tiwari, A. and Rao, J. (2002): Diabetes mellitus and multiple therapeutic approaches of phytochemicals: present status and future prospects. Current science, 83: 30-38.

Young, D. (1975): Effects of drugs on clinical laboratory tests. Pestaner, L. Clin. Chem., 21: 5, 1D- 432D. (Chemical Kits).

التأثير المضاد للسكر لثمار الكاكى فى الفئران المصابة بالسكر بتأثير الألوكسان

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الملخص العربى

تم تقييم تأثير تركيزات مختلفة (٥ ٬ ٧.٥ ٬ ١٠%) من ثمار الكاكي في الفئران المصابة بمرض السكر. واستخدم ٣٠ فأر في هذه الدراسة وتم تقسيمها إلى ٥ مجموعات، كل مجموعة تحتوي على ٦ الفئران. وتم اصابة الفئران (١٥٠ مجم/ كجم من وزن الجسم) بمرض السكر ابواسطة الألوكسان. وأظهرت النتائج أن أعلى قيم للزيادة فى وزن الجسم، كمية الغذاء المتناول وكفاءة استخدام الغذاء سجلت مع تركيز ١٠٪ من ثمار الكاكى، في حين أن أقل قيمة سجلت مع تركيز ٥٪ مع عدم وجود فرق معنوى بين معاملات الكاكى.. مجموعات الفئران التي تغذت على ثمار الكاكى بتركيز ١٠ ٪ سجلت أعلى وزن مع الكبد والكلى والطحال. بينما سجلت الفئران التي تغذت على ثمار الكاكى بتركيز ١٠ ٪ أقل مستوى لسكر الجلوكوز مع وجود فرق معنوى ،حيث كانت القيمة ٩٧.٥٣ ملجم / ديسيلتر. أعلى انخفاض لانزيمات الكبد GOT,ALT سجل مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ١٠٪ ، بينما أقل قيم كانت مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ٥%. ولكن أعلى قيمة لإنزيم GPT فى الكبد سجلت لمجموعة الفئران التي تغذت على ثمار الكاكى بتركيز٧.٥٪ مع وجود فرق معنوى. أقل قيمة من الدهون الثلاثية والكوليسترول مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ١٠٪. أعلى قيم للكوليستيرول عالى الكثافة سجلت مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ١٠٪ . في حين أعلى قيم من الكولسيتيرول منخفض الكثافة و الكولسيتيرول منخفض الكثافة جدا سجلت مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ٥٪. أعلى قيم لليوريا و حمض اليوريك سجلت مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ٧,٥٪. في حين أعلى مستوى للكرياتينين سجلت مع مجموعة الفئران التي تغذت على ثمار الكاكى بتركيز ٥٪.

الكلمات الكاشفة: ثمار الكاكى ـ الفئران ـ التأثير المضاد للسكر ـ التحاليل الكيميائية الحيوية.