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Effect of flax, sesame & sunflower seeds and cakes for lowering cholesterol and serum glucose levels

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1. Abstract

The present investigation aimed to assess the possibility of using flaxseeds, sesame seeds, sunflower seeds and their cakes for lowering serum glucose and hypercholesterolemia in male albino rats.

Also agroup of rats received subcutaneous injection of alloxan (150 mg/kg body weights) to induce diabetes. Inflicted rats fed on seeds or seeds cake powders at 5% level for 28 days. Biological & biochemical analyses as well as the histological investigation revealed that the best treatment was that of flaxseeds cake diet 5% provided that other diets improved also diabetes mellitus but at a less extent.

Since cakes revealed better results than the seeds diet it is suggested to use seeds cake after oil extraction in man’s diet to control diabetes e.g. not only for animal feeds.

2. Introduction

Large amounts ofoil seeds cake remains, considering the wide use of sunflower oil for cooking, sesame oil for production of Tahena, HalawaTehenia and Halawet El Moled. Also for flaxseeds, the seeds cake remains after oil extraction used for Foul Medmes and for other uses. Cakes are mainly used in animal feeds.

Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels ***(ADA, 2012).***

Flaxseed has been consumed for centuries for its good flavor and for its nutritional properties. In recent years, as people have become more concerned about health, demand for flax in food and beverages, functional foods and dietary supplements has risen dramatically***(Ankit et al., 2014).***

Thus, flaxseed and pressed flaxseed cake still have an immense usable potential in lipids, proteins, soluble fiber and lignans. A chemical and nutritional description was carried out using proximal analysis of flaxseed and flaxseed cake acquired in the La Araucania Region, Chile. The fatty acid profile of the oil was assessed, as well as the contents of mucilage, protein and total polyphenols in the cake ***(Ankit et al., 2014).***

Sunflower seeds contained n-2 & n-3 fatty acids, the cakes contained all the fibers and both are of good health effects for man***(Morsy et al., 2015).***

Moreover, studies on sesame oil and sesame cake showed relevant effects on oxidative stress, suggesting they could increase the antioxidant capacity***(Gouveia et al., 2016).***

3. Aim of study

This work aimed to investigate the effect of flaxseeds, sesame seeds, sunflower seeds and in particular their cakes for lowering serum glucose in male albino rats.

4. Materials and methods

4.1. Basal Diet

The basal diet (casein – basal diet) was composed of 12.3 g casein (10% protein in diet), 10 g corn oil (10% fat) , 4g cellulose (5% fiber), mineral mixture (4%), choline chloride(0.2), methionine (0.3%) and corn starch up to 100 g according***(AIN, 1993).***The salt mixture wasas recommended by***(Hegsted et al., 1941),*** and vitamin mixture as recommended by***(Meller, 1964).***Alloxan has been used as toxic chemical for pancreas injury according to***(Desai and Bhide, 1985).***It was obtained from a chemical company from which cholesterol was purchased.

Forty eight adult male albino rats, Sprague Dawley strain, mean weight 120± 10 g obtained from Research Institute of Ophthalmology Medical Analysis Department, Giza, Egypt. The animal were divided into eight homogeneous groups, and housed individually in stainless steel cages fitted with a wire mesh bottoms and kept in room maintained at 25-30 C with about 12 h light & 12 h dark. Then rats allocated to the various experimental diet for 4 weeks. During the trial feed and tap water provided adlibitum. Body weight gain and feed intake reordered and feet efficiency ratio calculated. The experiment lasted for 4 weeks.

Diabetes was inducing in 42 normal rats by subcutaneous injection of alloxan (150 mgI kg body weight) according to method described by (Desai and Bhide, 1985). One week after the injection of alloxan, fasting blood sample was obtained by retro orbital method for estimating fasting serum glucose. Rats having fasting serum glucose more than 200 gI dl were considered diabetics ***(NDDG, 1994).***

All rats were fed on basal diet for one week for adaptation, then rats were divided into 2 main groups:

- **The first main group(n=5)**: Normal rats, were fed on the basal diet as control negative.
- **The second main group (n=70)**: Inflicted rats, injected subcutaneously with of alloxan (150 mg l Kg body weight) to induce diabetes mellitus, and received plain eating diet .The diabetic rats were divided randomly into 6 groups (n=6) according to the following scheme.
- G1: Control (+), 5 diabetic rats fed on the basal diet.
- G2: 5 diabetic rats fed on 5% flaxseeds powder diet.
- G3: 5 diabetic rats fed on 5% flaxseeds cake diet.
- G4: 5 diabetic rats fed on 5% sesames seeds powder diet.
- G5: 5 diabetic rats fed on 5% sesames seeds cake diet.
- G6: 5 diabetic rats fed on 5% sunflowers seeds powder diet.
- G7: 5 diabetic rats fed on 5% sunflowers seeds cake diet.

At the end of the experiment, rats were fasted over night and anesthetized with diethyl ether. After sacrifice of rats blood samples were collected from portal hepatic vein. Each sample was placed in dry clean centrifuge tube and left to clot in water bath (37° C) for half an hour. The blood was centrifuged for 10 minutes at 3000 rpm to separate the serum.

Serum was carefully aspirated and transferred into clean cuvette tube and stored frozen at-20 °C for analysis as described by***(Schermer, 1967).***All serum samples were analyzed for determination the following parameters:

Glucose, lipid profile cholesterol, triglycerides (TG), high density lipoprotein cholesterol (HDL.c), low density lipoprotein cholesterol (LDL.c), very low-density lipoprotein cholesterol (VLDL.C), kidney function parameters (urea, creatinine, uric acid), liver function parameters as glutamic oxaloacetic transaminase (GOT), glutamic pyruvic transaminase (GPT) and alkaline phosphatase (ALP).

At the same time, the organs: Heart, kidney, liver and aorta were removed, washed in saline solution,wiped by filter paper, weighted and stored frozen in formalin solution 10% for histopathological testing according to method mentioned by***(Drury and Wallington, 1980).***The weight of organs was calculated (in g).

4.2. Biological evaluation

Biological evaluation of the different diet was carried out by determination of body weight gain (BWG), feed efficiency ratio (FER) according to***(Chapman et al., 1959).***

BWG (g) = Final weight – Initial weight

FER = Gain in body weight (g) /Feed intake (g).

4.3. Biochemical evaluation

4.3.1. Analytical methods

4.3.1.1. Determination of analysis methods of serum:

Enzymatic determination of plasma glucose was carried out colorimetrically according to method of ***(Tietz, 1995)*** by using Spectrum Company Kit.

4.3.1.2. Determination of Triglycerides (TG):

Determination of Triglycerides in serum was colorimetricallydetermined according to ***(Schettler and Nussel, 1975)*** by using Human company kit.

4.3.1.3. Determination of Total Cholesterol (TC):

Determination of Total Cholesterol in serum was colorimetrically determined according to ***(Richmond, 1973) and (Schettler and Nussel, 1975)***by using Human Company kit.

4.3.1.4. Determination of HDL-c:

Determination of HDL was carried out according to the method of ***(Fnedewaid, 1972) and (Gorden, 1977)***by using Human Company Kit.

4.3.1.5. Determination of VLDL-C and LDL-c:

This index calculates as the VLDL+LDL cholesterol / HDL ratio according to the formula described by***(Kikuchi-Hayakawa et al., 1998).***

Determination of VLDL-C and LDL-C were carried out according to the method of ***(Srivastava et al., 2002)*** as follows:

*Calculation: VLDL-c(mg/dl) = Triglycerides/5.LDL-c (mg/dl) = Total cholesterol–(HDL-c+VLDL-c).

*Calculation of Atherogenic Index (AI):Atherogenic Index = VLDL+LDL/HDL cholesterol.

4.3.1.6. Determination of kidney function:

Urea was determined by enzymatic method according to ***(Patton and Crouch, 1977).***

Serum uric acid was determined colorimetrically according to the method of ***(Barham and Trinder, 1972).***

Serum creatinine was determined according to the method described by ***(Henry, 1974).***

4.3.1.7. Determination of blood glucose:

Enzymatic dermination of plasma glucose was carried out colorimetrically according to the method of ***(Trinder, 1969).***

4.3.1.8. Determination of (ALP):

Determination of Alkaline Phosphatase (ALP): Kits were obtained from Biosystems S.A. Kits, Barcelona (Spain). Serum ALP was determined according to ***(IFCC, 1983).***

4.3.2. Histopathological investigation

Small specimens of the organ (liver and kidney) were taken from each experimental group, fixed in neutral buffered formalin, dehydrated in ascending concentration of ethanol (70, 80, and 90%), cleared in xylene and embedded in paraffin. Sections of (4-6) µm thickness were prepared and stained with Hematoxylin and Eosin according to ***(Bancroft et al., 1996).***

4.3.3. 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 result was analyzed by One Way ANOVA.

5. Results And Discussion

5.1. Biological parameter

5.1.1. Body weights gain (BWG), Feed intake (FI) and Feed efficiency ratio (FER).

Table (1) show the results in concern to the effect of flaxseeds, sesame seeds, sunflower seeds and their cakes for 28 days on BWG, FI and FER of diabetic rats.

The mean value of BWG of control positive diabetic group was less than that of control negative group, which were (0.43 ± 0.35 & 3.58 ± 0.43) g, respectively.But the values of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$) higher when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cakes (5% level) which was of more BWG than control positive with mean of (3.26 ± 0.40) g.

The mean value of FI of control positive diabetic group was less than control negative group, which were (9.30 ± 2.20 and 24.00 ± 1.32) g, respectively. But the values of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$)higher when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cakes (5% level) which was of higher FI than control positive with mean of (20.38 ± 1.95) g.

The mean value of FER of control positive group was less than control negative group, which were (0.046 ± 0.012 and 0.149 ± 0.012), respectively. But the values of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$)more when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cakes (5% level) which was of higher FER than control positive with mean of (0.160 ± 0.011).

As reported by***Ali, Amal (2015)*** diabetic rats showed less BWG the control healthy rats, while feeding on cabbage seeds diet increased BWG compared to control (+) group. In present work (Table 1) different diets reversed the changes due to seeds & cakes which may be due to all fibers as well as remained n-3 FA***(Taylor et al., 2010 and khan, 2019).***

It should be noted that experimental cakes showed always more FER than plain seeds diet, indicating the possible effect of cakes ingredients as fibers and remained oil ***(Ali, Amal, 2015).***

Table (1): Body weight gain (BWG), feed in take (FI) and feed efficiency ratio (FER) of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Groups	BWG(g) M ± SD	% Change of Control(+)	FI (g) M ± SD	% Change of Control(+)	FER M ± SD	% Change of Control(+)
(G1) Control (-)	3.58[a]± 0.43	+732.6	24.00[a]± 1.32	+158.1	0.149[b]± 0.012	+223.9
(G2) Control (+)	0.43[h]± 0.35	0.00	9.30[c]± 2.20	0.00	0.046[d]± 0.012	0.00
(G3) Flaxseeds 5%	2.95[c]± 0.45	+586.1	19.43[c]± 1.95	+108.9	0.152[a]± 0.029	+230.4
(G4) Flaxseeds cakes 5%	3.26[b]± 0.40	+658.1	20.38[b]± 1.95	+119.1	0.160[a]± 0.011	+247.8
(G5) Sesame seeds 5%	2.50[e]± 0.41	+481.4	17.33[d]± 2.20	+86.3	0.150[ab]± 0.025	+226.1
(G6) Sesame cakes 5%	2.72[d]± 0.75	+532.6	17.66[d]± 1.41	+89.9	0.158[a]± 0.012	+243.5
(G7) Sunflowers seeds 5%	1.60[g]± 0.70	+272.1	14.26[e]± 1.86	+53.3	0.112[c]± 0.010	+143.5
(G8) Sunflowers cakes 5%	2.30[f]± 0.35	+434.9	16.33[d]± 1.90	+75.6	0.141[b]± 0.008	+206.5
LSD	**0.012**		**1.2447**		**0.0106**	-

5.1.2. Internal organs weight

Table (2) show the results in concern to the effect of flaxseeds, sesame seeds, sunflower seeds and their cakes for 28 days on liver, heart, kidney, spleen and lung weight of diabetic rats.

It could be observed that hyperglycemia raised the weight of each internal organ, and oil seeds and their cake diets reversed such changes. Best group was that of diabetic rats fed on cakes especially that of the flaxseeds cake.

Table (2): Organs weight of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Groups	Organ Weight (g) liver M ± SD	% Change of Control (+)	Organ Weight (g) Heart M ± SD	% Change of Control (+)	Organ Weight (g) Kidney M ± SD	% Change of Control (+)	Organ Weight (g) Spleen M ± SD	% Change of Control (+)	Organ Weight (g) Lung M ± SD	% Change of Control (+)
(G1) Control (-)	2.34^{c}± 1.079	-37.27	0.49^{e}± 0.368	-74.07	0.69^{g}± 1.39	-66.18	0.56^{h}± 1.55	-72.00	0.65^{f}± 0.78	-42.48
(G2) Control (+)	3.73^{a}± 1.025	0.00	1.89^{a}± 1.067	0.00	2.04^{a}± 1.23	0.00	2.00^{a}± 1.59	0.00	1.13^{a}± 1.58	0.00
(G3) Flaxseeds 5%	3.46^{b}± 0.330	-7.24	0.90^{d}± 0.972	-52.38	0.85^{e}± 0.94	-58.33	0.74^{f}± 1.41	-63.00	0.72^{e}± 1.03	-36.28
(G4) Flaxseeds cakes 5%	2.43^{c}± 0.480	-34.85	0.57^{e}± 1.188	-69.84	0.78^{f}± 1.25	-61.76	0.65^{g}± 1.33	-67.50	0.71^{e}± 1.01	-37.17
(G5) Sesame seeds 5%	3.68^{a}± 0.491	-1.34	1.12^{c}± 1.704	-40.74	0.92^{c}± 1.22	-54.90	1.43^{c}± 1.40	-28.50	0.81^{d}± 1.18	-28.32
(G6) Sesame cakes 5%	3.28^{bc}± 0.802	-12.06	1.03^{c}± 0.699	-45.50	0.88^{d}± 1.41	-56.86	0.85^{e}± 1.06	-57.50	0.73^{e}± 1.06	-35.40
(G7) Sunflowers seeds 5%	3.70^{a}± 0.551	-00.80	1.85^{a}± 1.067	-2.12	1.60^{b}± 1.41	-21.57	1.55^{b}± 1.28	-22.50	1.05^{b}± 1.02	-7.08
(G8) Sunflowers cakes 5%	3.42^{b}± 0.507	-8.11	1.62^{b}± 1.091	-14.28	2.02^{a}± 0.68	-0.98	1.05^{d}± 1.86	-47.50	0.95^{c}± 0.71	-15.93
LSD	**0.163**		**0.129**		**0.024**		**0.056**		**0.037**	

5.1.3. Biochemical parameters

5.1.3.1. Glucose of serum

Table (3) show the effect of flaxseeds, sesame seeds, sunflower seeds and their cakes for 28 days on serum glucose of diabetic rats.

The mean value of glucose of control positive group was higher than control negative group, which were (200.18 ± 2.07 and 112.18 ± 1.65) mg/dl, respectively. Values showed significant difference, with percent of decrease -43.96% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (132.00 ± 1.41) mg/dl. These results (Table 3) revealed that cakes were of better effect than plain seeds diet, possibly because of cake higher fibers content. This along with the remained n-2 & n-3 FA.

Table (3): Serum glucose level of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Groups	Glucose(mg / dl) M ± SD	%Change of Control (+)
(G1) Control (-)	112.18^{h}± 1.65	-43.96
(G2) Control (+)	200.18^{a}± 2.07	0.00
(G3) Flaxseeds 5%	136.12^{f}± 2.69	-32.00
(G4) Flaxseeds cakes 5%	132.00^{g}± 1.41	-34.06
(G5) Sesame seeds 5%	144.80^{d}± 2.63	-27.67
(G6) Sesame cakes 5%	140.93^{e}± 1.61	-29.60
(G7) Sunflowers seeds 5%	156.87^{b}± 2.30	-21.64
(G8) Sunflowers cakes 5%	149.87^{c}± 2.00	-25.13
LSD	**3.434**	

5.1.4. Lipids profile

5.1.4.1. Total cholesterol (TC)

The mean value of total cholesterol of control positive group was higher than control negative group, which were (99.30 ± 2.20 and 75.65 ± 2.30) mg/dl, respectively. Values showed significant difference, with percent of decrease -23.82% in control negative group as compared with control positive group. But the value of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (80.60 ± 2.40) mg/dl.

5.1.4.2. Triglycerides (TG)

The mean value of triglycerides of control positive group was higher than control negative group, which were (154.30 ± 2.40 and 102.50 ± 2.10) mg/dl, respectively. Values showed significant difference, with percent of decrease -33.57% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds (5% level) which was of lower value than control positive with mean of (104.6 ± 1.70) mg/dl.

Table (4): Total cholesterol (TC) & Triglycerides (TG) of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Group	Total Cholesterol (mg / dl) M ± SD	% Change of Control (+)	Triglycerides (mg / dl) M ± SD	% Change of Control (+)
(G1) Control (-)	75.65^{e}± 2.3	-23.82	102.5^{e}± 2.1	-33.57
(G2) Control (+)	99.30^{a}± 2.2	0.00	154.3^{a}± 2.4	0.00
(G3) Flaxseeds 5%	82.60^{d}± 2.5	-16.82	115.1^{d}± 2.1	-25.41
(G4) Flaxseeds cakes 5%	$80.60\ ^{d}$± 2.4	-18.83	104.6^{e}± 1.7	-32.21
(G5) Sesame seeds 5%	88.33^{c}± 2.2	-11.05	129.6^{c}± 2.2	-16.01
(G6) Sesame cakes 5%	85.30^{d}± 1.7	-14.10	118.1^{d}± 2.3	-23.46
(G7) Sunflowers seeds 5%	94.20^{b}± 2.2	-5.14	149.4^{a}± 1.7	-3.18
(G8) Sunflowers cakes 5%	90.33^{c}± 1.8	-9.03	138.5^{b}± 2.2	-10.24
LSD	2.646		6.43	

5.1.4.3. High Density Lipoprotein (HDL)

The mean value of HDL of control positive group was higher than control negative group, which were (41.7 ± 2.5 and 50.6 ± 1.1) mg/dl, respectively. Values showed significant difference, with percent of decrease +21.34% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)higher when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds (5% level) which was of higher value than control positive with mean of (49.3 ± 2.2) mg/dl.

5.1.4.4. Low Density Lipoprotein (LDL)

The mean value of LDL of control positive group was higher than control negative group, which were (26.7 ± 1.8 and 4.55 ± 1.9) mg/dl, respectively. Values showed significant difference, with percent of decrease -82.96% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (10.38 ± 1.9) mg/dl.

Table (5): High-density lipoprotein cholesterol & low-density lipoprotein cholesterol of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Group	HDL (mg /dl) M ± SD	% Change of Control (+)	LDL (mg / dl) M ± SD	% Change of Control (+)
(G1) Control (-)	50.6^{a}± 1.1	+21.34	4.55^{g}± 1.9	-82.96
(G2) Control (+)	41.7^{g}± 2.5	0	26.7^{a}± 1.8	0.00
(G3) Flaxseeds 5%	46.8^{c}± 2.0	+12.23	12.78^{e}± 1.8	-52.14
(G4) Flaxseeds cakes 5%	49.3^{b}± 2.2	+18.23	10.38^{f}± 1.9	-61.12
(G5) Sesame seeds 5%	47.7^{e}± 2.2	+14.39	17.71^{c}± 2.1	-33.67
(G6) Sesame cakes 5%	45.9^{d}± 2.8	+10.07	15.78^{d}± 1.9	-40.90
(G7) Sunflowers seeds 5%	44.2^{ef}± 1.9	+5.00	20.12^{b}± 2.4	-24.64
(G8) Sunflowers cakes 5%	44.6^{e}± 1.9	+6.95	18.03^{c}± 2.5	-32.47
LSD	**0.474**		**1.043**	

5.1.4.5. Very low-density lipoprotein cholesterol (VLDL)

The mean value of VLDL of control positive group was higher than control negative group, which were (30.9 ± 1.6 and 20.5 ± 2.1) mg/dl, respectively. Values showed significant difference, with percent of decrease -33.66% in control negative group as compared with control positive group. But the value of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (20.92 ± 2.4) mg/dl.

5.1.4.6. Atherogenic index (AI)

The mean value of AI of control positive diabetic group was higher than control negative group, which were (1.38 ± 1.99 and 0.50 ± 0.12), respectively. Values showed significant difference, with percent of decrease -63.77% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cakes (5% level) which was of lower value than control positive with mean of (0.64 ± 1.01) mg/dl. It seems that more time of treatment is needed to achieve more pronounced improvement ofsome lipids profile. Similar trends of change were previously reported by diabetic rats considering lipids profile***(Ali, Amal 1915),***HDL increased while TC, TG, VLDL, LDL and AI decreased when hyperglycemic rats fed on diet containing cabbage seeds.According to***Bernacchia et al., (2014)*** found that flaxseeds lower the lipids of blood for hypercholesterolemic rats. This was also previously reported by***Moyo et al., (2012)*** for sunflower seeds.

Table (6): Very low-density lipoprotein cholesterol (VLDL) &atherogenic index (AI) of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Groups	VLDL (mg / dl)M ± SD	% Change of Control (+)	AI M ± SD	% Change of Control (+)
(G1) Control (-)	20.50[e]± 2.1	-33.66	0.50[f]± 0.12	-63.77
(G2) Control (+)	30.90[a]± 1.6	0.00	1.38[a]± 1.99	0.00
(G3) Flaxseeds 5%	23.02[d]± 2.1	-25.50	0.77[d]± 0.61	-44.20
(G4) Flaxseeds cakes 5%	20.92[e]± 2.4	-32.30	0.64[e]± 1.01	-53.62
(G5) Sesame seeds 5%	25.92[c]± 1.6	-16.12	0.98[c]± 0.12	-28.99
(G6) Sesame cakes 5%	23.62[d]± 2.1	-23.56	0.86[d]± 0.12	-37.68
(G7) Sunflowers seeds 5%	29.88[b]± 2.1	-33.01	1.13[b]± 0.12	-18.12
(G8) Sunflowers cakes 5%	27.70[c]± 1.7	-10.36	1.03[c]± 0.12	-25.36
LSD	**0.825**		**0.098**	

5.1.4.7. Liver enzyme activity

5.1.4.7.1. ALP activity

Table (7) show the effect of flaxseeds, sesame seeds, sunflower seeds and their cakes for 28 days on alkaline phosphatas (ALP) activity in serum of diabetic rats.

The mean value of ALP of control positive group was higher than control negative group, which were (373.00 ± 2.00 and 211.00 ± 2.00) u/l, respectively. Values showed significant difference, with percent of decrease -43.43% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (266.00 ± 2.00) u/l.

These results are in agreement with that of***Ali, Amal (2015)***reported that cabbage seeds reduced pronouncedly the level of serum ALP of diabetic rats.

Moreover,***Gök et al., (2016)*** found that flaxseeds lowered both AST & ALT of diabetic rats.

Table (7): Alkaline phosphatas (ALP) activity in serum of diabeticrats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Groups	ALP (U / L)M ± SD	%Change of Control (+)
(G1) Control (-)	211.00^{g}± 2.00	-43.43
(G2) Control (+)	373.00^{a}± 2.00	0.00
(G3) Flaxseeds 5%	273.00^{e}± 2.00	-26.81
(G4) Flaxseeds cakes 5%	266.00^{f}± 2.00	-28.69
(G5) Sesame seeds 5%	287.00^{d}± 2.00	-23.06
(G6) Sesame cakes 5%	289.00^{d}± 2.00	-22.52
(G7) Sunflowers seeds 5%	361.00^{b}± 2.00	-3.22
(G8) Sunflowers cakes 5%	344.00^{c}± 2.00	-7.78
LSD	**6.30**	

5.1.4.8. Kidney functions

Table (8) show the effect of flaxseeds, sesame seeds, sunflower seeds and their cakes on kidney functions of diabetic rats.

The mean value of uric acid of control positive group was higher than control negative group, which were (6.86 ± 0.296 and 2.27 ± 0.278) mg/dl, respectively. Values showed significant difference, with percent of decrease -66.91% in control negative group as compared with control positive group. But the values of groups (3, 4, 5, 6, 7, 8) were significantly ($P<0.05$)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (2.84 ± 0.234) mg/dl.

Ali, Amal (2015)reported similar trends of change considering kidney function parameters of rats injected with alloxan, and the improvement of function when diabetic rats fed on cabbage seeds diet.

The mean value of creatinine of control positive group was higher than control negative group, which were (0.598 ± 0.0576 and 0.096 ± 0.0056) mg/dl, respectively. Values showed significant difference, with percent of decrease -83.95% in control negative group as compared with control positive group. But the value of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (0.123 ± 0.0610) mg/dl.

The mean value of urea of control positive group was higher than control negative group, which were (54.46 ± 4.111 and 30.16 ± 2.448) mg/dl, respectively. Values showed significant difference, with percent of decrease -44.62% in control negative group as compared with control positive group. But the value of groups (3, 4, 5, 6, 7, 8) were significantly (P<0.05)lower when compared to control positive. The best treatment was observed for group of rats fed on basal diet contained flaxseeds cake (5% level) which was of lower value than control positive with mean of (36.76 ± 1.971) mg/dl.

Table (8): Uric acid, creatinine& urea of diabetic rats as affected by feeding with flaxseeds, sesame seeds, sunflower seeds (5%) and their cakes

Groups	Uric acid (mg / dl) M ± SD	%Change of Control (+)	Creatinine (mg / dl) M ± SD	%Change of Control (+)	Urea (mg / dl) M ± SD	%Change of Control (+)
(G1) Control (-)	2.27^{e}± 0.278	-66.91	0.096^{c}± 0.0056	-83.95	30.16^{f}± 2.448	-44.62
(G2) Control (+)	6.86^{a}± 0.296	0.00	0.598^{a}± 0.0576	0.00	54.46^{a}± 4.111	0.00
(G3) Flaxseeds 5%	3.41^{d}± 0.631	-50.29	0.164^{cd}± 0.0403	-72.58	41.66^{e}± 4.325	-23.50
(G4) Flaxseeds cakes 5%	2.84^{e}± 0.234	-58.60	0.123^{de}± 0.0610	-79.43	36.76^{d}± 1.971	-32.50
(G5) Sesame seeds 5%	4.44^{c}± 0.286	-35.28	0.266^{c}± 0.1110	-55.52	46.82^{c}± 4.112	-14.03
(G6) Sesame cakes 5%	4.02^{c}± 0.304	-41.40	0.231^{c}± 0.0980	-61.37	40.53^{d}± 3.563	-25.58
(G7) Sunflowers seeds 5%	5.49^{b}± 0.284	-19.97	0.369^{b}± 0.0750	-38.29	53.65^{b}± 3.032	-1.49
(G8) Sunflowers cakes 5%	5.39^{b}± 0.260	-21.43	0.354^{b}± 0.0420	-40.80	52.04^{b}± 4.764	-4.44
LSD	**0.542**		**0.0868**		**4.333**	

5.2. Histopathological investigation

It is evidence that control(-) rats revealed sections of healthy liver (Photo1) and kidney (Photo2) while marked histological changes occurred for diabetic (c+) rats (Photos 3&4). Feeding on experimental diets improved the structure of liver and kidney, at different degrees. But best improvement revealed for flaxseeds cake diet (Photo 5&6).

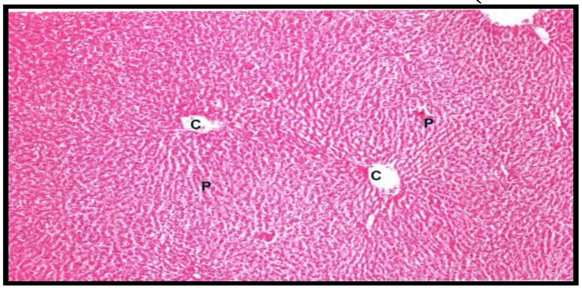

Photo (1): Liver of control (-) rat showing normal central vein (C) and hepatic parenchymal cells (P) (H&E, X100).

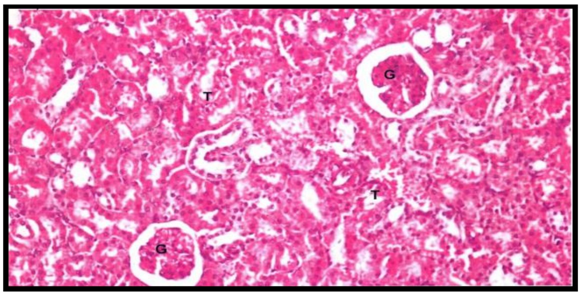

Photo (2): Kidney of control (-) rat showing normal renal glomeruli (G) and renal tubules (T) (H&E, X200).

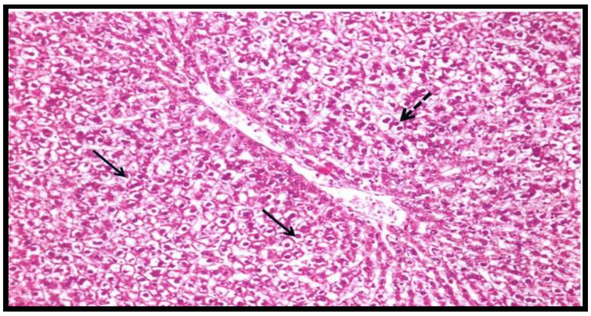

Photo (3): Liver of diabetic rat (c +) showing marked vacuolar degeneration of the hepatic cells (arrow eccentric nuclei dashed arrow) and many necrotic cells (arrow head) (H&E, X200).

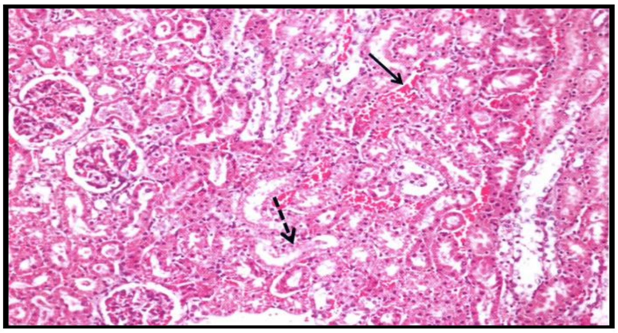

Photo (4): Kidney of diabetic rat (c +) showing congestion of the inter tubular blood vessels (arrow), marked swelling, degeneration, necrosis and desquamation of the renal tubular epithelium with appearance of granular renal cast (dashed arrow) in the lumen of the renal tubules (H&E, X200).

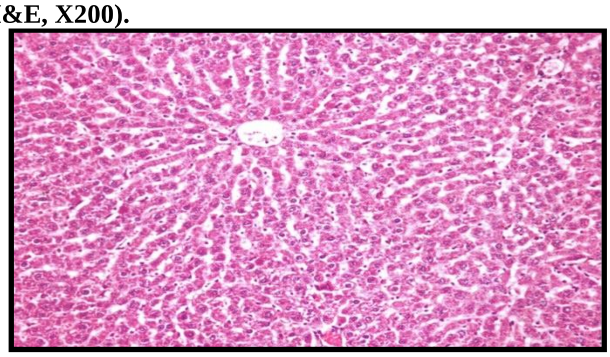

Photo (5): Liver of diabetic rat which treated with whole flaxseed cake diet showing marked restoration of the hepatic parenchymal cells with very mild necrobiotic changes (H&E, X200).

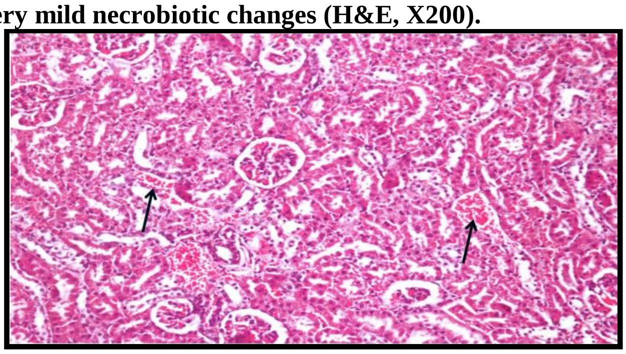

Photo (6): Kidney of diabetic rat which treated with whole flaxseed cake diet showing congestion of the intratubular blood vessels (arrow) with minute intratubular hemorrhages and moderated degree of restoration of the renal tubular epithelial linings that showing moderate degree of degenerative changes (H&E, X200).

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تأثير كلا من كسب وبذور الكتان والسمسم وعباد الشمس لخفض مستوى الكولسترول وجلوكوز الدم

محمد سمير الدشلوطى ،مى محمود الحسينى خفاجى ، شيماء الطاهر أحمد سليمان

المستخلص العربى

أجريت هذه الدراسة لتوضيح أثر بذور الكتان وبذور السمسم وبذور عباد الشمس على تحسن الفئران المصابة بمرض السكرى . وقد كان تأثير كسب البذور المذكورة من ضمن أهداف هذه الدراسة. وقد استخدم كلا من البذور والكسب على مستوى 5% فى العليقة. تم استخدام مجموعة مكونة من 48 من الفئران الذكور وقسمت فى 8 مجموعات ، 6 فئران لكل مجموعة، وقد تم حقن مجموعة من افئران بالألوكسان لإحداث فى ارتفاع الجلوكوز فى السيرم. المجموعة الأولى هى المجموعة الضابطه (-) تتغذى على النظام الغذائى العادى. تغذت الفئران المصابة على بذور الكتان وبذور السمسم وبذور عباد الشمس والكسب بنسبة 5% لمدة 28 يوم. وقد تم تقييم الخواص البيولوجية والكيماوية الحيويه والهستولوجيه وكان ملخص النتائج على النحو التالى:

لوحظ تحسن واضح عند التغذية على البذور وعلى الأخص الكسب الناتج منها، وكانت أفضل مجموعة هى التى تناولت كسب وبذر الكتان 5% ، بحيث أن باقى المجموعات قد تحسنت أيضا من حالة السكرى ولكن بدرجة أقل ، وهذا يدل على ضرورة الإهتمام بالكسب فى طعام الإنسان وليس فقط علائق الحيوان.