Effect of Chia seed (Salvia Hispanica L.) on weight Reduction of obese Rats

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Abstract

Chia is an annual herbaceous plant that belongs to genus Salvia of Lamiacea family. Salvia includes more than 1000 species.The effects of Chia seed on adiposity index, serum liver enzymes, lipid profile, blood glucose and renal functions in obese rats were investigated. Forty two adult male Sprague-Dawley rats were randomly divided into 6 groups. The first main group (12 rats) was divided into two subgroups (the first subgroup was fed on basal diet containing 14% protein) and (the second subgroup was fed on high protein diet "25%protein from casein") as a control negative groups. The second main group (30 rats) was used to induce obesity by using high fat diet for 8 weeks, the second main group was divided into five subgroups (n= 6 rats) Subgroup (1):fed on high fat diet (HFD), containing 14% protein from casein as a control positive group. Subgroup (2): fed on high fat diet (HFD) containing 25% protein from casein, as a control positive group. *Subgroup (3, 4 and 5):* fed on HF and HP diets containing 2.5%, 5% and 10% Chia seeds. Blood samples were collected for separating the serum, which used for biochemical analyses. Livers and kidneys were taken for the histopathological examination. The results showed that oral administration of HFDto obese rats led to significantincrease(*P*<0.05) in BWG%, Relative Organ's Weights ,serum glucose, lipid profile, except HDL-c, liver enzymes,and kidney functions Test. Treating obese rats with high protein diet containing (2.5%, 5% and 10%) chia seeds improved all above parameters.The histopathological examination of livers confirmed these results, especially with the useof the high level of chia seeds. These results encourage the possibility of trialon obese patients.
Keywords: Chia seed; obese rats; glucose; lipid profile; liver enzymes; kidney function .

Introduction

Overweight is defined by body mass index >25 that exceeds a standard body weight; however, the excess weight may also come from muscle, bone, fat, or body water ***(Nelson-Dooley et al., 2005)***. Obesity specifically refers to having a high amount of body fat, which is usually accompanied by abnormalities in leptin and insulin secretion and their action, together with defects in lipid and carbohydrate metabolism ***(Batsiset al., 2007and Lorenzo et al., 2007).***Obesity occurs when the body's energy intake exceeds the body's energy consumption for a prolonged period of time. The degree of obesity is characterized by the volume and number of adipocytes, which is regulated in the so called adipocyte life cycle ***(Rayalam et al., 2008).*** Obesity is associated with many metabolic diseases, including cardiovascular disease, diabetes mellitus, high blood pressure, atherosclerosis, various cancers, and hyperlipidaemia***(Achike et al., 2011).***Thus, treatments targeting the regulation of adipocyte size and number may provide a therapeutic approach ***(Rosen et al., 2000).*** Several plant extracts and their respective bioactive components are well recognized for their potential to exert anti-obesity effects ***(Rayalam et al., 2008).***

An important population behavior is a strong tendency to use foods, nutritional supplements or diets that have reports on weight loss ***(Vaughan et al., 2014).*** It is well known that dietary fiber may promote weight loss, improve lipid profile and blood glucose and reduce blood pressure ***(Lattimer and Haub 2010).*** These fibers can lead to weight loss by delaying gastric emptying and increasing secretion of intestinal hormones which promote satiety ***(Anderson et al.,***

2009).Chia (*Salvia Hispanica L.*) is a source of dietary fiber that has been investigated recently. Studies show that eating chia seeds can reduce systolic blood pressure, postprandial blood glucose and inflammation, and increases α-linolenic acid and plasma concentrations of eicosapentaenoic acid ***(Jin et al., 2012).***

Chia seeds (*Salvia Hispanica L*.), a non-conventional seed, It has radiated extensively in three regions of the world: Central and South America , western Asia and eastern Asia ***(Alziar,1988),*** which is increasingly being recognized as a novel food and is receiving scientific attention. Chia is an annual herb. It is a good source of omega-3/omega-6 fatty acids, soluble dietary fiber and contains appreciable amount of proteins and phytochemicals. It thus has nutritional attributes, which support the prevention of several non-communicable diseases such as obesity, hypertension, cardiovascular disease (CVD's), cancer and diabetes ***(Suri et al., 2016).***

Chia promotes the stability of nutrients in food. It has been used to enrich the omega-3 fatty acid content in foods such as egg, milk and poultry***. Ayerza in the year (2008),*** found the stability of these acids to be higher in animals fed with chia compared to flax seeds. The study showed that higher availability of omega-3 fatty acids in animals fed with chia was because the antioxidants present in the seeds prevent fatty acid degradation. Because of the aforementioned nutritional properties, these seeds are gaining importance among the food industries for formulation of healthy foods.

The main target of the present work is to study the effect of some levels from Chia seed in the presence of high protein diet on weight loss of obese rats.

Materials and Methods

Materials

(1) Casein, all vitamins, minerals, cellulose, L -Cystine and choline chloride were obtained from El–Gomhoriya company, Cairo, Egypt.

(2) Chia seed was obtained from Agriculture Research Center Giza Egypt.

(3) Beef tallow, sucrose, starch and corn oil were obtained from local market, Cairo, Egypt.

(4) Normal male albino rats of Sprague Dawley Strain were obtained from the Laboratory Animal Colony. Ministry of Health and Population, Helwan, Cairo, Egypt.

(5) Kits: kits used to determine serum cholesterol, triglycerides, LDL-c, HDL-c, VLDL-c, glucose, AST, ALT, ALP, uric acid, urea nitrogen, creatinine and leptin hormone were obtained from Gama tread Company, Cairo, Egypt.

Methods

Experimental Design

Male albino rats spragueDawley Strain (42 rats) weighing (150± 10 g) were housed in well aerated cages under standard conditions such as humidity (50-60%), temperature (24-25°C) and light (12-hr light: 12- hr dark cycle)and fed on basal diet for one week for adaptation.The whole period of experiment was 10 weeks. The rats were divided into two main groups. ***The first main group (12 rats)***: This group was divided into two subgroups, the first subgroup was fed on basal diet containing the normal amount of protein "14%" from casein (as a control negative group[1]) according to ***Reeves et al., (1993),*** while the second subgroup fed on basal diet containing high amount of protein "25%" from casein (as a control negative group[2]) .***The second main group (30 rat)*** was fed 6 week on high fat diet HFD containing (beef tallow 19%, corn oil 1% to provide essential fattyacids, sucrose 10%, casein 25%, cellulose 5%, vitamin mixture 1%, salt mixture 3.5%, choline chloride 0.25% and the remainder is corn starch) to induce obesity in rats ***(Min et al., 2004).***

After these period, the mean value of body weight gain was estimated in the two main groups, also blood samples were collected from all rats to estimate the levels of cholesterol and triglycerides, to insure the elevation of these parameters in obese group, then the rats in obese group were divided into five subgroups (n = 6 each) according to the following scheme:

Subgroup (1): fed on high fat diet (HFD), containing 14% protein from casein, as a control positive group (+ve)[1] "HF and normal protein diet".***Subgroup (2):*** fed on high fat diet (HFD) containing 25% protein from casein, as a control positive group (+ve)[2] "HF and HP diet". ***Subgroup (3, 4 and 5):*** fed on HF and HP diets containing 2.5%, 5% and 10% Chia seeds, respectively.

High fat and high protein diet (25% protein + 20% fat).

The high fat and high protein diet consists of 20 % fat (beef tallow 19g and corn oil one g) to provide essential fattyacids; sucrose 10g, casein (31.25 g) equal (25 % protein), cellulose 5g, vitamin mixture 1g, salt mixture 3.5g, choline chloride 0.25g and the remainder is corn starch.

At the end of the experimental period (4 weeks), rats were fasted over night before sacrificing. Blood samples collected from each rats and centrifuged at 3000 r.p.m. to separate the serum. Serum was carefully separated and transferred into dry clean Ebendorf tubes and kept frozen at – 20° C till analysis.

Liver was removed by careful dissection and blotted free of adhering blood immediately after sacrificing the rats. The organs were washed with cold saline (0.9%) and dried between two filter papers, then weighed and kept in formalin solution (10 %) according to ***Drury and Wallington, (1980).***

Biological Evaluation:

Biological evaluation of the different tested diets was carried by determination of feed intake (FI), weight of rats in the (initial, mid period at the end of the experiment), body weight gain% (BWG %) and (organs relative weight / body weight%) according to ***Chapman et al., (1959).***

Biochemical Analysis of Serum:

Serum cholesterol was estimated according to the method described by ***Allainet al., (1974),***while serum triglycerides TG wasmeasured according to the method described by ***Fossati and Principe (1982).***Serum HDL-c was calorimetrically determined according to the method described by ***Burstein (1970).***Serum LDL-c and serum VLDL-c was colorimetrically measured according to the method described by ***Friedewaldet al., (1972).***Serum glucose was estimated in the serum according the method described by ***Trinder (1959).***Serum uric acid was measured according to the method described by ***Fossati et al., (1980).***Serum urea nitrogen was determined according to the method described by ***Patton & Crouch (1977).***Serum creatinine concentration of the sample was estimated by colorimetric method using Jaffe reaction as described by ***Bohmer (1971).***Serum Aspartate and Alanine Amine Transferase (AST and ALT) were carried out according to the method of ***Henry (1974).***Enzymatic colorimetric determination of alkaline phosphatase ALP was carried out according to ***Belfield and Goldberg (1971).***

Histological examination:

Specimens from liver tissues were taken immediately after sacrificing animals, and fixed in 10% buffered neutral formalin solution according to ***(Sheehan and Harpchak, 1980).***

Statistical analysis:

The statistical analysis was carried out by using SPSS, PC statistical software (version 10.0; SPSS Inc, Chicago, USA), using least significant difference (LSD) test at ($P<0.05$) **(*Steel and Torri, 1980).***

Results and Discussion

Effect of Different Levels Chia Seed on feed intake, body weight gain% and relative liver weight of Obese Rats.

The data in table (1) showed that,high protein in the healthy and obese groups decreased the mean value of feed intake, compared to normal protein. While feeding healthy and obese rats on high protein diet decreased the body weight gain % and **relative** liver weight ,as compared to healthy rats fed on basal diet. on feeding obese rats high fat, high protein diet they showed significant decrease in body weight gain% and **relative** liver weight, compared to obese rats fed on high fat, normal protein diet. Finally, feeding obese rats on high fat, high protein diet containing (2.5%, 5% and 10% chia seeds) decreased the mean values of body weight gain% and **relative** liver weight, as compared to the positive control group fed on high fat, high protein diet.Treating obese rats on high fat, high protein diet containing high levels of chia seeds (10%) recorded the best body weight gain % and **relative** liver weight, because this treatment showed significant decrease in this parameter, compared to the other treated groups.

Table (1)
Effect of Different Levels Chia Seed on feed intake, body weight gain% and liver weight % of Obese Rats.

Groups	Parameters	Feed Intake(g/day)	Body weight gain %	Liver relative weight%
Control (-ve)	Fed on BD containing (14% protein)	16.5	26.070 ^{e}± 1.141	3.003 ^{d}± 0.195
	Fed on BD containing (25% protein)	16	21.736 ^{f}± 1.413	2.936 ^{d}± 0.202
Control (+ve)	Fed on BD containing (14% protein)	15.6	38.143 ^{a}± 1.030	3.766 ^{a}± 0.057
	Fed on BD containing (25% protein)	14.23	35.066 ^{b}± 0.672	3.663 $^{a\,b}$± 0.047
High protein diet containing 2.5% Chia		14	33.063 $^{b\,c}$± 1.444	3.496 $^{b\,c}$± 3.296
High protein diet containing 5% Chia		13.43	31.186 ^{c}± 1.130	3.296 ^{c}± 0.085
High protein diet containing 10% Chia		13.00	28.900 ^{d}± 1.041	3.063 ^{d}± 0.047

All results are expressed as mean ± SD.Values in each column which have different letters are significantly different ($p<0.05$).

In this respect, ***Westerterp-Plantenga et al., (2004)***reported that protein and not carbohydrate content is the more important factor in promoting short-term weight loss, may be attributed to increased satiety rather than increased energy expenditure.***Abete et al., (2008)*** cleared that high protein diets lowered energy intake, enhanced weight loss, improved body composition, and helped to maintain a reduced body weight following food restriction in humans. On the other hand, ***Claessens et al., (2009)*** suggested that protein rich diets are postulated to induce stronger satiety; this led not only to a lower energy intake but also to a reduction in energy efficiency because of the increase in metabolic rate and postprandial energy expenditure (EE). Indeed, pair-feeding experiments has shown that a lower energy intake cannot account entirely for reduced adiposity in rats.***Westerterp – Plantenga et al., (1999)*** suggested that a high-protein (HP) diet increased EE and the thermal effect of feeding (TEF). Furthermore, a higher rate of fat oxidation has been reported in people who consumed HP meals ***(Batterham et al., 2008).***

Buckleyand Howe (2010) reported that,supplementing the diet with Long-Chain n-3 PUFA can attenuate weight gain and reduce body fat, in particular epididymal (visceral) fat. Similarly, in human studies there is a growing body of evidence indicating that increasing the intake of Long-Chain n-3 PUFA by 0.3–3.0 g/day can reduce body weight and body fat in overweight and obese individuals.

Toscano et al., (2015)demonstrated that 12 weeks of supplementation with 35 g of chia flour/day caused a significant reduction in body weight and waist circumference of men and women. In this respect, dietary fiber may improve satiety, decrease caloric intake and promote weight loss ***(Lattimer and Haub 2010).*** The high content of omega-3 present in chia can help to reduce obesity by suppressing appetite, improving lipid oxidation and energy expenditure and reducing fat deposition, although these effects are only clearly evident in studies with animals ***(Buckley and Howe, 2010).***

Effect of Different Levels Chia Seed on Serum Glucose of Obese Rats.

Table (2) showed that, feeding healthy rats on high protein diet showed non-significant changes in serum glucose, as compared to healthy rats fed on basal diet. When feeding obese rats on high fat, high protein diet showed significant decrease in serum glucose, as compared to obese rats fed on high fat, normal protein diet. While feeding obese rats on high fat, high protein diet containing (2.5%, 5% and 10% chia seeds) decreased the mean values of serum glucose, as compared to the positive control groups. Finally, treating obese rats on high fat, high protein diet containing high levels of chia seeds (10%) recorded the best results in serum glucose, because this treatment showed significant decrease in this parameter, as compared to the other treated groups.

Table (2)

Effect of different levels of Chia Seed on Serum glucose of Obese Rats,versus control rats.

Groups	Parameters	Serum Glucose (mg/dl)
Control (-ve)	Fed on BD containing (14% protein)	74.786 [f]± 4.061
	Fed on BD containing (25% protein)	72.300 [f]± 3.581
Control(+ve)	Fed on BD containing (14% protein)	140.910 [a]± 3.924
	Fed on BD containing (25% protein)	131.986 [b]± 1.522
High protein diet containing 2.5% Chia		122.970 [c]± 2.705
High protein diet containing 5% Chia		108.886 [d]± 3.639
High protein diet containing 10% Chia		97.036 [e]± 3.619

All results are expressed as mean ± SD.Values in each column which have different letters are significantly different (p<0.05).

In this respect, **(Gannon et al., 2003)**reported that high-protein diet lowers blood glucose postprandially in persons with type 2 diabetes and improves overall glucose control**.** On the other hand, higher protein intake increases satiety and enhances the leptin concentrations in central nervous system CNS as well as elevates leptin sensitivity which tends to maintain body weight ***(Weigle et al., 2005).Vuksan et al., (2007)*** reported that, on eating Chia seeds (*Salvia hispanica L.*) as a source of dietary fiber it reduced systolic blood pressure, postprandial blood glucose and inflammation, and increased α-linolenic acid and plasma concentrations of eicosapentaenoic acid**.** This was supported by, ***Vuksan et al., (2010)*** who demonstrated a reduction of postprandial blood glucose on consuming different amounts of chia (7, 15 and 24 g), in healthy individuals.

The insoluble dietary fibre of chia is capable of retaining water several times of its weight during hydration and thus provides bulk and prolongs the gastro-intestinal transit time. Increased gastro-intestinal time is directly related to gradual increase in post-prandial blood glucose levels and decrease in insulin resistance over a period of time ***(Munoz et al., 2012)*** Few studies indicate that chia seeds exhibit positive effects on health such as reduction of post-prandial blood glucose levels and systolic blood pressure ***(Toscano et al., 2014; Vuksan et al, 2010 and Ho et al., 2013).***

Chia seeds may help in the prevention, treatment and management of several non-communicable diseases, improving immunity and perhaps modifying the blood clotting mechanism. Chia also helps in improving the post-prandial blood glucose levels in blood by slowing down the digestion of carbohydrates ***(Suri et al., 2016).***

Effect of Different Levels Chia Seed on Lipid Profile of Obese Rats.

Table (3 and 4)confirmed that, feeding healthy rats on high protein diet showed non-significant changes in serum cholesterol, triglycerides, HDL-c and VLDL-c, while LDL-c decreased significantly, as compared to healthy rats fed on basal diet containing 14% protein. When feeding obese rats on high fat, high protein diet showed non-significant changes in serum cholesterol, triglycerides, HDL-c and VLDL-c, while LDL-c decreased significantly, as compared to obese rats fed on high fat diet containing 14% protein. While feeding obese rats on high fat, high protein diet containing (2.5%, 5% and 10% chia seeds) improved the mean values of lipid profile (cholesterol, triglycerides, HDL-c, LDL-c and VLDL-c), especially the obese group which treated with 10% chia seeds. Finally the mean values of lipid profile improved gradually with increasing the level of chia seeds.

Table (3)
Effect of Different Levels of Chia Seed on Serum Cholesterol ,Triglyceride and Serum Lipoproteins of Obese Rats of Obese Rats.

Groups	Parameters	Cholesterol	Triglyceride	HDL-c	LDL-c	VLDL-c
		mg/dl		Lipoproteins (mg/dl)		
Control (-ve)	Fed on BD containing (14% protein)	78.496 ^{e}± 3.371	38.750 ^{e}± 3.705	41.796 ^{a}± 1.403	28.950 ^{f}± 1.680	7.750 ^{e}± 0.741
	Fed on BD containing (25% protein)	74.523 ^{e}± 3.143	36.233 ^{e}± 2.124	43.340 ^{a}± 1.814	23.936 ^{g}± 1.478	7.246 ^{e}± 0.424
Control (+ve)	Fed on BD containing (14% protein)	149.800 ^{a}± 3.904	85.806 ^{a}± 4.950	23.273 ^{d}± 2.472	109.365 ^{a}± 2.996	17.161 ^{a}± 0.990
	Fed on BD containing (25% protein)	145.060 ^{a}± 4.162	82.206^{ab}± 4.451	25.296 ^{cd}± 2.780	103.322 ^{b}±1.119	16.441^{ab}± 0.890
High protein diet containing 2.5% Chia		136.126 ^{b}± 3.699	76.456 ^{b}± 4.137	29.600 ^{c}± 4.032	91.135 ^{c}± 1.166	15.391 ^{b}± 0.832
High protein diet containing 5% Chia		116.576 ^{c}± 4.590	67.126 ^{c}± 3.00	34.883 ^{b}± 3.606	68.268 ^{d}± 3.079	13.425 ^{c}± 0.600
High protein diet containing 10% Chia		102.733 ^{d}± 4.148	57.393 ^{d}± 3.221	39.710 ^{a}± 1.909	51.544 ^{e}± 3.386	11.478 ^{d}± 0.644

All results are expressed as mean ± SD.

Values in each column which have different letters are significantly different (p<0.05).

Dietary protein content affects body weight and lipid profiles. While differences in dietary protein content appear to have similar effects on body weight, diets higher in protein may produce more favorable changes in lipid profiles. For example, replacing carbohydrates with protein was found to significantly reduce TG levels and LDL cholesterol ***(Appel et al., 2005).***

According to the American Association of Cereal Chemists, dietary fibers promote beneficial physiological effects including laxation, and blood cholesterol and glucose attenuation ***(Ausman, 1993).*** Research supports this claim: it has been found that fiber improves glycemic control ***(Bazinetet al., 2003),*** lowers blood lipid levels ***(Burdge and Wootton, 2002)*** and may even reduce the risk of colon cancer **(*Burdge et al., 2002).***One tablespoon of chia seeds provide a total of 5 grams of fiber, which contributes to the heart healthy nature of chia seeds. Soluble fiber, found in chia seeds, dissolves in water and passes though the digestive system more slowly than insoluble fiber. Soluble fiber with a healthy diet may help lower LDL cholesterol levels without lowering HDL cholesterol ***(Hunter & Cason 2005).***

Previous studies using animal models showed robust results of consumption of chia in lipid profile. Reduction in visceral adiposity, prevention of dyslipidemia, hypertriglyceridemia normalization ***(Chicco et al., 2009)***; improvement in adipose tissue and lipid metabolism dysfunction; decrease in serum triglycerides and increased HDL-C were observed in rats ***(Oliva et a., 2013).***

Effect of Different Levels of Chia Seed on Serum Lipoproteins of Obese Rats.

As mentioned in table (4) healthy rats fed on high protein diet showed non-significant changes in serum cholesterol, triglycerides, HDL-c and VLDL-c, while LDL-c decreased significantly, as compared to healthy rats fed on basal diet containing 14% protein. When, feeding obese rats on high fat, high protein diet showed non-significant changes in serum cholesterol, triglycerides, HDL-c and VLDL-c, while LDL-c decreased significantly, as compared to obese rats fed on high fat diet containing 14% protein. While, feeding obese rats on high fat, high protein diet containing (2.5%, 5% and 10% chia seeds) improved the mean values of lipid profile (cholesterol, triglycerides, HDL-c, LDL-c and VLDL-c), especially the obese group which treated with 10% chia seeds. Finally, the mean values of lipid profile improved gradually with increasing the level of chia seeds.

Effect of Different Levels of Chia Seed on Liver Enzymes of Obese Rats.

Table (4)show that, feeding healthy rats on high protein diet caused non-significant changes in serum AST, ALT and ALP, as compared to healthy rats fed on basal diet containing 14% protein. When feeding obese rats on high fat, high protein diet showed non-significant changes in serum AST and ALT enzymes, while ALP increased significantly, as compared to obese rats fed on high fat diet containing 14% protein. While feeding obese rats on high fat, high protein diet containing (2.5%, 5% and 10% chia seeds) improved the mean values of liver enzymes (AST, ALT and ALP), especially the obese group treated with 10% chia seeds. Finally the mean values of liver enzymes decreased gradually with increasing the level of chia seeds.

Table (4)

Effect of Different Levels of Chia Seed on Liver Enzymes of Obese Rats.

Groups	Parameters	Liver Enzymes (u/l)		
		AST	ALT	ALP
Control (-ve)	Fed on BD containing (14% protein)	54.290 [e]± 3.084	18.886 [d]± 1.814	76.136 [e]± 3.946
	Fed on BD containing (25% protein)	56.473 [e]± 3.169	20.236 [d]± 1.345	80.426 [e]± 4.371
Control (+ve)	Fed on BD containing (14% protein)	138.556[ab]± 6.090	65.216 [a]± 4.565	149.813 [b]± 3.276
	Fed on BD containing (25% protein)	142.210 [a]± 4.994	68.313 [a]± 4.076	156.810 [a]± 3.203
High protein diet containing 2.5% Chia		134.416 [b]± 4.166	62.380 [a]± 2.646	148.423 [b]± 3.359
High protein diet containing 5% Chia		118.500 [c]± 3.263	53.553 [b]± 3.436	133.986 [c]± 5.011
High protein diet containing 10% Chia		101.976 [d]± 3.202	45.830 [c]± 3.454	118.620 [d]± 3.989

All results are expressed as mean ± SD.

Values in each column which have different letters are significantly different ($p<0.05$).

Effect of Different Levels of Chia Seed on Kidney Functions of Obese Rats.

Table (5) shows that, feeding healthy rats on high protein diet (25% protein) showed non-significant changes in serum uric acid and creatinine, while serum urea nitrogen increased significantly, as compared to healthy rats fed on basal diet containing 14% protein. When feeding obese rats on high fat, high protein diet showed significant increase in serum uric acid, urea nitrogen and creatinine, as compared to obese rats fed on high fat diet containing 14% protein. While feeding obese rats on high fat diets containing (14% and 25% protein) showed significant increase in serum uric acid, urea nitrogen and creatinine, as compared to the negative control groups fed on diets containing (14% and 25% protein). Finally feeding obese rats on high fat, high protein diet containing (2.5%, 5% and 10% chia seeds) improved the mean values of kidney functions (uric acid, urea nitrogen and creatinine), especially the obese group which treated with 10% chia seeds, the mean values of serum (uric acid, urea nitrogen and creatinine) decreased gradually with increasing the level of chia seeds.

Table (5)

Effect of Different Levels of Chia Seed on Kidney Functions of Obese Rats.

Groups	Parameters	Kidney Functions (mg/dl)		
		Uric Acid	Urea Nitrogen	Creatinine
Control (-ve)	Fed on BD containing (14% protein)	1.490 ^{e}± 0.085	22.560 ^{e}± 2.510	0.573 ^{e}± 0.075
	Fed on BD containing (25% protein)	1.600 ^{e}± 0.070	28.143 ^{d}± 2.889	0.690 ^{e}± 0.062
Control (+ve)	Fed on BD containing (14% protein)	2.743 ^{b}± 0.096	64.143 ^{b}± 4.936	1.733 ^{b}± 0.105
	Fed on BD containing (25% protein)	3.040 ^{a}± 0.130	77.650 ^{a}± 4.220	1.986 ^{a}± 0.150
High protein diet containing 2.5% Chia		2.790 ^{b}± 0.075	72.283 ^{a}± 2.731	1.853 ^{ab}± 0.128
High protein diet containing 5% Chia		2.310 ^{c}± 0.110	63.450 ^{b}± 1.904	1.483 ^{c}± 0.104
High protein diet containing 10% Chia		2.053 ^{d}± 0.110	54.036 ^{c}± 1.366	1.203 ^{d}± 0.116

All results are expressed as mean ± SD.

Values in each column which have different letters are significantly different ($p<0.05$).

Taga et al., (1984) reported that, chia seeds have an oil content of 25% to 35%, are rich in n-3 polyunsaturated fatty acids**.**Omega-3 fatty acid supplementation is associated with a significantly reduced risk of end-stage renal disease and delays the progression of this disease ***(Hu et al., 2017).***Over the past few decades, many studies have shown that omega-3 fatty acids are clearly effective at reducing proteinuria in patients with chronic glomerular disease ***(Hogg, 1995 and De Caterina et al., 1993).***Several studies have indicated that short- or long-term intervention with omega-3 fatty acids might reduce the risk of end-stage renal disease ESRD and proteinuria and increase the creatinine clearance rate (CCR) ***(Ferraro et al., 2009).***

Histopathological examination of liver

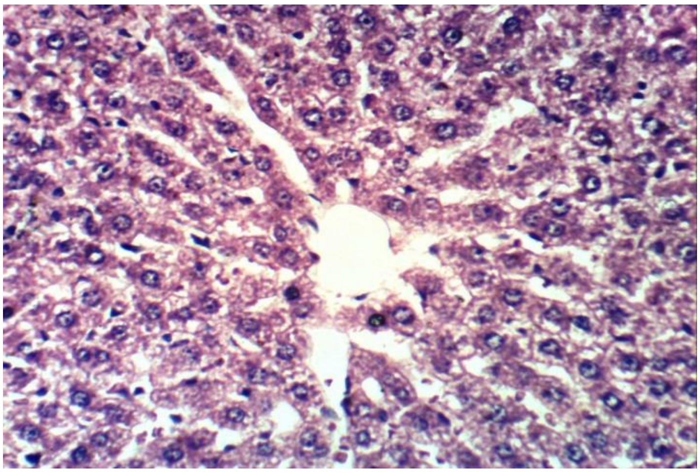

Photo (1): Liver of rat from negative control group fed on basal diet containing 14% protein showing the normal histological structure of hepatic lobule (H & E X 400).

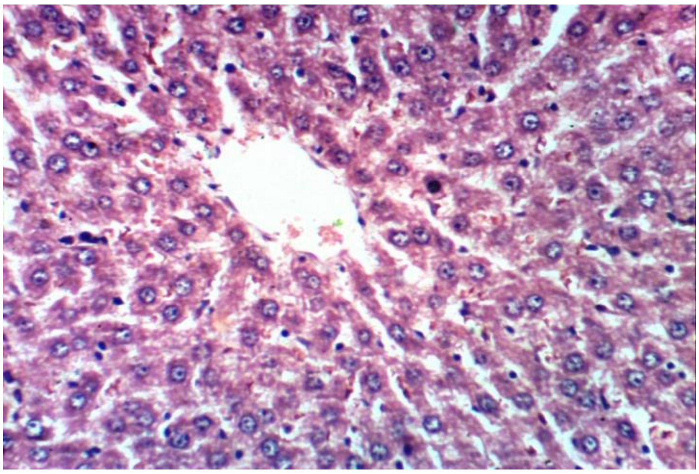

Photo (2): Liver of rat from negative control group fed on diet containing 25% protein showing the normal histological structure of hepatic lobule (H & E X 400).

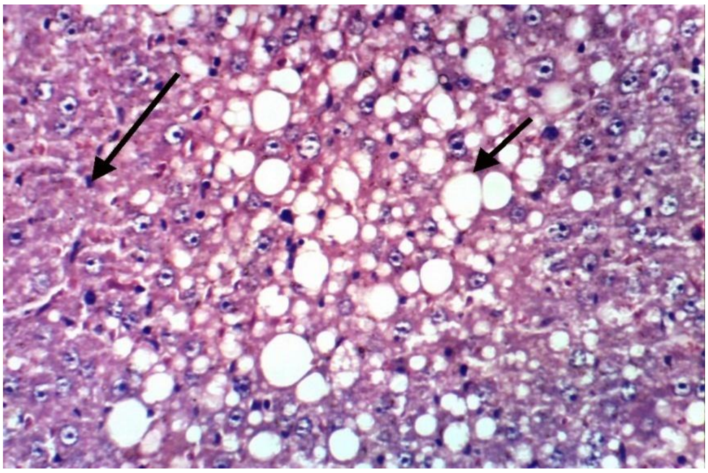

Photo (3): Liver of rat from control positive group (obese rats) fed on high fat diet containing 14% protein showing steatosis of hepatocytes and activation of Kupffer cells (H & E X 400).

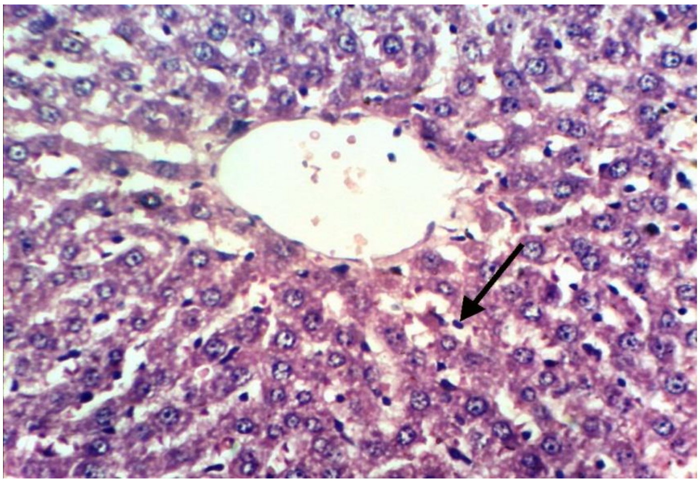

Photo (4): Liver of rat from control positive group (obese rats) fed on high fat diet containing 25% protein showing activation of Kupffer cells (H & E X 400).

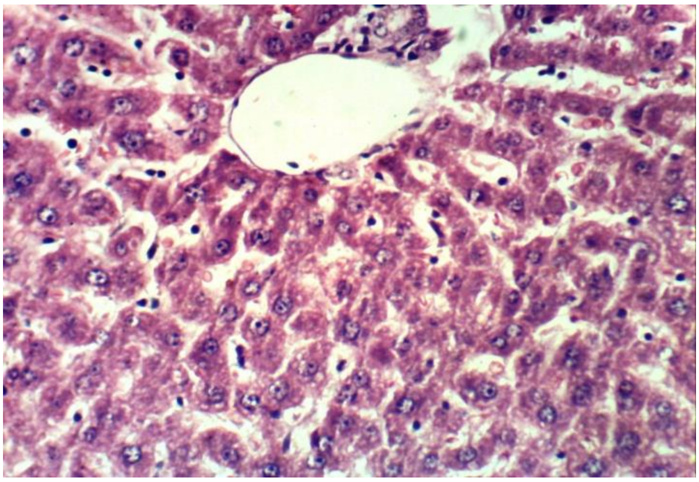

Photo (5): Liver of rat from obese group fed on high fat, high protein diet containing 5% chia seeds showing no histopathological changes (H & E X 400).

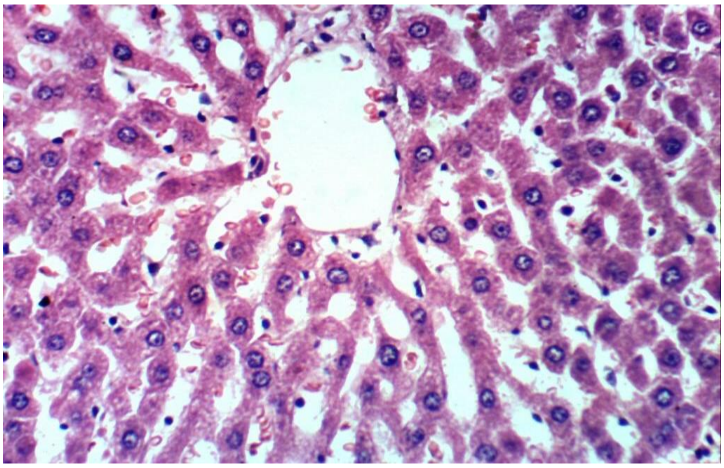

Photo (6): Liver of rat from obese group fed on high fat, high protein diet containing 10% chia seeds showing no histopathological changes (H & E X 400).

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تأثير بذور الشيا على خفض الوزن في الجرذان المصابه بالسمنه

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الملخص العربى

هدفت الدراسة لتقييم تأثير بذور الشيا على معدل النسيج الدهني ، انزيمات الكبد ، مستوى الدهون في السيرم ، نسبة السكر في الدم وظائف الكلية في الجرذان المصابه بالسمنه . وقد تم تقسيم أثنين وأربعونجرذمن الذكور البالغين من فصيلة(الاسبراج داولي) عشوائيا إلى 6 مجموعات. المجموعة الرئيسية الأولى (12 جرذاً) تم تقسيمها إلى مجموعتين فرعيتين (المجموعة الفرعية الأولى التي تم تغذيتها على الغذاء الأساسي تحتوي على 14٪ بروتين) و (المجموعة الفرعية الثانية المغذاه على النظام الغذائي عالي البروتين "25٪ بروتين") كمجموعات ضابطةسالبة.وتم استخدام المجموعة الرئيسية الثانية (30 جرذاً) لاصابتها بالسمنة باستخدام نظام غذائي عالي الدهون لمدة 8 أسابيع ، وتم تقسيم المجموعة الرئيسية الثانية إلى خمس مجموعات فرعية (كل مجموعه = 6 جرذ) المجموعة الفرعية (1): تغذت على النظام الغذائي مرتفع الدهون (HFD) ويحتوي على 14٪ بروتين كمجموعة إيجابية. المجموعة الفرعية (2): تغذت أيضا على نظام غذائي مرتفع الدهون (HFD) يحتوي على 25٪ بروتين ، كمجموعة إيجابية. المجموعة الفرعية (3 و 4 و 5): تغذت على الوجبة الغذائية مرتفعة الدهونHF و البروتينHPو تحتوي على 2.5٪ و 5٪ و 10٪ من بذور Chia. تم جمع عينات الدم لفصل السيرم ، والذي استخدم للتحليلات البيوكيميائية. وتم أخذ الكبد للفحص النسجي. وقد أوضحت النتائج أن التغذية على نظام غذائي مرتفع الدهونHFDللجرذان أدى إلى حدوث زيادة معنوية في معدل الزيادة في وزن الجسم %BWGونسبة الجلوكوز في الدم ومستوى الدهون باستثناء HDL-c وأنزيمات الكبد ووظائف الكلى. وقد وجد أن معاملةالجرذانالبدينةبنظام غذائي مرتفع البروتين الذي يحتوي على (2.5 ٪ ، 5 ٪ و 10 ٪) من بذور الشيا أدى إلي حدوث تحسنفي جميع المعاملات المذكورة أعلاه ، كما أكد الفحص النسيجي للكبد هذه النتائج ، وخاصة عند استخدام مستوى عال من بذور الشيا. وهذه النتائج تشجع محاولة اجراء الدراسة علي الانسان مريض السمنه.

الكلمات المفتاحيه: بذور الشيا؛ الجرذان البدينه؛ الجلوكوز، مستوى الدهون؛ انزيمات الكبد. وظيفة الكلى.