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Effect of low fat high protein diets in the presence of Arabic gum on weight loss of obese rats.

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Abstract

Obesity is considered a serious disease affecting a large population worldwide. The present work was conducted to study the effect of low fat high protein diets in the absence or presence of Arabic gum on weight loss, some nutritional and biochemical parameters of obese rats. Normal male's albino rats (49) of Sprague Dawley Strain weighted 130 ± 5 g. were used in this study. The rats were divided into two main groups. The first main group (7 rats) fed on basal diet as a control negative group. The second main group (42 rats) were fed on high fat diet (HFD) for four weeks to induce obesity. After this period, the mean values of serum cholesterol, triglycerides and body weight gain were determined in the first and second main group to ensure obesity induction. The rats in the second main group was divided into seven subgroups (n=7rats) as follow: Subgroup (1) were fed on HFD as a control positive group, subgroup (2) were fed on HFD containing 5% Arabic gum AG, subgroups (3 and 4) were fed on low and very low caloric diets respectively [through the replacement of some dietary fat (saturated fat) with protein], , subgroups (5 and 6) were fed on low fat high protein diets respectively and containing the same amount of AG used in subgroup (2),. The results in this study revealed that, the mean value of feed intake, body weight gain relative, liver weight decreased in all treated groups, as compared to obese groups. The mean values of serum glucose, leptin hormone, all lipid fractions (cholesterol, triglycerides, LDL-c, the ratio between LDL-c/HDL-c and VLDL-c), kidney functions (uric acid, urea nitrogen and creatinine) and liver enzymes (aspartate amino transferase AST, alanine amino transferase ALT and alkaline phosphatase ALP) decreased significantly $p<0.05$ in all tested groups, while HDL-c increased in all treated groups, as compared to the obese group (control +ve group). The best results recorded for the groups treated with low and very low fat high protein diets containing AG. It is concluded supplemented rat high protein low fat diet with Arabic gum improved the nutritional and biological parameters of obese rats.

Key words: rats, obesity, high protein diets, high fat diets, Arabic gum, glucose, leptin hormone, lipid profile, kidney functions, liver enzymes.

Introduction

The importance of nutrient composition has been more widely recognized on account of dysmetabolic diseases such as obesity and diabetes, which are directly related to the incidence of cardiovascular disease. Obesity is considered a serious disease affecting a large population worldwide ***(Bessesen, 2008)***. In humans, reducing body weight even by modest amounts (e.g. 5–10%) can reduce the risk of associated diseases, and improve patient quality of life ***(Avenell et al., 2006).*** Moderate weight loss reduces visceral adipose tissue, improves insulin sensitivity, glycemic control, and dyslipidemia in overweight subjects with insulin resistance ***(Goodpaster et al., 1999).***

Baba et al., (1999) reported that, the replacement of some dietary carbohydrate with protein, combined with low total (< 30%) and saturated (< 10%) fat contents, was shown to enhance weight loss in free-living subjects. On the other

hand, ***Farnsworth et al., (2003)*** reported that, replacing carbohydrate with protein from meat, poultry, and dairy foods has beneficial metabolic effects and no adverse effects on markers of bone turnover or calcium excretion. Also, ***Westerterp-Plantenga et al., (2004)*** found that protein and not carbohydrate content is the more important factor in promoting short – term weight loss, they attributed it to increased satiety rather than increased energy expenditure.

Samaha et al., (2003) randomized 64 obese patients to receive counseling on maintaining a high-protein, low-carbohydrate diet (22% protein) and 68 to receive counseling on consuming a low-fat, high-carbohydrate diet (16% protein). After 6 mo, the high-protein, low-carbohydrate group lost significantly more weight (5.8 vs 1.9 kg; $P \leq 0.002$). Also, ***Skov et al., (1999)*** found that obese subjects randomized to a high-protein intake (25% of energy) lost significantly more weight (8.8 vs 5.1 kg) and fat (7.6 vs 4.3 kg) after 6 mo compared with those on a low protein diet (12% of energy). On the other hand, ***Vazquez et al., (1995)*** reported that lean mass was preserved after weight loss with an energy-restrictive high-protein diet.

One weight-loss and 2 weight maintenance studies also showed that replacing some carbohydrate with protein improves the fasting lipid profile ***(Wolfe and Piche 1999).*** In 13 obese hyperinsulinemic men, an increase in HDL-cholesterol concentrations was reported after greater weight loss with consumption of an energy-restrictive high-protein diet (45% of energy) than that with consumption of an isoenergetic standard protein diet (15% of energy) ***(Baba et al., 1999).***

The US Food and Drug Administration consider Gum Arabic (GA) as one of the safest dietary fibres ***(Anderson, 1986).*** Gum Arabic (GA) is derived from exudates of Acacia senegal or Acacia seyal trees. It consists of a mixture of polysaccharides (major component) plus oligosaccharides and glycoproteins **(Goodrum et al., 2000)**; however, its composition can vary with its source, climate and soil. Sudan is the world's largest producer, followed by many other African countries. It readily dissolves in water to form solutions characterized by low viscosity. This allows its use in various applications ***(Dziezak, 1991).***

Gum Arabic (GA) ingestion causes significant reduction in body mass index and body fat percentage among healthy adult females. The effect could be exploited in the treatment of obesity ***(Babiker et al., 2012).*** Several epidemiological studies suggest that a high intake of dietary fiber, including GA, is associated with beneficial effects on fat metabolism ***(Ali et al., 2009).*** Dietary fiber promotes satiation and satiety, alter glycaemic index, affects gastric emptying, gut hormone secretion and thus helps to manage weight ***(Chandalia et al., 2000).*** Leptin promotes weight loss by two different mechanisms. It reduces appetite, and thus food intake, and at the same time increases energy expenditure also dietary fiber was inversely associated with leptin level in young Japanese adults ***(Murakami et al., 2007 and Kuroda et al., 2010).***

The aim of this study was to compare the effects of replacement of some dietary fat (saturated fat) with protein in the presence or absence of Arabic gum on rats suffering from obesity.

Materials and Methods

Materials:

- Casein, all minerals, vitamins, choline chloride, cellulose, and L -Cystine were obtained from El–Gomhoriya Company, Cairo, Egypt.
- Hydrogenated margarine, sucrose, starch and soybean oil were obtained from local market, Cairo, Egypt.
- Gum Arabic of Giza 128 variety was obtained from Agriculture Research Center, Giza, Egypt.

- Forty-nine normal male albino rats (Sprague Dawley Strain) were obtained from the Laboratory Animal Colony. Ministry of Health and Population, Helwan, Cairo, Egypt.
- Kits used to determine serum parameters are obtained from Gama tread Company, Cairo, Egypt.

Methods:

Male albino rats Sprague Dawley Strain (49 rats) weighing (130 ± 5 g) were housed in well aerated cages under hygienic condition and fed on basal diet for one week for adaptation. The basal diet consists of 14 % protein from casein (≥ 80 %), 4% soybean oil, 0. 25 % choline chloride, 1 % vitamin mixture, 3.5% salt mixture, 5 % cellulose, 0.18 % L – cystine and the remainder is corn starch ***(Reeves et al ., 1993)***. The salt mixture was prepared according to ***(Hegested et al., 1941)*** and the vitamin mixture was prepared according to ***(A.O.A.C. 1975).***

The rats were divided into two main groups, the first main group (7 rats)were fed four weeks on basal diet, while the second (42 rats) were fed on high fat diet consisted of (14% protein from casein, soybean oil to provide essential fatty acid 1%, hydrogenated margarine 19%, 0. 25 % choline chloride, 1 % vitamin mixture, 3.5% salt mixture, 5 % cellulose, 0.18 % L – cystine and the remainder is corn starch ***(Min et al., 2004).*** After this period, the mean value of body weight was estimated in the first and second main groups, also blood samples were collected from all rats to estimate the levels of cholesterol and triglycerides (healthy rats was 73.433 ± 5.421 mg/dl cholesterol and 35.200 ± 3.220 mg/dl triglycerides), while the second main group recorded (144.509 ± 7.991 mg/dl cholesterol and 67.454 ± 5.872 mg/dl triglycerides), Then the rats were divided into six subgroups (n = 7 each) according to the following.

Subgroup (1) fed on high fat diet (HFD) as a positive control group, subgroup (2) fed on HFD containing 5% Arabic gum (AG), subgroups (3 and 4) fed on high and very high protein diet, respectively, subgroups (5 and 6) fed on high and very high protein diet containing the same amount of AG used in subgroup (2), respectively. The following Table (1) shows the composition of the diets of rats.The study continued for four weeks.

Table(1)

Diet composition (g/kg diet)

Groups / Ingredients	Control Negative	Control (+) HFD	HFD and Arabic Gum	Replacement of fat with protein		Replacement of fat with protein in the presence of AG	
				HPD	VHPD	HPD	VHPD
Casein	140	140	140	190	290	190	290
soybean oil	40	10	10	10	10	10	10
Vitamin	10	10	10	10	10	10	10
Minerals	35	35	35	35	35	35	35
cellulose	50	50	50	50	50	50	50
L -Cystine	1.8	1.8	1.8	1.8	1.8	1.8	1.8
choline chloride	2.5	2.5	2.5	2.5	2.5	2.5	2.5
hydrogenated margarine	--	190	190	140	40	140	40
sucrose	100	100	100	100	100	100	100
AG	--	--	50	--	--	50	50
Starch	620.7	460.7	410.7	460.7	460.7	410.7	410.7

AG: Arabic gum. HFD: High Fat Diet HPD: High protein Diet VHPD: Very High Protein Diet

During the experimental period, the diets consumed and body weights were recorded twice weekly. At the end of the experiment, the animals were fasted overnight, and then the rats were anaesthetized and sacrificed, blood samples were collected from the aorta in centrifuge tubes. The blood samples were centrifuged after time at 3000 rpm and the serum was separated to estimate some biochemical parameters, i.e. serum glucose according to ***Trinder, (1959),*** cholesterol ***(Allain et al., 1974),*** triglycerids ***(Foster and Dumns, 1973),*** high density lipoprotein HDL-c ***(Lopes-Virella et al., 1977),*** low density lipoprotein LDL-c and VLDL-c calculated according to ***(FriedWald et al., 1972),*** aspartateamino transaminase (AST) and alanineamino transaminase (ALT) ***(Ritman and Frankel, 1957),*** alkaline posphatase ALP ***(Kind and King, 1954),*** uric acid ***(Fossati et al., 1980),*** urea nitrogen ***(Patton & Crouch 1977),*** creatinine ***Bohmer (1971)*** and serum leptin according to ***Guillaume and Bjorntorp (1996).*** Liver of all groups was separated from each rat and weighed to calculate relative liver weight

Statistical analysis:

The results were expressed as mean ± (standard deviation **"SD"**) and tested for significance using one way analysis of variance **"ANOVA"** test, according to ***(Armitage and Berry, 1987).***

Results and Discussion

Effect of low fat high protein diets of Arabic gum on feed intake, weights and relative liver weight of obese rats.

The data in Table (2) shows the effect of Arabic gum, low fat diet (LFD) [through the replacement of some dietary fat (saturated fat) with protein] and LPDs containing Arabic gum on feed intake, final weights, body weight gain % and relative liver weight of obese rats. The mean daily value of feed intake of healthy rats (control negative group) fed on basal diet BD was 18.075 g/day/each rat, while this mean increased in the positive group (obese rats) fed on high fat diet by about 13.54%, than that of the negative group. The mean values of feed intake in all treated groups decreased, as compared to the positive control group. The highest decrease in feed intake was recorded for the obese group fed on very high protein diet and Arabic gum together, this treatment decreased feed intake by about 21.474%, than that of the positive control group.

Table (2)

Effect of low fat high protein diets in the presence of Arabic gum on feed intake, weights and relative liver weight of obese rats.

Parameters / Groups		Mean daily Feed intake (g/day/rat)	Weight(g)		BWG %	Relative Liver weight
			Initial	Final		
Control (-) fed on BD		18.075	158.14^{b} ± 5.640	184.71^{e} ± 7.674	16.79^{f} ± 1.568	2.92^{d} ± 0.189
Control (+) fed on HFD		20.522	219.00^{a} ± 5.033	302.86^{a} ± 6.841	38.30^{a} ± 1.102	3.98^{a} ± 0.178
Obese rats treated with	Arabic gum	17.242	218.43^{a} ± 5.711	283.75^{b} ± 4.504	29.86^{b} ± 1.614	3.54^{b} ± 0.137
	High protein diet	17.00	220.00^{a} ± 3.366	279.57^{bc} ± 5.255	27.08^{c} ± 1.237	3.60^{b} ± 0.087
	Very high protein diet	16.532	221.71^{a} ± 5.936	267.29^{d} ± 4.535	20.59^{e} ± 1.653	3.34^{c} ± 0.084
	High protein diet and Arabic gum	16.334	222.14^{a} ± 3.579	275.71^{c} ± 5.851	23.85^{d} ± 1.002	3.20^{c} ± 0.141
	Very high protein diet and Arabic gum	16.115	222.43^{a} ± 4.391	261.43^{d} ± 4.894	17.54^{f} ± 0.910	2.83^{c} ± 0.108

BWG%: Body weight gain %. All results are expressed as mean ± SD.

Values in each column which have different litters are significant different ($p<0.05$).

The mean value of weights of rats in the negative group at the beginning of the experimental period was significantly less ($p< 0.05$), compared to the positive and all treated groups. Final weight in the positive group increased significantly $p<0.05$, as compared to the negative group, the percentage increase was estimated by about 63.97%, than that of the negative control group. Treated obese rats with Arabic gum, high & very high protein diets alone or high & very high protein diets with Arabic gum their final weight decreased significantly $p<0.05$, compared to the positive control group. The final weight of the group treated with very high protein diet decreased significantly $p<0.05$, compared to the group treated with the high protein diet, The same trend was observed on using the very high protein diet with Arabic gum. Body weight gain % of all treated groups decreased significantly ($p<0.05$), in comparison with the positive control group. The highest decrease in BWG was recorded for the group fed on very high protein diet containing 5% Arabic gum, this group showed non-significant difference in this parameter, as compared to the negative control group.

Relative liver weight of the positive group increased significantly, as compared to the negative control group. The mean values of relative liver weight in all treated groups decreased significantly ($p<0.05$), as compared to the positive control group. Feeding obese rats with very high protein diet containing 5% Arabic gum recorded the best results, this treatment recorded non-significant change, as compared with the negative control group.

In this respect, ***Boer et al., (1986)*** reported that, weight loss due to very-low-calorie diets VLCD regimens resulted in energy deficit or the difference between total expenditure and intake. This deficit and the weight loss that results diminish progressively with continued dieting because total energy expenditure decreases. While ***(Halton and Hu, 2004)*** reported that, there is convincing evidence that high-protein diets increase satiety in short-term studies. Higher-protein diets may also reduce subsequent energy intake.

A higher thermogenesis for protein is a possible mechanism as well. A main reason for the difference in the thermic effects of foods higher in protein compared with those higher in carbohydrates or fats may be attributable to the fact that the body has no storage capacity for protein, and thus it needs to be metabolically processed immediately. The synthesis of protein, the high ATP cost of peptide bond synthesis, as well as the high cost of urea production and gluconeogenesis are possible reasons for the higher thermic effect of protein ***Mikkelsen et al., (2000)***. A number of short-term trials suggest that protein exerts a more powerful effect on satiety than both carbohydrate and fat ***(Toubro and Astrup 1997),*** and these could be the reasons because a generous protein intake may contribute more consistently to weight loss ***(Whitehead et al., 1996).***

Accordingly, ***Labayen et al., (2003)*** showed that body weight and fat mass losses were higher in a moderately high protein (HP) based slimming program, as compared to a isoenergetic low calorie diet with different macronutrient distribution. Recently, a diet formulated to contain high levels of both protein and fibre was shown to improve satiety in healthy dogs, when compared with diets supplemented with either fibre or protein alone ***(Weber et al., 2007).***

Gum Arabic (GA) ingestion causes significant reduction in BMI and body fat percentage among healthy adult females. The effect could be exploited in the treatment of obesity ***(Babiker et al., 2012).***

Gum Arabic influence on energy intake and body weight regulation remains controversial. A growing body of scientific evidence indicates that GA ingestion causes significant reduction in caloric intake with an increased subjective feeling of satiety ***(Calame et al., 2011).***

Effect of low fat high protein diets the presence of Arabic gum on serum glucose and leptine hormone of obese rats.

Results presented in table (3) illustrate the effect of low fat high protein diets without and with Arabic gum on serum glucose and leptin hormone of albino rats suffering from obesity. Feeding obese rats on high fat diet increased serum glucose significantly ($p<0.05$), as compared to the positive control group, serum glucose increased in the positive

control group by about 112.24%, than that of the negative control group. Feeding obese rats on high fat diet containing 5% Arabic gum reduced serum glucose significantly ($p<0.05$), as compared to the positive control group. Treating obese rats with high and very high protein diets without and with Arabic gum led to significant decrease ($p<0.05$) in serum glucose, as compared to the positive control group. On the other hand, the mean value of serum glucose decreased gradually with increasing the level of protein in the diet whether in the presence or absence of Arabic gum. The highest decrease in serum glucose recorded for the group treated with very high protein diet and Arabic gum together.

Table (3)

Effect of low fat high protein diets in the presence of Arabic gum on serum glucose and leptin hormone of obese rats.

Groups \ Parameters		Glucose mg/dl	Leptin ng /dl
Control (-) fed on BD		80.571 ^{f} ± 4.928	2.214 ^{f} ± 0.195
Control (+) fed on HFD		171.000 ^{a} ± 7.958	24.571 ^{a} ± 1.718
Obese rats treated with	Arabic gum	159.428 ^{b} ± 5.223	20.857 ^{b} ± 1.463
	High protein diet	153.000 ^{b} ± 7.549	20.714 ^{b} ± 1.253
	Very high protein diet	129.857 ^{d} ± 4.488	15.000 ^{c} ± 1.633
	High protein diet and Arabic gum	139.142 ^{c} ± 6.866	13.285 ^{d} ± 1.112
	Very high protein diet and Arabic gum	119.000 ^{e} ± 4.899	8.571 ^{e} ± 1.618

All results are expressed as mean ± SD.

Values in each column which have different litters are significant different ($p<0.05$).

Results in this table revealed that serum leptin in the negative control group fed on basal diet was (2.214 ± 0.195 ng/dl), while the positive control group fed on high fat diet was (24.571±1.718 ng/dl). The statistical analysis showed that there was a significant increase ($p<0.05$) in serum leptin level of positive control group, as compared to the negative control group. Arabic gum decreased the mean value of serum leptin significantly, as compared to the positive control group. Serum leptin decreased in all treated groups. Very high protein diet decreased serum leptin significantly ($p<0.05$), as compared to high protein diet. Very high protein diet in the presence of Arabic gum improved serum leptin, as compared to other treated groups.

Frederich et al., (1995) and Van et al., (1997) reported an increase in leptin resistance in rodents as a result of consuming a diet containing high fat. The observation of high serum leptin level in obese patients could indicate leptin resistance. On the other hand ***(Lerario et al., 2001 and Pilcova et al., 2003)*** reported that, fat mass loss triggers a decrease in serum leptin levels and may reflect restoration of leptin sensitivity.

Reinehr et al., (2005) revealed that changes of leptin levels were significantly correlated to the changes of percentage body fat. Human obesity is associated with elevated leptin level. Leptin, a cytokine that is primarily expressed by adipose tissue, is considered to be involved in satiety regulation. Leptin controls food intake by its interaction with the leptin receptor in the brain. Moreover, leptin affects a wide range of metabolic functions in the peripheral tissue and it controls processes within the reproductive axis ***(Bluher and Mantozoros, 2004)***.

Many studies suggested a strong positive correlation between blood leptin concentration, BMI and intake of dietary fiber, On the other hand, serum leptin concentrations were not related to dietary patterns in the US population **(Ganji et al., 2009)** and no significant correlation was found between leptin and dietary fiber ***(Wayne et al., 2008)***. In

addition to these effects, dietary fibers including GA bind bile acids and diminish their absorption in the terminal ileum **(Moundras et al., 1994)**. Then in the large intestine, degradation of GA releases the sequestered bile acids and the acidic pH generated during the fermentation process renders them insoluble and promotes their excretion in stool.

Effect of high protein diet in the presence of Arabic gum on lipid profile of obese rats.

The effect of Arabic gum and (high & very high protein diets) through the replacement of some dietary saturated fat with the protein separate or together on serum (cholesterol, triglycerides, HDL-c, LDL-c, VLDL-c and the ratio between LDL-c/HDL-c) of obese rats are presented in table (4). Feeding obese rats on high fat diet induced significant increase $p<0.05$ in all parameter, except HDL-c which recorded significant decrease, as compared to the negative control group, fed on basal diet. Treating obese rats with high fat diet containing 5% Arabic gum decreased all parameter, except HDL-c which showed on increase, as compared to the positive control group. The same trend was observed in all treated groups with high and very high protein diet whether in the presence or absence of Arabic gum. Serum lipid fractions improved gradually with increasing the level of protein in the diet. The highest improvement in lipid profile recorded for obese group treated with very low protein diet and Arabic gum together, this group showed significant improvement in all parameters, as compared to the other treated groups. This treatment decreased serum cholesterol, triglycerides, LDL-c, VLDL-c and the ratio between LDL-c/HDL-c by about 26.85%, 32.26%, 42.37%, 32.26% and 63.41% respectively, while HDL-c increased by about 52.31%, than that of the positive control group.

In this respect, ***Wolfe and Giovannetti (1991)*** Conducted their experiment subjects with moderate hypercholesterolemia they randomly assigned them to either high-protein (23% energy) and low-carbohydrate (53% energy) diet or low-protein (11% energy) and high-carbohydrate (65% energy) diet for 4–5 wk. Intakes of dietary fat, cholesterol, and fiber were kept constant. The main sources of protein were turkey, cottage cheese, beef, fish, and ham. Exchanging protein for carbohydrate significantly reduced LDL cholesterol (by 6.4%) and triacylglycerol (by 23%) levels and increased HDL (by 12%). Favorable effects on plasma lipids of substitution of protein for carbohydrates were also observed among subjects with familial hypercholesterolemia ***(Wolfe and Giovannetti 1992)*** and normolipidemia ***(Wolfe and Piche 1994).***

Rats fed with a protein-deficient diet (8% energy) had slight hypercholesterolemia and increased activity of liver β-hydroxy- β -methylglutaryl coenzymeAreductase compared with controls (16% casein diet) ***(Moundras et al., 1996).*** In the Nurses' Health Study ***(Hu et al., 1999),*** after adjustment for age, consumption of red meat and high-fat dairy products was associated with increased risk of CHD, whereas consumption of poultry/fish and low-fat dairy products was associated with a lower risk. On the other hand, Iowa Women's Health Study, higher consumption of red meat was significantly associated with increased CHD mortality ***(Kelemen et al., 2005).***

A recent meta-analysis indicates that frequent intake of fish is associated with reduced risk of coronary death ***(He et al., 2004a).*** Other recent data link increased consumption of fish with decreased risk of ischemic stroke ***(He et al., 2004b).*** Similarly ***(Hu et al., 1999)*** found that exchange of poultry or fish for red meat was associated with a significantly decreased risk of CHD.

Sudanese people in Western Sudan had been using arabic gum for long time without limitations. It is indigestible to both humans and animals, not degraded in the intestine, but fermented in the colon to give short-chain fatty acids, leading to a large range of possible health benefits ***(Phillips and Phillips 2011).*** One of these benefits is its prebiotic effect ***(Phillips et al., 2008).*** It has been claimed that four week supplementation with Gum Arabic (10 g/day) led to significant increases in Bifidobacteria, Lactobacteria, and Bacteriodes indicating a prebiotic effect ***(Calame et al., 2008).*** Other effects include reduction in plasma cholesterol level in animals and humans ***(Sharma, 1985),*** anticarcinogenic effect ***(Nasir et al., 2010)*** and anti-oxidant effect ***(Ali et al., 2003)*** with a protective role against hepatic and cardiac toxicities. In addition to that, it has been claimed that Gum Arabic alleviates effects of chronic renal failure in humans.

Table (4)

Effect of high protein diet in the presence of Arabic gum on lipid profile of obese rats.

Groups \ Parameters		Cholesterol	Triglycerides	LDL-c	HDL-c	LDL/HDL ratio	VLDL-c
		mg/dl					
Control (-) fed on BD		84.571 ^{f} ± 7.590	40.857 ^{e} ± 4.947	25.257 ^{g} ± 3.136	51.142 ^{a} ± 3.532	0.491 ^{f} ± 0.028	8.171 ^{d} ± 0.989
Control (+) fed on HFD		183.571 ^{a} ± 9.144	80.142 ^{a} ± 2.968	140.542 ^{a} ± 7.690	27.857 ^{d} ± 5.459	5.228 ^{a} ± 1.137	16.028 ^{a} ± 0.593
Obese rats treated with	Arabic gum	173.142 ^{b} ± 6.388	71.428 ^{b} ± 4.466	128.285 ^{b} ± 3.660	30.571 ^{d} ± 2.699	4.220 ^{b} ± 0.351	14.285 ^{b} ± 0.893
	High protein diet	166.571 $^{b c}$ ± 6.451	71.142 ^{b} ± 5.145	118.200 ^{c} ± 3.583	34.142 ^{c} ± 2.410	3.472 ^{c} ± 0.187	14.228 ^{b} ± 1.029
	Very high protein diet	152.714 ^{d} ± 6.074	62.428 ^{c} ± 3.408	102.371 ^{e} ± 2.801	37.857 ^{c} ± 2.853	2.712 ^{d} ± 0.145	12.485 ^{c} ± 0.681
	High protein diet and Arabic gum	159.428 $^{c d}$ ± 6.579	65.857 ^{c} ± 4.413	108.685 ^{d} ± 3.966	37.571 ^{c} ± 2.370	2.895 ^{d} ± 0.145	13.171 ^{c} ± 0.882
	Very high protein diet and Arabic gum	134.285 ^{e} ± 3.903	54.285 ^{d} ± 3.302	81.000 ^{f} ± 1.077	42.428 ^{b} ± 2.507	1.913 ^{e} ± 0.097	10.857 ^{d} ± 0.660

All results are expressed as mean ± SD.

Values in each column which have different litters are significant different ($p<0.05$)

Effect of low fat high protein diet in the presence of Arabic gum on kidney functions of obese rats.

Feeding rats on high fat diet increased the mean values of serum uric acid, urea nitrogen and creatinine significantly $p<0.05$, as compared to healthy rats fed on basal diet (control negative group) Table (5). Treating obese groups with Arabic gum, low and very low fat diets with or without Arabic gum led to significant decrease $p<0.05$ in all parameters, as compared to the positive control group. Non-significant changes in serum uric acid were observed between the group treated with diets containing low and very low fat diets that have been replaced by high protein and very high protein without or with Arabic gum. While serum urea nitrogen and creatinine increased significantly with increasing the level of protein. The highest decrease in serum uric acid, urea nitrogen and creatinine recorded for the group which treated with low caloric diet (HPD) containing Arabic gum, this treatment decreased these parameters by about 19.74%, 29.571% and 32.18%, than that of the positive group, respectively.

Table (5)

Effect of low fat high protein diet in the presence of Arabic gum on kidney functions of obese rats.

Groups \ Parameters		Uric acid	Urea nitrogen	Creatinine
		mg/dl		
Control (-) fed on BD		1.647 ^{e} ± 0.106	26.571 ^{f} ± 1.718	0.608 ^{e} ± 0.089
Control (+) fed on HFD		3.105 ^{a} ± 0.232	73.428 ^{a} ± 4.825	1.330 ^{a} ± 0.063
Obese rats treated with	Arabic gum	2.820 ^{b} ± 0.262	63.571 ^{b} ± 2.760	1.012 ^{c} ± 0.082
	Low fat high protein diet (HPD)	2.744 $^{b c}$ ± 0.195	59.000 ^{c} ± 2.708	1.041 ^{c} ± 0.083
	Very low fat high protein diet (VHPD)	2.887 ^{b} ± 0.169	62.428 ^{b} ± 2.636	1.143 ^{b} ± 0.110
	Low fat high protein diet (HPD) and Arabic gum	2.492 ^{d} ± 0.162	51.714 ^{e} ± 2.138	0.902 ^{d} ± 0.073
	Very low fat very high protein diet (VHPD) and Arabic gum	2.586 $^{c d}$ ± 0.132	55.428 ^{d} ± 2.760	0.965 $^{c d}$ ± 0.107

HPD: High protein diet VHPD: Very high protein diet

Values are given as mean ± SD for 7 rats in each group.

Mean values in each column with same letters are not significantly different.

LSD: Least significant differences (P<0.05).

In agreement with our results, **Tang & Xia (1998)** revealed that level of uric acid was significantly increased in over weight. On the other hand, reducing body weight is one of the effective measures to prevent and treat hyperuricemia. In addition, **EL-Gohary (2005)** confirmed that renal disease and serum uric acid levels vary with body weight also, with the various conditions throughout their lives.

Bliss et al. (1996) investigated that supplementation with gum arabic fiber increases fecal nitrogen excretion and lowers serum urea nitrogen concentration in chronic renal failure patients consuming a low-protein diet. **Nasir et al., (2008)** concluded that, treatment with GA resulted in moderate but significant increases of creatinine clearance and altered electrolyte excretion, i.e., effects favorable in renal insufficiency.

Al-Mosawi (2004) have tested acacia gum supplementation of a low-protein diet in children with end-stage renal disease. and concluded that, dietary supplementation with acacia gum may be an alternative to renal replacement therapy to improve the quality of life and reduce or eliminate the need for dialysis in children with end-stage renal disease in some developing countries.

Younes et al. (1999) indicated that, the addition of oligosaccharides (gum Arabic) to the diet induced a 20 to 30% decrease in blood urea and renal and renal nitrogen excretion relative to the control, indicating a potential for oligosaccharide diet therapy in chronic renal disease.

GA attenuated renal dysfunction in a model of chronic renal failure, suggesting a promising potential for it in protecting against renal failure progression. The mechanism(s) of this nephroprotection is uncertain but may involve anti-oxidant and/or anti-inflammatory actions ***(Badreldin et al., 2010).***

Effect of low fat high protein diet in the presence of Arabic gum on liver enzymes of obese rats.

The effect of Arabic gum, low and very low fat high protein diets (HPD &VHPD) with or without Arabic diet on Aspartate aminotransferase AST, Alanine aminotransferase ALT and Alkaline Phosphatase ALP of obese rats are presented in Table (6).

Feeding rats which suffer from obesity on high fat diet increased AST, ALT and ALP significantly $p<0.05$, as compared to the negative group fed on basal diet. All treated obese groups with the different tested diets decrease liver enzymes significantly $p<0.05$, as compared to the positive control group. Feeding obese rats on high fat diet containing Arabic gum decreased serum AST, ALT and ALP by about 14.98%, 20.818% and 11.249%, than that of the positive control group. The data in this table revealed that, serum AST, ALT and ALP decreased gradually with increasing the level of protein. The presence of Arabic gum on very low fat diet recorded the best results in liver enzymes, because this treatment showed significant decrease in (AST, ALT and ALP), as compared to other treated groups. This treatment decreased AST, ALT and ALP by about 33.611%, 45.195% and 29.519% than that of the positive control group.

In this respect, **(Qureshi et al., 2006)** reported that overweight and obesity significantly affects liver function and may lead to further complications of the liver.

Liver is profoundly affected by obesity where it may be associated with hepato megaly, increased liver biochemistry values and alterations in liver histology like macrovesicular steatosis, steatohepatitis, fibrosis and cirrhosis ***(Mokdad et al., 2001)***.

Macrophages play an important role in the regulation of immuological process in rats ***Mochida et al. (1996)*** studied the effect of GA on macrophage activation by their ability to produce superoxide anions in vitro, and found that GA suppresses macrophage activation in vitro. This confirms an earlier report that GA is capable of almost completely blocking the macrophage function ***(Fujiwara et al., 1995; Mochida et al., 1990).*** The authors inferred that such effects of GA would merit consideration in the therapy for chronic liver disease, as deranged function of Kupffer cells and hepatic macrophages occurs in this disease and is involved in its complications, such as endotoxemia. ***Ayman et al., (2003)*** reported that, arabic gum is effective in protecting mice against acetaminophen-induced hepatotoxicity.
Arabic gum was found to block the hepatic macrophage function ***(Fujiwara et al., 1995).*** Since, nitric oxide and hepatic macrophages are important mediators of acetaminophen-induced hepatotoxicity ***(Gardner et al., 1998).***

Table (6)

Effect of low fat high protein diet in the presence of Arabic gum on liver enzymes of obese rats.

Groups \ Parameters		AST	ALT	ALP
		u/l		
Control (-) fed on BD		71.571 ^{e} ± 4.353	20.428 ^{e} ± 2.636	90.857 ^{f} ± 3.236
Control (+) fed on HFD		137.285 ^{a} ± 5.908	80.285 ^{a} ± 5.765	148.571 ^{a} ± 3.408
Obese rats treated with	Arabic gum	116.714 ^{b} ± 3.903	63.571 ^{b} ± 4.076	131.857 ^{b} ± 4.561
	Low caloric diet (HPD)	114.428 ^{b} ± 3.505	60.142 ^{b} ± 5.273	129.571 ^{b} ± 2.992
	Very low caloric diet (VHPD)	104.285 ^{c} ± 4.111	52.714 ^{c} ± 4.231	122.571 ^{c} ± 3.258
	Low caloric diet (HPD) and Arabic gum	102.142 ^{c} ± 4.488	52.000 ^{c} ± 3.829	117.428 ^{d} ± 3.309
	Very low caloric diet (VHPD) and Arabic gum	91.142 ^{d} ± 3.716	44.000 ^{d} ± 3.829	104.714 ^{e} ± 3.728

HPD: High protein diet VHPD: Very high protein diet

Values are given as mean ± SD for 7 rats in each group.

Mean values in each column with same letters are not significantly different.

LSD: Least significant differences ($P<0.05$).

In conclusion our study revealed the best results recorded for the groups treated with low and very low fat high protein diets containing AG improved the nutritional and biological parameters of obese rats.

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تأثير الوجبات منخفضة الدهون عالية البروتين في وجود الصمغ العربي علي إنقاص الوزن في الفئران البدينة

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الملخص العربى

تعتبر السمنة من الأمراض الخطيرة التي تؤثر على عدد كبير من السكان في جميع أنحاء العالم. صممت هذه الدراسة لمعرفة تأثير الصمغ العربي، (الوجبات منخفضة الدهون عالية البروتين) في غياب أو وجود الصمغ العربي علي خفض الوزن، بعض الخواص الغذائية والبيوكيميائية في الفئران البدينة. استخدمت في هذه الدراسة عدد (٤٩) فأر من نوع الالبينو من فصيلة الاسبراجو داولي اوزانهم (١٣٠ ± ٥ جرام). تم تقسيم الفئران الي مجموعتين أساسيتين. المجموعة الاساسية الأولي (٧ فئران) تم تغذيتها علي غذاء أساسي واستخدمت كمجموعة ضابطة سالبة. أما المجموعة الثانية الأساسية (٤٢ فأر) تم تغذيتها علي غذاء مرتفع الدهن لمدة أربعة أسابيع لإحداث السمنة (البدانة). تم تقدير مستوى الكولسترول، الجلسريدات الثلاثية، والنسبة المئوية للزيادة في الوزن في المجموعتين الاساسيتين الاولي والثانية للتأكد من إحداث الإصابة. تم تقسيم فئران المجموعة الثانية الرئيسية (البدينة) الي سبعة مجموعات فرعية (تشمل كل مجموعة ٧ فئران) كالتالي: المجموعة الفرعية الأولي تم تغذيتها علي غذاء عالي الدهن وإستخدمت كمجموعة ضابطة مصابة (مجموعة موجبة)، المجموعة الفرعية (٢) تم علي غذاء مرتفع الدهن يحتوى علي ٥% صمغ عربي، المجموعات الفرعية (٣ – ٤) تم تغذيتهم علي غذاء منخفض ومنخفض جدا في الدهون عالية البروتين (من خلال إحلال جزء من الدهون الغذائية "الدهون المشبعة" بالبروتين)، المجموعات الفرعية (٥ – ٦) تم تغذيتهم علي غذاء منخفض ومنخفض جدا في الدهون عالية البروتين يحتويان علي نفس كمية الصمغ العربي المستخدم في المجموعة الفرعية الثانية، علي التوالي. أشارت نتائج هذه الدارسة إلي أن، الطعام المتناول، والنسبة المئوية للزيادة في الوزن، والنسبة المئوية لوزن الكبد منسوبة لوزن الجسم تناقصت في كل المجموعات المعاملة، مقارنة بالمجموعة البدينة. متوسط مستويات كل من الجلوكوز، هرمون الليبتين، جميع جزئيات الدهون (كولسترول – جلسريدات ثلاثية – كولسترول الليبوبروتينات منخفضة الكثافة، والنسبة بين كولسترول الليبوبروتينات منخفضة الكثافة الي كولسترول الليبوبروتينات عالية الكثافة، و كولسترول الليبوبروتينات منخفضة الكثافة جدا)، ووظائف الكلي (حامض اليوريك – نيتروجين اليوريا – الكرياتينين) و إنزيمات الكبد (AST, ALT and ALP) تناقصت معنويا في كل المجموعات المختبرة، في حين تزايدة مستويات كولسترول الليبوبروتينات عالية الكثافة، مقارنة بالمجموعة الضابطة البدينة. أفضل النتائج سجلت للمجموعات المعاملة بالوجبات منخفضة الدهون والمنخفضة جدا والمحتوية علي الصمغ العربي. تدعيم الوجبات منخفضة الدهون عالية البروتين والمنخفضة جدا بالصمغ العربي يحسن من الخواص البيولوجية والبيوكميائية في الفئران البدينة.

الكلمات المفتاحية: فئران – سمنة – وجبات مرتفعة البروتين – وجبات مرتفعة الدهون – صمغ عربي – جلوكوز – هورمون الليبتين – صورة الدهن – وظائف الكلي – انزيمات الكبد.