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The Effect of Arabic Gum and High-Fat Diets on Obese Rats

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Abstract:
Obesity is now recognized as a chronic or non-communicable disease. Overweight obesity is a process characterized by excessive accumulation of body fat with multiple organ-specific consequences that could impair health. This study was conducted to study the effect of Arabic Gum and a drug with a high-fat diet on obese rats. Twenty-five obese male rats were divided into five groups: The first group was fed a high-fat diet (G1). The second group was fed 50% Gum Arabic, 15% protein, and 35% fat (G2). The third group was fed 45% Gum Arabic, 15% protein, and 40% fat (G3). The fourth group was fed 40% Gum Arabic, 15%protein, and 45% fat (G4), and the last group was fed on basal diet+ Chitogree (G5). At the end of the experiment (28 days), the rats were sacrificed; the serum was analyzed for liver enzyme, kidney functions, antioxidant status, and lipid profile. The results showed that group 3(40% AG) with a high-fat diet was highly significant (P≤0.05) in losing weight compared with the control group. The lower AST and ALT liver enzyme of a group recorded for group 1(50% AG) with a high-fat diet. Group 4 (Basil diet + drug) was the lowest value in urea, while it was highly significant (P≤0.05) with uric acid values. The lowest values in lipid level were in group 1 (50% AG) compared with the positive control group, while it significantly increased with antioxidant values.

Keywords*: Overweight, Low-Carbohydrate, Liver Enzymes, Kidney Functions, Lipids*

Introduction

The occurrence of obesity is growing and resumes being the main public health issue worldwide (1). Obesity forms the basis of the metabolic syndrome associated with dyslipidemia (2), insulin resistance (3), type 2 diabetes (4), heart disease (5), hypertension (6) and nonalcoholic fatty liver disease (7).Abdominal obesity is the main manifestation of metabolic syndrome which considered a fatal outcome of visceral obesity (8). Understanding the consequence of abdominal obesity and its role in the development of metabolic syndrome is fundamental to understanding the link between the diseases associated with this condition. The visceral fat reduction is vital to decrease the risk of metabolic diseases in this context (9). Thus, it is essential to establish strategies for preventing obesity

(10). Arabic Gum (AG) is an edible biopolymer obtained as exudates of mature trees of *Acacia Senegal* and *Acacia seyal* which grow principally in the African region of Sahe in Sudan. The exudates are a non-viscous liquid, rich in soluble fibers, and their emanation from the stems and branches usually occurs under stress conditions such as drought, poor soil fertility, and injury (11). Chemically, AG is a complex mixture of macro molecules of different sizes and composition (mainly carbohydrates and proteins). Today, the properties and features of AG have been widely explored and developed and it is being used in a wide range of industrial sectors. (12). Currently, most guidelines recommend pharmacy co-therapy as the second-line treatment for obesity, with bariatric devices and surgery as third- and fourth-line treatments, respectively. The European Association for the Study of Obesity (13). There are a limited number of pharmacotherapeutics for the treatment of obesity, and those that are approved have modest efficacy to date. Recent insights into the path physiology of obesity have spurred the exploration of several promising drug targets and novel therapeutic strategies to address the global obesity epidemic and its co morbidities (14).

In the last decades, low carbohydrate diets (LCD)and high fat diets (HFD) have become widely known and popular ways to lose weight, not only within the scientific community, but also among the public, with best-selling dedicated books or intense discussion on social media networks staying at the top of the diet trend list for years. These dietary approaches are effective for losing weight, but there is growing evidence suggesting that caution is needed, especially when these diets are followed for long periods of time, or by individuals of a very young age or with certain diseases (15).

Materials and Methods

Materials

Arabic Gum *Acacia Senegal* was purchased from Haraz-Cairo

The drug name is (Chitogree) hard gelatin capsules, were obtained from local pharmacy in Cairo. Casein, cellulose, vitamins mixture and minerals mixture were obtained from EL Gomhorya Pharmaceutical Company, Cairo - Egypt. All analysis kits were purchased from Bio. Diagnostic Company, Giza. Twenty- five male albino rats of Sprague Dawley strain ,their weight (180±5g) was obtained from Research Institute of Ophthalmology, Animal House Department, Giza, Egypt.

Methods

Preparation of gum Arabic

Arabic gum was cleaned by removing impurities, after that, were grinding in finally(2-3roll) in home grinder (Multi quick System BRAUN Company made in Germany) then kept in polyethylene bags till use.

Experimental design

Albino rats(n=25) of Sprague Dawley Strain weighting (180±5) will housed in well aerated individual wire cages under hygienic laboratory in (Faculty of Home Economics) conditions and feed on the experiment diet according to the type of group.

In the beginning rats into five groups all groups fed high fat diet for two weeks to be obese: High fat diet prepared from fine ingredients per 100g according to the following composition:

Fat 30% (tallow 15% + corn oil 15%) according to (16)**.** Feed them after that as follows: Positive control group: fed on high fat diet. The second group fed on a high fat diet and 50% AG. Third group: fed on a high fat diet and 45% AG. Fourth group fed on high fat diet 40% AG. At the end of experiment period, rats were fasted over night before sacrificed and blood samples were collected from arteries of the eye in clean centrifuge tubes. Serum was carefully separated and transferred into dry clean Eppendorf tubes and kept deep freezers till analysis**.**

Biochemical analysis

Alanine amino transferase (ALT), aspartate amino transferase (AST) was measured according to the methods described by (17&18) respectively. Urea was determined by the enzymatic methods of (19).Creatinine was determined to the enzymatic methods of (20).uric acid was determination by (21).

The results were determined by Triglycerides (TG), Total cholesterol (TC), high density lipoprotein HDL-c. Low-density lipoprotein LDL-c and very Low-density lipoprotein VLDL -c were determined by (22, 23, 24&25) respectively. Determination of (CAT) was carried out according to the method of (26). SOD activity in the serum was measured by the method described by (27). Serum samples were used for determination of malondialdehyde (MDA) as a measure of lipid peroxidation according to (28).

Statistical analysis

Data were statistically analyzed using a statistical analysis system (29). One way analysis of variance (ANOVA) was used to test the variations among groups and post Hoc test (Duncan's Test) was used to compare group means.

Results and Discussion

Data in table (1) indicated the mean value of FI, Feed efficiency ratio (FER) and relative body weight gain (RBWG) for obese rats. It is showed that feed intake value was significantly (p≤0.05) decreased in group 3(AG40%+45% Fat) compared with positive control group, there were no significant difference between group1&4 (AG50%+ 35% Fat) and (B.D + drug), on the other side, feed efficiency ratio, there is no significant (p≤0.05) differences between groups 1,2&3. relative body weight gain % was significantly (p≤0.05) increased in group 3(AG40%+45% Fat) when compared with positive group. This finding was in line with the result obtained that Arabic Gum is considered an inert substance, recent information revealed multiple pharmacological and medical effects like weight reduction, ant diabetic, and other effects (30). The Arabic gum (AG) variants from Morocco (AGMo), Mauritania (AGMau), and Senegal (AGSe) in which these three variants were characterized by FTIR analysis, weight loss (WL) measurements (31).

Table: (1) The effect of AG and tested drug on FI, FER and RBWG.

GROUPS	Control group	AG50% + 35% Fat	AG45% + 40% Fat	AG40%+45% Fat	B. D+ drug
FI/day/rat	18.8^{a}±0.10	15^{b}±0.500	11.3^{c}±0.30	9.20^{d}±0.70	15.3^{b}±0.30
FER g/28day	0.0210^{c}±0.001	0.062^{a}±0.003	0.059^{a}±0.001	0.060^{a}±0.00	0.035^{b}±0.001

RBWG %	-6.41^{a}±0.30	-17.6^{c}±0.20	-35^{d}±2.20	-46.4^{e}±0.50	-13.2^{b}±0.70

Mean ± standard deviation in the same row with different letters is Significantly (p < 0.05).

Table (2): The effect of Arabic gum and drug on liver functions. The data indicated that there are significant differences (P≤0.05) in AST between control positive group and other groups. The results of values of AST &ALT showed that group1 (AG50%+35% Fat) has a good effect with low values comparing with control positive group. Group 4 has a significant (P≤0.05) decreasing compared with control group. Dietary administration of AG has a beneficial result on the hepatic apoptosis, oxidative stress, and inflammatory response in experimentally induced hepatotoxicity in rats (32). AG ameliorates the histopathological changes in the liver tissues. (33)

Table (2): The effect of Arabic gum and drug on liver enzymes in obese rats

GROUPS	Control group	AG50% + 35% Fat	AG45% + 40% Fat	AG40%+45% Fat	B. D+ drug
AST U/L	36.9^{a}±0.45	25.4^{e}±0.05	28.6^{d}±0.156	29.9^{c}±0.45	31.3^{b}±0.10
ALT U/L	45.0^{a}±0.70	32.3^{d}±0.36	33.6^{c}±0.43	35^{b}±0.264	32.9^{cd}±0.1

Mean ± standard deviation in the same row with different letters are significantly (p ≤ 0.05). AST: Aspartate amino transferase, ALT: Alanine amino transferase.

The results of tale (3) showed the effect of Arabic gum and drug on kidney functions on obese rats. There are no significant (P≤0.05) differences among the treatment groups with AG and drug whereas they showed significant changes with control in case creatinine values. On the other hand, there were significant (P≤0.05) differences between tasted group and control group value and group 4 were the lowest value for urea. Group fed on (AG50%+ 35% Fat) records the best result urea value. There were significant (P≤0.05) differences between groups comparing with control group within the values of uric acid. The results found that the treatment with AG had lowered the effects of gentamicin and streptozotocin, as evidenced by improvement of the lipids profile, kidney function, some minerals in serum, and antioxidant enzyme in kidney tissue, which may be referred to as its content of antioxidant active ingredients. Therefore, it is recommended that Arabic Gum is a beneficial dietary tool in reducing the advancement of chronic kidney disease in diabetic rats (34).

Table (3): The effect of Arabic gum and drug on kidney functions on obese rats

GROUPS	Control group	AG50% + 35% Fat	AG45% + 40% Fat	AG40%+45% Fat	B. D+ drug
Creatinine (mg/dl)	1.40^{a}±0.20	0.90^{bc}±0.02	0.80^{b}±0.01	1.00^{b}±0.010	0.89^{bc}±0.02
Urea (mg/dl)	51.6^{a}±0.300	45.4^{d}±0.320	47^{c}±0.010	48.6^{b}±0.10	41.5^{e}±0.321
Uric acid (mg/dl)	2.01^{a}±0.010	1.55^{e} ± 0.04	1.64^{d}±0.047	1.71^{c}±0.01	1.86^{b}±0.010

Mean standard deviation in the same row with different letters are Significantly (p ≤ 0.05) creatinine, urea and uric acid.

Table (4) indicated the effect of Arabic gum and drug on lipid profile on obese rats. Values of triglyceride (TG), low density lipoprotein LDL-c and HDL-c were significantly (p≤0.05) in tasted groups compared to control group While there are no significant (p≤0.05) differences between groups3&4 for HDL-c values. The mean values of LDL-c revealed no significant differences between groups 2&3. For vLDL-c values, there were significant differences

between all groups. Supplementation of AG significantly (P < 0.05) decreased body weight gain and associated with decreases in blood glucose, total cholesterol LDL and increased HDL concentrations (35).

Table (4) the effect of Arabic gum and drug on lipid profile on obese rats:

GROUPS	Control group	AG50% + 35% Fat	AG45% + 40% Fat	AG40%+45% Fat	B. D+ drug
TC (mg/dl)	172.86^{a}±.002	142.26^{e}±0.04	155.62^{b}±0.21	151.64^{d}±0.10	152.84^{c}±0.10
TG (mg/dl)	104.30^{a}±0.10	85.30^{e}±0.100	88.1^{d}±0.10	90.70^{c}±0.20	93.2^{b}±.300
HDL (mg/dl)	40.70^{d}±0.70	46.60^{b}±0.40	48.9^{a}±0.20	44.20^{c}±0.40	43.6^{c}±0.10
LDL (mg/dl)	111.3^{a}±0.10	78.60^{d}±0.30	89.1^{c}±0.00	89.3^{c}±0.100	90.6^{b}±0.400
VLDL (mg/dl)	20.86^{a}±0.02	17.06^{e} ±0.02	17.62^{d}±0.10	18.14^{c}±0.10	18.64^{b}±0.10

Mean standard deviation in the same row with different letters is Significantly (p ≤ 0.05). TC: Total cholesterol, T.G: Triglyceride, HDL-c: High density lipoprotein, LDL-c: Low density lipoprotein, vLDL-c: Very low-density lipoprotein

Table (5) the effect of Arabic gum and drug on antioxidant status of obese rats. All treated obese groups showed significant increase (p≤0.05) for CAT and SOD when compared to control group. The highest significant increases (p≤0.05) were recorded for group1 (AG50%+35% Fat) which recorded31.46±0.15 and 28.8±0.10 respectively. While the mean values of MDA showed a significant (p≤0.05) difference between all groups. Group fed on AG50%+35% Fat was the lowest value from MDA. The previous results (36) showed that treatment with basil and Arabic Gum AG macroscopic and histopathological damage scores of the colon, MDA, and increased SOD. Rectal administration of combination of basil seeds plus Arabic Gum after induction of colitis, exhibited antioxidant and anti-inflammatory effects, Also, another study indicated that consumption of AG may help to prevent obesity related complications through down regulation of anti-inflammatory cytokines gene (37).

Table (5): The effect of Arabic gum and drug on antioxidant status

GROUPS	Control group	AG50% + 35% Fat	AG45% + 40% Fat	AG40%+45% Fat	B. D+ drug
CAT	13.6^{e}±0.100	31.46^{a}±0.15	28.5^{b}±0.100	22.4^{d}±0.100	25.3^{c}±0.30
SOD	14.50^{e}±0.20	28.8^{a}±0.10	25.43^{b}±0.450	22.56^{c}±0.300	20.6^{d}±0.32
MDA	40.23^{a}±0.30	22.36^{e}±0.35	26.06^{d}±0.208	29.4^{c}±0.458	31.7^{b}±0.152

Mean ± standard deviation in the same row with different letters is significantly (p ≤ 0.05). CAT: Catalase, SOD: Superoxide dismutase MD A: Malondialdehyde,

Conclusion

From the above results, it can be concluded that for losing weight with low-carbohydrate, high-fat diet is better than group with medications, So. It was recommended that diet contained 45% fat and 40% Arabic gum led to decrease the body weight and Arabic gum had a vital role as a prevention and treatment from diseases for antioxidant and anti-inflammatory properties when compared with the weight loss drug.

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تأثير الصمغ العربي والوجبات عالية الدهون على الفئران المصابة بالسمنة

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الملخص العربي:

السـمنة هي من الأسـباب الرئيسـية للإصـابة بالأمراض المزمنة والتي تعتبر ناتجة من تراكم الدهون بداخل الأعضـاء الداخلية بالجسـم مما يؤثر بالسـلب على الصـحة العامة وكفاءة الجسـم. لذلك هدفت هذه الدراسـة إلى تقييم تأثير الصـمغ العربي والدواء مع تناول وجبات عالية الدهون على الفئران المصـابة بالسـمنة حيث تمت الدراسـة على (25 فأر) مصـابين بالسـمنة وتم تقسـيم المجموعات . المجموعة الأولى تم تغذيتها على غذاء عالى الدهون والمجموعة الثانية تم تغذيتها على 50% صـمغ عربى و15%بروتين و 35% دهون بينما كانت المجموعة الثالثة تم تغذيتها على 45% صـمغ عربى و15% بروتين و40% دهون . المجموعة الرابعة تم تغذيتها على 40% صـمغ عربى و15%بروتين و 45% دهون .المجموعة الخامسـة تم تغذيتها على الغذاء الأسـاسى + دواء شـيتوجراى . فى نهاية التجربة بعد 28 يوما تم ذبح الفئران وجمع عينات السـيرم حيث تم تحليل أنزيمات الكبد ووظائف الكلى ومضـادات الأكسـدة وصـورة كاملة لدهون الدم . حيث أظهرت النتائج أن المجموعة الثالثة التى تغذت على 40% صـمغ عربى مع وجبات عالية الدهن نقص وزنها بشكل ملحوظ مقارنة مع نتائج المجموعة الأولى . كما تبين نقصان فى نسب ALT, AST (أنزيمات الكبد) فى نتائج المجموعة التى تغذت على 50% صـمغ عربى . بينما قلت نسـب اليوريا فى نتائج المجموعة التى تم تغذيتها بالغذاء الأسـاسى + الشـيتوجراى بينما أوضـحت إرتفاعا فى نسـب اليوريك أسـيد. أظهرت المجموعة التى تغذت على 50% صمغ عربي أقل نسبة فى دهون الدم بينما كانت الأعلى فى نسب مضادات الأكسدة .

الكلمات المفتاحية: زيادة الوزن , قليلة الكربوهيدرات , أنزيمات الكبد ,وظائف الكلى , الدهون.