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Influence of Red Beet (Roots and Leaves) on Biological, and Biochemical Changes in Obese Rats

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Abstract:
Beet and its extracts are used as common medications, colored foods, and as a vegetable. It has strong antioxidant qualities and may be helpful in the management of a variety of disorders. The goal of this study is to determine the efficacy of roots and leaves of red beet in reducing overweight in rats. In this study, forty male Sprague-Dawley white rats weighing 140-150 gm had been randomly labeled into 8 categories. Five rats served as a negative control group fed only on standard diet while they were fed high fat diet (20 % animal fat) to induce overweight, these rats were reclassified into a positive control group, six groups of rats treated were 2.5 and 5% red beet roots and leaves and their mixture. The study period was 28 days. The study also measured lipid fractions, sugar ranges, liver, and kidney activities. Research findings demonstrated that the overweight group had reduced glucose levels, liver activities, and renal biomarkers when they were fed a5% mix of roots and leaves of red beet, with significant differences. Red beet roots and leaves reduced total cholesterol and triglyceride levels, as well as LDL-c, VLDL-c and AI values, with significant differences. The group feda5% mix had the highest level of HDL-c levels. As conclusion, overweight rats given 5% red beet roots and leaves powder demonstrated superior lipid fractions, sugar ranges, liver, and kidney functioning.

Keywords*: Plants roots and leaves, Weight loss, Lipid profile*

Introduction

A disorder called obesity causes an excessive buildup of bodily fat, which could be harmful to one's health (1). It is mainly brought on by way ofa mismatch between the amount of energy consumed and expenditure as a result of an excessive diet high in fat. Several lipid problems, such as high TG and TC levels, low HDL-C levels, and an abnormal LDL-C composition, are present (2). It is a long-lasting metabolic condition brought on by an unbalanced energy intake and usage. It is a huge public health issue that is quickly growing to be a serious health issue in developing nations (3). In addition, obesity is strongly linked to the emergence of co-morbid illnesses such as metabolic disorders, hypertensive, hyperlipidemia, and type two diabetes as well as insulin resistance (4). Regular activity and nutritional management are two methods for avoiding and reducing obesity. Nevertheless, changing one's lifestyle is not easy, and medicine is ineffective or has unwanted side effects (5).

It is thought to possess health-promoting qualities, antioxidant and anti-inflammatory effects, anti-carcinogenic and anti-diabetic activities, hepatoprotective, hypotensive, and wound medicinal qualities as a rich and nutritional source (6). As a result, beetroot is currently used as a practical element in the creation of many foods (7). It has been noted that red beetroot juice in concentrations of 1.0-10.0% in 24 hours lowers oxidative stress in the demographic indicated. Moreover, red beetroot has demonstrated anti-apoptotic properties and may reduce caspase 3 activation. Red beetroot thus plays a crucial part in the management of obesity (8).Furthermore, elderly overweight and chubby men and women who consume beet juice rich in nitrate have been linked to lower hypertension and a reduction in systolic pressure. It appears that red beetroot's nitrate content also helps to manage sugar levels and lower blood pressure in addition to helping in losing weight (9).

The current study examined how varying concentrations of red beet roots, leaves, as well as mixes powder (2.5%, 5%) affected the biological and biochemical parameters of overweight rats.

Materials and methods

Materials:

Beta vulgaris, commonlycalled red beet, was purchased from a local market at EL Mahalla EI-Kubra City, GharbiaGovernorate, Egypt.

Experimental animals

The Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt delivered 40 adult normal male albino Sprague Dawley rats, each weighing 150±5 g.

Methods

Preparation of red beet

Red beet (roots and leaves) was carefully puréed and repeatedly rinsed in tap water before being sliced into thin slices and placed on shelves in an electric convection oven at 45°C. Drying and grinding these pieces into a powder, that was then put in a bag out of the dampness of the air(10).

Induction of overweight in experimental rats

Male albino rats that were otherwise healthy and normal were given a diet rich in fatcontaining 20% animal fat supplied in a basal diet and were employed as the positive control group(11).

Experimental design

The research used to be carried out and permittedin the Faculty of Home Economics, Animal House, Department of Nutrition and Food Science, University of Menoufia, Egypt, according to Ethical approval of the Science Research Ethics Committee of Faculty ofHome Economics cleared the study protocol#04-SREC-07-2022.

Forty adult male albino white rats. In this research, a weighted Sprague Dawley strain (150±5 g) was tested. For seven days straight, all rats received a basic diet prepared in accordance with (12). Following this duration of adapting. Eight groups, each with 5 rats were created by dividing the rats into the following groups: Group 1 consists of rats fed a basil diet as a negative control. Group 2: As a positive control group, obese rats were fed a standard diet. Groups (3): A group of Overweight rats consumed 2.5% of basal dietred beet leaf powder. Groups (4): A group of Overweight rats consumed 5% of basal diet in the form of powdered red beet leaves. Overweightrats in group (5) were given 2.5% of basal diet in red beet powder. Overweight rats in group (6) were given 5% of basal diet in red beet powder. Overweight rats in Group 7 were given 2.5% of basal diet in powdered (1:1) red beet roots and leaves.Overweight rats in Group 8 were given 5% of basal diet in powdered (1:1) red beet roots and leaves.

All rats were starved for 12 hours after the experiment's four-week run before being sacrificed. To separate the serum, blood samples were drawn from the portal vein and placed into dry, clean centrifuge tubes. The blood was then spun for 10 minutes at 4000 rpm (13). At -18 °C, serum samples were kept frozen pending chemical analysis.

Biochemical analysis

Total cholesterol was determined according to (14), Triglycerides (T.G) according to (15). High Density Lipoprotein (HDL- c) according to (16), Low Density Lipoprotein (LDL-c) and Very Low-density Lipoprotein (VLDL-c) were calculated according to the following equation: LDL-cholesterol=Total cholesterol – (HDL-c + TG/5). VLDL-c=TG/5 (17). The Atherogenic index was calculated as the (VLDL-c+ LDL-c/HDL-c ratio according to the formula of (18).As stated by the methods of (19, 20, and 21), which evaluated the serum levels of each liver enzyme such as alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP).Historically, calorimetric methods method of (22) were utilized to measure the enzyme activation of serum glucose.Serum uric acid, urea and creatinine have been decided by using enzymatic techniques according to (23, 24 and 25).

Statistical analysis

Version 20.0 of the application software for IBM SPSS (Armonk, NY: IBM Corp) was employed to analyze the data. Mean and standard deviation have been used to describe quantitative data. The acquired results' significance was determined at the 5% level (26).

Results and discussion

The influence of red beet powder on the levels of serum total cholesterol and triglycerides in overweight rats are represented in Table (1). The collected data demonstrated that the control positive group had the highest serum total cholesterol levels, while negative control group had the lowest value with statistically significant differences. The mean readings were, respectively, 157.65 and 70.54 mg/dl. However, there were no noticeable differences between the smallest find ever calculated for 5% combination powder and the highest value recorded for 2.5% red beet leaves powderin the treated groups (overweight groups). The mean readings were respectively 139.2 and 79.9 mg/dl.

In the case of serum triglyceride levels, it could be observed that positive control group had the highest serum triglyceride levels, while negative control group had the lowest value with statistically significant differences. The average readings were respectively 136 and 71.5 mg/dl. While the treated groups (the obese groups) had the highest serum triglyceride levels ever observed. 2.5% red beet leaves powder was recorded as the highest value, while 5% combination powder was the lowest notable variations. The mean readings were, respectively, 107.67 and 65.17 mg/dl. These results are in accordance with (27) who reported that juice from red beets lowers blood cholesterol levels, due to it containdietary fiber and polyphenolrich beet extract encourage the intestinal excretion of cholesterol and cholesterol metabolites. This mechanism is probably what causes beet products to lower cholesterol.

In addition, a significant decrease in serum triglyceride, total cholesterol and LDL-c, VLDL-c levels and vice versa in HDL-c level was observed in rats treated with red beet compared with positive control group (28).

Table(1): Impact of red beets leaves and roots on triglycerides and cholesterol of obese rats

Parameters Groups	Triglycerides mg/dl	Cholesterol mg/dl
G1 C (-)	71.5e±0.70	70.54g±2.6
G2 C (+)	136a±4.30	157.65b±2.75
G3 (2.5%Red beets leaves powder)	107.67b±2.83	139.2b±2.10
G4 (5% Red beets leaves powder)	95.58c±3.82	120.1c±4.50
G5 (2.5 Red beets roots powder)	67.34e±41.76	117.8c±1.90
G6(5% Red beets roots powder)	83.95d±1.55	109.86d±2.74
G7 (2.5% Mixture powder)	70e ± 3.40	99.01e ±3.29
G8 (5% Mixture powder)	65.17ef± 3.03	79.9f±3.70
LSD (P≤ 0.05)	25.899	4.619

Each value is represented as mean ± standard deviation (n = 3)
The values in each column varying the superscript letters are significantly different (P≤ 0.05).

According to the information in Table (2), red beet leaves and roots have an influence on obese rats' levels of HDL-c, LDL-c, VLDL-c,and AI. The acquired results showed that, with significant differences, the positive control group had the lowest high density lipoprotein cholesterol levels, and the negative control group had the highest levels. They were 49.19 and 23.38 mg/dl on average, respectively. However, there were significant differences between the highest ranges of HDL-c in treated groups (overweight groups) measured for 5% combination powder and the lowest values measured for 2.5% Red beet leaves powder, the mean values which were48.04 and 31.99 mg/dl, respectively.

Results also showed that, with statistically significant differences, the positive control group had the highest levels of LDL-c while the negative control group had the lowest values. The relative mean values were 89.42 and 10.01 mg/dl. On the other hand, 2.5% red beet leaf powder had the greatest low density lipoprotein cholesterol levels among the treated groups

(overweight groups), while.5% mixes had the lowest value, with significant differences, the respective meanswere 54.06 and 4.01 mg/dl.
Once it was discovered that the controlpositive group had the greatest amounts of very low-density lipoprotein cholesterol, whereas the negative control group had the lowest levels, with statistically significant differences. The relative mean values were 23.2 and 12.3 mg/dl. In contrast, 2.5% red beet leaf powder had the greatest VLDL-c levels among the treated groups (obese groups), while5% combination had the lowest value, with differences that were statistically significant, whichwere21.53 and 13.04 mg/dl respectively. These results agree with (29)who found that fresh red beet taken orally significantly decreased total cholesterol, triglycerides, low and very low-density lipoprotein. Rats given red beetroot showed a significant rise in high-density lipoprotein levels.
Moreover, betalains, which are commonly utilized as antioxidants, are present in high concentrations in beetroots, giving them their vivid red color. The reduction of lipid peroxidation and improved resistance to the oxidation of low-density lipoproteins are two advantages of betalains (30).
Due to their ability to lower the ratio between LDL cholesterol (LDL-c) and serum total cholesterol (TC), the phytochemical components may be linked to this plant's positive effects on the cardiovascular system (31).
Cholesterolemia was reduced by 30% as a result of red beet fiber. The shift in LDL at 60% of the decrease may be attributed to this, but HDL's contribution to the transport of cholesterol significantly increased. Red beet fiber had no effect on the liver or heart's cholesterol levels, but it did significantly lower the aorta's by over 30% (32).

Table (2): Influence of red beets leaves and roots on serum lipid fractions of overweight rats.

Parameters / Groups	HDL-c mg/dl	LDL-c mg/dl	VLDL-c mg/dl	AI %
G1 C (-)	49.19a±2.21	7.05g±2.69	14.3d±2.9	0.45±0.11
G2 C (+)	23.38f±3.12	107.07a±1.28	27.2a±2.5	4.82a±0.51
G3(2.5%Red beet leaves powder)	31.99e±1.41	85.68b±2.34	21.53ab±3.67	2.36b±0.32
G4(5%Red beet leaves powder)	38.77d±1.43	62.22c±2.81	19.11ab±3.38	1.47c±0.25
G5(2.5%Red beetroots powders)	43.19bc±2.21	61.15d±3.72	13.46abc±2.03	1.11c±0.21
G6(5%Red beetroots powders)	46.21ab±2.89	46.86e±1.65	16.79bcd±1.81	0.82d±0.20
G7 (2.5% Mixture powder)	41.61cd±2.99	43.4f±1.91	14cd±2.9	0.68d±0.16
G8 (5% Mixture powder)	48.04a±2.56	18.82h±2.19	13.04d±2.55	0.35d±0.13
LSD (P≤ 0.05)	4.208	3.178	4.959	0.425

Each value is represented as mean ± standard deviation (n = 3)
The values in each column with different superscript letters are significantly different (P≤ 0.05).
HDL-c= High density lipoprotein cholesterol. LDL-c =Low density lipoprotein cholesterol. VLDL = Very low-density lipoprotein cholesterol.
AI= Atherogenic index.

The influences of red beet leaves and roots powders on renal biomarker parameters (urea, uric acid, and creatinine) are shown in obese rats by the data in Table (3). The collected results showed that the control positive group had the highest serum urea levels, whereas negative control group had the lowest value with statistically significant differences. The corresponding mean values were 58.69 and 26.41 mg/dl. However, the greatest urea levels of the treated groups (overweight groups) were found in 2.5% leaves powder, while the lowest value was found in a 5% combination. These differences were statistically significant. The corresponding mean values were 44.38 and 29.87 mg/dl.
The acquired results demonstrated that the controlpositive group had the highest serum uric acid levels, whereas the negative control group had the lowest value, with significant differences. 5.71 and 2.18 mg/dl on average, respectively. However, the treated groups (obese groups) had serum uric acid levels that were highest when 2.5% leaves powder was used, and lowest when 5% mixes was used, with statistically significant. They were 5.45 and 3.88 mg/dl on average, respectively.
According to the results, the positive control group had the highest serum creatinine levels, while the negative control group had the lowest values, with differences that were statistically significant. The relative mean readings were 0.97 and 0.79 mg/dl. On the other hand, the treated groups (obese groups) had serum creatinine levels that ranged from the greatest for 2.5% leaves powder to the lowest for 5% combination, with differences that were statistically significant. The relative mean values were 0.59 and 0.89 mg/dl. Despite the beetroot juice's beneficial effects on hypertension and blood sugar, only a few research have acknowledged the reno-protective characteristics linked to renal markers (33).
Rats treated with beetroot ethanolic extract at doses of 250 and 500 mg/kg significantly reduced the rise in serum urea, creatinine and uric acid concentrations (34).
Furthermore, all tested nephrotoxic rats fed on different diets indicated non-significant increases in mean values as compared to positive control group. The best treatment of urea, uric acid and creatinine was recorded for rats fed on 10% beet root as compared to negative control group (35).

Table (3): Effect of red beets leaves and roots on renal biomarkers of overweightrats

Parameters Groups	Urea mg/dl	Creatinine mg/dl	Uric acid mg/dl
G1 C (-)	26.41e±5.37	0.79b±0.10	2.18b±.17
G2 C (+)	58.69a±2.51	0.97a ±0.16	5.71a±2.59
G3 (2.5%Red beet Leaves powder)	44.38b±2.74	0.89b±0.11	5.45a±1.75
G4 (5% Red beet Leaves powder)	36.42c±3.00	0.74b±0.17	5.18a±1.15
G5 (2.5Red beetroots powder)	37.92c±2.38	0.82b±0.13	5.11a ±2.01
G6(5% Red beetroots powder)	30.31de ±4.09	0.72bc±0.06	4.66a±0.47
G7 (2.5% Mixture powder)	33.59cd±1.81	0.66c±0.12	4.81a±1.49
G8 (5% Mixture powder)	29.87de±2.63	0.59c±0.04	3.88a±1.43
LSD (P≤ 0.05)	5.942	0.17	2.775

Each value is represented as mean ± standard deviation (n = 3).
The values in each column with different superscript letters are significantly different (P≤ 0.05).

The influences of red beet leaves and roots as powders on the ALT, AST, and ALP levels of overweight rats are shown in Table (4). It is obvious that the controlpositive group had the greatest ALT enzyme levels, whereas the controlnegative group had the smallest value, with significant differences. The corresponding mean values were 119.95 and 62.79 U/L. In contrast, 2.5% of red beet leaves had the greatest ALT enzyme among the treated groups (overweight groups), while 5% combination had the smallest value, with differences that were statistically significant. The average values were respectively 99.75 and 68.37 U/L.
The controlpositive group had the greatest levels of the AST enzyme, whereas the negative control group had the smallest values, with significant differences. The relative mean values were 152.75 and 75.21U/L. Contrarily, the greatest AST liver enzyme of treated groups (obesity groups) was found in2.5% red beet leaves, while the lowest value was found in a 5% mixture, with differences that were statistically significant. The corresponding mean values were 123.65 and 93.45 U/L.
The positive control group had the highest levels of the ALP enzyme whereas the negative control group had the lowest levels, with significant differences. There were 330 and 129.5 U/L on average, respectively. Regarding ALP enzyme, the treated groups (overweight groups) recorded the highest values for2.5% red beet leaves and the lowest values for a 5% mixture, with a significant difference, which were 218.5 and 159 U/L on average, respectively. These findings support the findings of(36)who noted that beetroot products caused a decrease in plasma liver enzyme. Oral administration of fresh juice from red beetroot also significantly decreased serum liver enzyme.
Additionally, it was noted long-term consumption of beet root juice protected the liver from oxidative damage (37).

Table (4): Impact of red beets leaves and roots on liver functions of obese rats

Parameters Groups	ALT U/L	AST U/L	ALP U/L
G1 C (-)	62.79f± 1.71	75.21f± 1.99	129.5g± 1.50
G2 C (+)	119.95a±1.75	152.75a ± 2.45	330a± 5.00
G3 (2.5% Red beet leaves powder)	99.75b± 3.45	123.65b ± 3.55	218.5b± 1.50
G4 (5% Red beet leaves powder)	91.85c± 3.35	118.55c± 1.55	198c ± 4.00
G5 (2.5% Red beetroots powder)	88.92c ± 1.51	116.9c± 2.60	196.5c± 3.50
G6(5%Red beetroots powder)	69.32e± 0.90	106.81d ± 3.42	183d± 2.00
G7 (2.5% Mixture powder)	82.64d± 1.76	109.4d ± 1.10	177.5e ± 2.50
G8 (5% Mixture powder)	68.37e± 1.85	93.45e± 1.95	159f± 2.00
LSD (P≤ 0.05)	3.485	3.305	4.384

Each value is represented as mean ± standard deviation (n = 3)
The values in each column with different superscript letters are significantly different (P≤ 0.05).

The influence of red beet leaves and roots as well as their mixespowders on the glucose levels of obese rats is demonstrated by the data in Table (5). It is obvious that the controlpositive group had the higher glucose levels, whilst the negative control group had the smaller value with statistically significant differences, the corresponding mean valueswere219.55 and 120.3 mg/dl. However, the greatest glucose levels of the treated groups (overweight groups) were found in a mix of 2.5% and vice versa with.5% red beet leaf powder, with significant differences between the two. The mean values were respectively 179.6 and 135.95 mg/dl. These findings are consistent with (38)who found that beetroot extract reduces blood glucose levels by regenerating pancreatic beta cells when fed via tube feeding.

It also supports the findings of (39)who suggested that one of the several antioxidant chemicals found in beetroot, namely alpha-lipoic acid, which boosts insulin sensitivity, may be responsible for this anti-glycaemic effect.

Additionally, nephropathy diabetic rats consumption of beet root juice showed an elevation in blood and urine glucose levels, Also, giving rats with 15µl/g body weight of beet root juice showed the best effects through improving the previous changes to near the normal levels. Beet root juice had hypoglycemic effects and can attenuate gentamicin- induced nephropathy (40).

Table (5): Impact of red beets leaves and roots on glucoseof overweightrats

Groups	(glucose) mg/dl
G1 C (-)	120.3g ± 4.80
G2 C (+)	219.55a ± 3.50
G3 (2.5% Red beet leaves powder)	179.6b ± 2.70
G4 (5%% Red beet leaves powder)	173.55c ±1.65
G5 (2.5% Red beetroots powder)	159.4d ± 1.90
G6(5% Red beetroots powder)	147.45e ±2.05
G7 (2.5% Mixture powder)	155.3d ± 5.00
G8 (5% Mixture powder)	135.95f ±1.55
LSD (P≤ 0.05)	5.933

Each value is represented as mean ± standard deviation (n = 3)
The values in each column with different superscript letters are significantly different (P≤ 0.05).

Conclusion

Overweight rats given 5% powdered red beet roots and leaves had better lipid profiles, glucose levels, liver, and renal biomarkers.

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تأثير البنجر الأحمر (الجذور والأوراق) على التغيرات البيولوجية والكيميائية الحيوية للفئران البدينة

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الملخص العربي:
يستخدم م البنجر ومستخلصاته كدواء تقليدي، وملون غذائي، وكخضروات. يحتوي على خصائص قوية مضادة للأكسدة وقد يكون مفيدًا في علاج العديد من الاضطرابات، بما في ذلك السمنة. الهدف الأساسي من هذه الدراسة هو تقدير فاعلية البنجر الأحمر كجذور وأوراق في تقليل السمنة لدى الفئران البدينة. في هذا البحث، تم تقسيم أربعين فأر من ذكور الفئران وزنها ١٥٠ جم ± ٥ جم إلى ثماني مجموعات، كل منها بها خمسة فئران. للحث على السمنة في الفئران، تم إطعامهم نظام غذائي عالي الدهون (٢٠ ٪ من الدهون الحيوانية). قامت الدراسة أيضًا بقياس الكوليسترول الكلي (TC)، والدهون الثلاثية (TG) ، والبروتين الدهني عالي الكثافة (HDL-c) ، والبروتين الدهني منخفض الكثافة (LDL-c) ، والبروتين الدهني منخفض الكثافة جدًا (VLDL-c) ، ومؤشر تصلب الشرايين (AI) ، ومستويات الجلوكوز ، ووظائف الكبد مثل ألانين أمينو ترانسفيراز (ALT) ، وأسبارتات أمينو ترانسفيراز (AST) ، والفوسفاتاز القلوي (ALP) ، ووظائف الكلى (اليوريا ، وحمض البوليك ، والكرياتينين). أظهرت النتائج أن مجموعة السمنة قللت من مستويات الجلوكوز وأنشطة الكبد ووظائف الكلى عندما تم تغذيتها بنسبة ٥٪ من خليط جذور وأوراق البنجر الأحمر، مع وجود فروق معنوية. كان للبنجر الأحمر كجذور وأوراق أقل مستويات الكوليسترول الكلي والدهون الثلاثية، وكذلك أقل البروتين الدهني منخفض الكثافة، والبروتين الدهني منخفض الكثافة للغاية وقيم مؤشر تصلب الشرايين ، مع وجود فروق معنوية. المجموعة التي تم تغذيتها بخليط ٥٪ كان لديها أعلى مستويات البروتين الدهني عالي الكثافة. في الختام، أظهرت الفئران البدينة التي أعطيت ٥٪ بنجر أحمر كمسحوق للجذور والأوراق مستويات دهون منخفضه، وتحسين مستويات الجلوكوز،والكبد، والكلى.

الكلمات الأفتتاحية: النباتات،خفض الوزن،صورة دهون الدم