Effect of some Common Leafy Plants on Hypercholesterolemic Rats

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ABSTRACT

This study was conducted to investigate the effect of rocket (*Eruca sativa Mill.)* and radish (*Raphanus stivus, L*) as 2.5% and 5% on hypercholesterolemic male albino rats induced by Triton-x-100 (100mg/kg of the weight of the rat). Also, determination of identification of phenolics compounds of rocket and radish were done by using HPLC method. The study included 40 rats, weight about 140-150g, each which divided into 8 equal group, two were kept as a control (-ve) and (+ve) groups, while, the other 6 groups were induced hypercholesterolemic by Triton-x-100 (100mg/kg of the weight of the rat). Body weight, feed efficiency ratio, feed intake, total cholesterol, triglycerides, lipoprotein fraction (HDL, LDL, VLDL, AI), glucose, kidney function (urea, uric acid and creatinine), serum liver function (ALT and AST) total biliruben, albumin ratio and hestopathological changes of liver, heart, kidney, spleen and pancreas, have been determined. The obtained results indicated that rocket, radish leaves and their mixture contains different amount of phenolics compounds, its use as antioxidant. Data also of rocket, radish leaves and their mixture showed a significant in weight gain, food intake, food efficiency ratio, albumin level, TC, TG, HDL-c, LDL-c, VLDL-c, and all other parameters including internal organs weights were improved. The histopathological examination confirmed the improvement of biochemical parameters. As conclusion, rocket, radish and mixture of them could be considered powerful nutraceutical therapeutic means for the treatment of hypercholesterolemia rats.

Keywords: Hypercholesterolemia, radish, rocket, Phenolic compounds, Biochemical analysis.

INTRODUCTION

Hyperlipidemia is an increase in one or more of the plasma lipids, including triglycerides, cholesterol, cholesterol esters and phospholipids and/or plasma lipoproteins including very low density lipoprotein and low-density lipoprotein, and reduced high-density lipoprotein levels **(Mishra *et al*., 2011)**. Hyperlipidemia is considered one of the major risk factors causing cardiovascular diseases (CVDs).CVDs accounts for one third of total deaths around the world, it is believed that CVDs will turn out to be the main cause of death and disability worldwide by the year 2020 **(Jorgensen *et al*., 2013)**. Generally hyperlipidemia does not have any obvious symptoms but they are usually discovered during routine examination or until it reaches the danger stage of a stroke or heart attack. Patients with high blood cholesterol level or patients with the familial forms of the disorder can develop xanthomas which are deposits of cholesterol may form under the skin, especially under the eyes. At the same time, patients with elevated levels of triglycerides may develop numerous pimple-like lesions at different sites in their body **(Tripathi, 2008)**.

Rocket salad also known as arugula is an annual herbaceous plant whose name encloses several species of the *Brassicaceae* family characterized by leaves with peculiar pungent taste and strong flavour. The crop has been originated in the Mediterranean and Near East, with a major centre of diversity in the regions of Western Mediterranean **(Hall *et al*., 2015)**, which represent also the main areas of cultivation thanks to their growing conditions and climate.

Eruca sativa extracts show improving liver functions, lipid profile and antioxidants it is concluded that *Eruca sativa* extracts may exerts their prophylactic and treatment role against oxidative stress produced by ethanol by increasing g/maintaining the antioxidant molecules levels and antioxidant enzymes. Liver is susceptible to many different diseases. *Eruca sativa* seeds and leaves possess free radical scavenging antioxidants which protect against oxidative damage by increasing and maintaining the level of antioxidant molecule and enzymes **(Sarkar *et al*., 2005).** These advantageous effects have been linked to the variety of phytochemicals they consist of, such as vitamins(C, A), glucosinolates and flavonoids, all of which are found in large quantities in *Brassicaceae* crops **(Bell and Wagstaff, 2014)**. **Al-Al-Amoudi and Araki, (2013)** studied the effect of the garden rocket on rats' plasma lipid profile and they found that the garden rocket oil provided a good effect in reducing the rat lipid profile. Garden rocket oil can induces turning of serum lipid profile, also prevent the changes of triglycerides **(Guarrera and Savo, 2013)**.

Radish (*Raphanus sativus, L.*) is a cruciferous vegetable. It is not only a vegetable crop but also an important source of medicinal compounds and from antiquity, it has been used in folk medicine against many toxicants **(Salah-Abbe`s *et al*., 2009)**. In general, radish

contains carbohydrates, sugars, dietary fibers, protein, and even some fat and fluoride. In addition, it contains various water-soluble vitamins (B1, B2, B3, B5, B6, B9 and C) and minerals (calcium, iron, magnesium, manganese, zinc, potassium, and phosphorous) **(Khattak, 2011)**. Radishes are rich in ascorbic acid, folic acid, vitamin B6, riboflavin, potassium, magnesium, copper, and calcium **(Jan and Badar, 2012).** The radish has been used in some societies as a laxative, stimulant, digestive acid, appetizer, and to treat stomach disorders **(Gilani and Ghayur 2004)**. Some reports show that radish can decrease the plasma cholesterol, triglyceride and phospholipids in normal rats **(Taniguchi *et al*., 2006)**. It seems that *Raphanusstativus* increases the lipid metabolism and lowers the lipid plasma by increasing the activity of lipoprotein lipase.

Material and Methods

Materials

1- Fresh samples of rocket and radish were purchased from a local market, Benha City, Qalyubia Governorate, Egypt.

Triton- X-100

2-The chemical Triton X-100 used to induce the hypercholesterolemia obtained from SIGMA Chemical Co.

Casein, cellulose, choline, chloride, and DL Methionine:

3- Casein, cellulose, choline chloride powder, and DL methionine powder, were obtained from Morgan Co. Cairo, Egypt.

Experimental animals

A total of 40 adult normal male albino rats strain weighing 140-150 ± 10g were obtained from Vaccine and Immunity Organization, Ministry of Health, Helwan Farm, Cairo, Egypt.

Methods

Preparations of plants leaves

Fresh samples of rocket and radish were purchased from a local market, Benha City, Qalyubia Governorate, Egypt, and the plants were authenticated by the Botany Department, Agriculture University, then cut into small slices. Slices were dried by Solar Dreier (Drying Vazl) to save the phenol compounds as they are until constant moisture level as described by the method of **A.O.A.C., (1995)**. The dried samples were pounded using electric stainless still mill (Braun, 537, Germany) to give homogenous powder, and kept in polyethylene bags at freezing temperature until using.

Experimental design

Forty male albino rats, 6 weeks age, weighing (140-150) ± 10g, were used in this experiment. All rats were fed on basal diet (casein diet) prepared according to **AIN, (1993)** for 7 consecutive days. After this adaptation period, rats are divided into 8 groups, each group which consists of five rats as follows: group (1): rats fed on basal diet as negative control. Group (2): A group injected by single dose of freshly

prepared solution of Triton-X-100 (100 mg/kg) and used as a positive control group. Group (3): A group infected by hypercholesterolemia fed on basal diet and 2.5% rocket as powder. Group (4):A group infected by hypercholesterolemia fed on basal diet and 5% rocket as powder. Group (5): A group infected by hypercholesterolemia fed on basal diet and 2.5% radish as powder. Group (6): A group infected by hypercholesterolemia fed on basal diet and 5% radish as powder. Group (7): A group infected by hypercholesterolemia fed on basal diet and 2.5% mixture as powder. Group (8): A group infected by hypercholesterolemia fed on basal diet and 5% mixture as powder. The experiment period was take 28 days, at the end of the experimental period each rat weight separately then, rats are slaughtered.

Blood sampling:

Blood samples were collected after 12 hour fasting at the end of the experiment. Using the retro-orbital method by means of a micro capillary glass tubes, blood was collected into a dry clean centrifugal tube and left to clot in a water bath (37°C) at room temperature for half an hour. The blood was centrifuged for 10 minutes at 3000 rpm to separate the serum in clean glass well stoppered and stored at and kept (-20°C) until analysis **(Schermer, 1967).**

Body weight gain (BWG), feed intake (FI), and feed efficiency ratio(FER):

During the experimental period (28 days) the net feed intake was daily recorded, while body weight was weekly recorded. The net feed intake and gained body weight were used for the calculation of feed efficiency ratios (FER) according to **Chapman *et al.*, (1959)** as follow:

$$\text{FER \%} = \frac{\text{Body weight gain (g)}}{\text{Food intake (g)}} \times 100$$

Biochemical analysis

Lipids profile

Determination of total cholesterol

Colorimetric method for cholesterol was determined according to **Richmond, (1973)**.

Determination of serum triglycerides

Serum triglyceride was determined by enzymatic colorimetric method used to determine triglycerides according to **(Young and Pestaner, 1975)**.

Determination of high density lipoprotein (HDL-c):

HDL-c was determined according to the method described by**Friedewaid (1972) and Grodon and Amer (1977)**.

Calculation of very low density lipoproteincholesterol (VLDL-c)

VLDL-c was calculated in mg/dl according to **Lee and Nieman (1996)** using the following equation:

VLDL-c (mg/dl) = Triglycerides / 5

Calculation of low density lipoprotein cholesterol (LDL-c)

LDL-c was calculated in mg/dl according to **Lee and Nieman (1996)** as follows:

LDL-c (mg/dl) = Total cholesterol – HDL-c – VLDL-c.

Liver functions:

Determination of serum alanine amino transferase (ALT), serum asparatate amino transferase (AST), according to the method of **Chawla (2003) and Srivastava *et al.*, (2002).**

Determination of total phenolic content

Total phenolics in the selected extract samples were determined according to Mazza's method **(Mazza *et al*., 1999)**, with some modifications as described by **Radovanović and Radovanović, (2010)**.

Statistical analysis:

Data were analyzed using a completely randomized design **(SPSS, 2010)** when a significant main effect was detected, the means were separated with the student-Newman-Keuls test. Differences between treatments of ($P \leq 0.05$) were considered significant **Wolfinger and Chang, (1995)**.

RESULTS AND DISCUSSION

Data given in Table (1) show the effect of rocket and radish on the serum lipid profiles of hypercholesterolemic rats. The obtained results indicated that the cholesterol levels of positive control group recorded the highest value when compared with negative control group with significant difference. The mean values were 241.00 and 112.66 mg/dl, respectively. While, the lowest cholesterol levels recorded for group fed on 5 % mixture powder of rocket and radish, while the highest value recorded for 2.5% rocket with significant difference. The mean values were 117.66 and 164.33 mg/dl, respectively. These results are in agreement with **Abozid *et al*., (2014)**they reported that the rocket seed oil administered to rat's fed on high fat diet reduced all plasma lipid profile, that's may be because of higher ratio of unsaturated fatty acids, and high amount of plant sterols and **Yeh *et al*., (2009)**, they reported that the active components of radish Caffeic acid, ferulic acid and coumaric acid supplements decrease plasma cholesterol concentration , they attributed this to the increased fecal sterol, which in turn led to a decreased absorption of dietary cholesterol.

On the other hand, the obtained results indicated that triglyceride of positive control group recorded the highest value when compared with negative control group with significant difference. The mean values were 183.66 and 94.00 mg/dl, respectively. While, the lowest triglyceride recorded for group fed on 5 % mixture powder of rocket and radish, while the highest value recorded for 5% rocket with significant difference. The mean values were 96.00 and 124.70 mg/dl, respectively. These results are in agreement with **Guarrera and Savo, (2013)**they reported that the garden rocket oil can induces turning of

serum lipid profile, also prevent the changes of triglycerides and **Taniguchi *et al*., (2006)** they reported that the *Raphanus stativus* can decrease the plasma cholesterol, triglyceride and phospholipids in normal rats due to the presence of biologically active components.

Data presented in Table (2) show the effect of rocket and radish on serum lipid profiles of hypercholesterolemic rats .The obtained results indicated that the HDL-c of negative control rats group recorded the highest value when compared with positive control group with significant difference. The mean values were 40.33 and 30.33 mg/dl, respectively. While, the highest HDL-c of treated group recorded for group fed on 2.5% mixture powder of rocket and radish but, the lowest value recorded for group fed on 5% radish with significant difference. The mean values were 40.33 and 30.36 mg/dl, respectively. On the other hand, the LDL-c of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 173.93 and 53.53 mg/dl, respectively. While, the highest LDL-c of treated group recorded for group fed on 2.5 % rocket but, the lowest value recorded for group fed on 5% mixture powder of rocket and radish with significant difference. The mean values were 106.13 and 61.80mg/dl, respectively. In case of VLDL-c, the positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 36.74and 18.80 mg/dl, respectively. While, the highest VLDL-c of treated group recorded for group fed on 5 % rocket but, the lowest value recorded for group fed on 5% mixture powder of rocket and radish with significant difference. The mean values were 24.93 and 19.18mg/dl, respectively. **Kim *et al*., (2003)** showed that ferulic acid has the ability to reduce the level of low density lipoproteins in rats. They also suggested that synthesis of cholesterol was decreased by competitive inhibition of hydroxymethylglutaryl coenzyme A reductase (HNG-CoA reductase) by ferulic acid. This enzyme is the most important regulatory step in the biosynthesis of cholesterol.

Data given in Table (3) show the effect of rocket and radish on (GOT) and (GPT)of hypercholesterolemic rats. The obtained results indicated that they GOT liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 56.00 and 29.00 U/L, respectively. While, the highest GOT liver enzyme of treated group recorded for group fed on 2.5 % rocket but, the lowest value recorded for group fed on 5% radish with significant difference. The mean values were 42.00 and 29.33 U/L, respectively.

On the other hand, GPT liver enzyme of positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 47.00 and 18.00 U/L, respectively. While, the highest GPT liver enzyme of treated group recorded for group fed on 2.5 % mixture powder of rocket and radish

but, the lowest value recorded for group fed on 5% mixture powder of rocket and radish with significant difference. The mean values were 34.66and 19.33 U/L, respectively. Treatments with both ESS and RSS oil decrease the AST and ALT levels. These results are in agreement with those of **Okamoto *et al*., (2005)** who reported the ability of coumarin, one of rich constituents of ES, to lower plasma ALT activity. Also, the effect of the tested plants may be due to their ability to prevent cell damage and recover the cellular damage in the liver.

In case of total bilirubin the positive control rats group recorded the highest value when compared with negative control group with significant difference. The mean values were 0.75and 0.64 mg/dl, respectively. While, the highest level of treated group recorded for group fed on 5 % rocket but, the lowest value recorded for group fed on 2.5% radish and 5% mixture powder of rocket and radish with significant difference. The mean values were 0.74 and 0.64 mg/dl, respectively. These result are in agreement with **Anwar and Ahmad (2006)** who reported that ethanol extracts from R. sativus leaf powder was effective in decreasing total bilirubin**.**

Data presented in Table (4) showed the highest phenolic compound in rocket was p-coumaric acid and the lowest phenolic compound was kaempferol. The mean values were 16.10 and 0.04 mg/g DW, respectively. Also, the highest phenolic compound in radish was Ferulic acid and the lowest phenolic compound was Quercetin.The mean values were 4.13 and 0.49mg/g DW respectively. These result are in agreement with **Lin and Harnly ,(2010)** who mentioned that in *Brassica* vegetables the most common are p-coumaric, and ferulic acids, often found in conjugation with sugar or other hydroxycinnamic acids and **Syed *et al*., (2012)** who reported that the root of *R. sativus*has several polyphenolics like vanillic acid, phenyl pyruic, syringic acid, p-coumaric, o-coumaric and caffeic**.**

Data given in Table (5) show the effect of rocket and radish on body weight gain of hypercholesterolemic rats. The obtained results indicated that they BWG of positive control rats group recorded the lowest value when compared with negative control group with significant difference. The mean values were 13.98 and 19.50 g, respectively. While, the highest BWG of treated group recorded for group fed on 2.5 % rocket but, the lowest value recorded for group fed on 2.5% mixture powder with significant difference. The mean values were 14.78 and 14.03 g, respectively.

On the other hand, the feed intake of positive control rats group recorded the lowest value when compared with negative control group with significant difference. The mean values were 452.20 and 455.80 g, respectively. While, the highest FI of treated group recorded for group fed on 2.5 % radish but, the lowest value recorded for group fed on 2.5 and 5% rocket with significant difference. The mean values were 455.4 and 453.2g, respectively.

In case of feed efficiency ratio the positive control rats group recorded the lowest value when compared with negative control group with significant difference. The mean values were 0.030 and 0.040g, respectively. While, the highest level of treated group recorded for group fed on 5 % mixture powder of rocket and radish but, the lowest value recorded for group fed on 5% radish and 2.5% mixture powder of rocket and radish with significant difference.

Table (1): Effect of rocket, radish and their mixtures as powder on serum total cholesterol and triglycerides of hypercholesterolemic rats

Groups / Parameters	TC (mg/dl)	TG (mg/dl)
G_1Control (-)	112.66 ±1.93	94.00 ±2.30
G_2Control (+)	241.00±2.85***	183.66 ±1.24***
G_3(2.5 %Rocket)	164.33±1.68***	124.33 ±1.95***
G_4 (5 %Rocket)	134.33±2.30***	124.70 ±2.07***
G_5 (2.5 % Radish)	142.33±2.12***	112.33 ±3.20***
G_6 (5 %Radish)	119.33±1.15***	96.66 ±0.80***
G_7(2.5 % Mixture)	153.66±3.25***	118.3 ±1.34***
G_8 (5 % Mixture)	117.66±1.74***	96.00 ±0.71***

Values denote arithmetic ± standard deviation of the mean (n = 5).
TC= Total Cholesterol. TG= Triglyceride.
***Very high significant differences ($p \leq 0.001$).

Table (2): Effect of rocket, radish and their mixtures as powder on serum lipid profiles of hypercholesterolemic rats

Groups / Parameters	HDL-C mg/dl	LDL- C mg/dl	VLDL- C mg/dl
G_1 Control (-)	40.33 ±1.57	53.53 ±0.10	18.80 ±0.46
G_2 Control (+)	30.33 ±2.34***	173.93±0.26***	36.74 ±0.25***
G_3 (2.5 %Rocket)	33.33±2.04**	106.13±0.75***	24.86 ±0.39***
G_4 (5 %Rocket)	34.00 ±1.42**	75.39 ±0.45***	24.93 ±0.42***
G_5 (2.5 % Radish)	31.66 ±1.86**	88.20 ±0.37***	22.46 ±0.63***
G_6 (5 %Radish)	30.36 ±1.15	69.64 ±0.16***	19.33 ±0.16***
G_7(2.5% Mixture)	40.33 ±1.90**	89.67±1.08***	23.66±0.27***
G_8 (5 % Mixture)	36.66 ±2.12**	61.80±0.52***	19.18±0.16***

Values denote arithmetic ± standard deviation of the mean (*n* = 5).
HDL-C= High density lipoprotein Cholesterol.
LDL =Low density lipoprotein Cholesterol.
** High significant differences ($p \leq 0.01$).
***Very high significant differences ($p \leq 0.001$).

Table (3): Effect of rocket, radish and it's mixtures as powder on some liver function of hypercholesterolemic rats:

Groups / Parameters	GOT (U/L)	GPT (U/L)	Bilirubin (mg/dl)
G_1 Control (-)	29.00±2.80	18.00±2.30	0.64±0.03
G_2 Control (+)	56.00±2.66***	47.00±3.21***	0.75±0.06**
G_3 (2.5 %Rocket)	42.00±1.25***	26.33±2.43***	0.65±0.01**
G_4 (5 %Rocket)	33.66±2.28***	21.66±1.98***	0.74±0.01
G_5 (2.5 % Radish)	32.66±1.56***	33.66±1.74***	0.64±0.03**
G_6 (5 %Radish)	29.33±0.2***	22.33±0.99***	0.72±0.02**
G_7(2.5 % Mixture)	37.33±2.98***	34.66±1.88**	0.66±0.02**
G_8 (5 % Mixture)	29.66±0.41***	19.33±0.87***	0.64±0.02**

Values denote arithmetic ± standard deviation of the mean (n = 5)
** High significant differences ($p \leq 0.01$).
***Very high significant differences ($p \leq 0.001$).

Table (4): phenolics compounds of rocket and radish leaves (mg/g dry weight):

Active compounds	Rocket (mg/g DW)	Active compounds	Radish (mg/g DW)
Quercetin	0.23	Quercetin	٠.٤٩
Syringic acid	15.32	Syringic acid	0.70
Ferulic acid	14.60	Ferulic acid	4.13
Sinapic acid	ND	Sinapic acid	1.29
Vanillic acid	ND	Vanillic acid	3.21
P-Coumaric acid	16.10	O-Coumaric acid	2.13
Epicatechin	0.43	Catechin	1.13
Procatequic acid	0.05	Proto-catechuic acid	ND
Kaempferol	0.04	Myricetin	ND
Quinic acid	0.08		
Rutin	0.17		
Hydroxycinnamic derivatives	2.43		

ND = Not detected.
Mean under the same column bearing different superscript letters are differentsignificantly ($p < 0.05$).

Table (5): Effect of rocket, radish and it's mixtures as powder on BWG,FI and FER of hypercholesterolemic rats:

Groups / Parameters	BWG (g)	FI (g/day)	FER (g/day)
G_1 Control (-)	19.50 ± 4.65	٤٥٥.٨٠ ± ٣.٠٢	٠.٠٤0 ± ٠.٠١
G_2 Control (+)	13.98 ± 2.33**	٤٥٢.٢٠ ± ١.٥٨**	٠.٠٣0 ± ٠.٠٢**
G_3 (2.5 %Rocket)	١٤.٧٨ ± 1.14	٤٥٣.٢ ± ١.٩٨	٠.٠٣0 ± ٠.٠١٩
G_4 (5 %Rocket)	١٤.٣٢ ± ٠.٩٥	٤٥٣.٢ ± ٢.١١	٠.٠٢٩ ± ٠.٠١٩
G_5 (2.5 % Radish)	١٤.٥٩ ± ٢.٥٤	٤٥٥.٤ ± ٠.١٥**	٠.٠٢٩ ± ٠.٠١٩
G_6 (5 %Radish)	١٤.٠٩ ± ١.٥٨	٤٥٣.٦ ± ١.٦٥**	٠.٠٢٧ ± ٠.٠١٥
G_7 (2.5 % Mixture powder)	١٤.٠٣ ± ٢.٠٤	٤٥٤.٠٠ ± ١.٧٧**	٠.٠٢٧ ± ٠.٠١٥
G_8 (5 % Mixture powder)	١٤.٥٩ ± ٢.٨٨	٤٥٤.٤ ± ١.٣٨**	٠.٠٣٢ ± ٠.٠١٤

Values denote arithmetic ± standard deviation of the mean (n = 5)
** High significant differences ($p \leq 0.01$).

RECOMMENDATIONS

1- Encourage the use of the plants used in the study by all groups in society, where they are available in markets at cheap price.

2- The possibility of eating plants under study in any amount where they are really free of calories and rich had pronounced level, fiber thus help to keep weight acceptable, especially to diabetics and others suffer from obesity, and this reduces the complications of obesity, such as atherosclerosis and high blood cholesterol.

3- The use of 2.5- 5% of rocket and radish, addition to the ordinary diet lower blood lipids.

4- Rocket and radish had a positive role in improving kidney function (creatinine, urea and uric acid).

5- The use of the plants had a positive impact in improving liver enzymes

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تأثير بعض أوراق النباتات الشائعة علي الفئران المصابة بإرتفاع الكوليسترول

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الملخص العربى

تم تقييم تأثير تركيزات مختلفة (٢.٥ – ٥%) من أوراق الجرجير والفجل والخليط الجاف في الفئران المصابة بإرتفاع الكوليسترول. واستخدم ٤٠ فأر في هذه الدراسة وتم تقسيمها إلى ٨ مجموعات، كل مجموعة تحتوي على ٥ فئران (١٤٠-١٥٠±10). وتم اصابة الفئران بإرتفاع الكوليسترول بواسطة مادة تريتون إكس ١٠٠(١٠٠ مجم/ كجم من وزن الجسم). وأظهرت النتائج أن كلا من أوراق الفجل والجرجير تحتوى على العديد من المركبات الفينولية والتى تعمل كمضادات أكسدة. لوحظ أن أعلى قيم للكوليسترول عالى الكثافة سجلت مع مجموعة الفئران التي تغذت على مخلوط أوراق الجرجير والفجل بتركيز ٢,٥٪ الجاف. في حين أعلى قيم من الكوليسترول منخفض الكثافة سجلت مع مجموعة الفئران التي تغذت على الجرجير بتركيز ٢,٥% والكوليسترول منخفض الكثافة جدا سجلت مع مجموعة الفئران التي تغذت على الجرجير بتركيز ٥%. أقل قيمة من الدهون الثلاثية سجلت مع مجموعة الفئران التي تغذت على الجرجير بتركيز ٥% والكوليسترول مع مجموعة الفئران التي تغذت على الجرجير بتركيز ٢,٥%. أعلي انخفاض لإنزيمات الكبد GOT, ALT سجل مع مجموعة الفئران التي تغذت على الجرجير بتركيز ٢,٥ ٪ ، بينما أقل قيم كانت مع مجموعة الفئران التى تغذت على الفجل بتركيز ٥%. أعلى قيم من البيليروبين سجلت مع مجموعة الفئران التي تغذت على الجرجير بتركيز ٥% بينما أقل قيمة سجلت مع مجموعة الفئران التي تغذت على الفجل بتركيز ٢,٥ % و مخلوط الجرجير والفجل بتركيز ٥٪ .

الكلمات الكاشفة: الجرجير ، الفجل ، الكوليسترول الكلي ، الدهون الثلاثية ، المركبات الفينولية.