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Potential Protective Effects Of Arabica Coffee Beans And Peels In Improving The Biological Condition Of Hyperlipidemic Rats

Lobna Saad Mohammed Abd Elmeged[1], Abdullah M. Almotayri[2], Ranyah Shaker M. Labban[3], Ohood K. Hesseki[4], Nahla A. Alshaihk[5], Mr. Hashim Awaji[6], Mr. Zaid Shoei Madkhali[7]

[1a]Department of Nutrition, Applied collage, AL-Baha University, Saudi Arabia
Email: lobna@bu.edu.sa ORCID iD: 0000-0003-1527-9457
[1b] Department of Nutrition and Food Sciences, Faculty of Home Economics, Menoufia University, Shibin el Kom, Menofia Governorate 6131567, Egypt.
Email: Lobna_lolo_2007@yahoo.com
[2]Department of Biology, Faculty of Science, Al-Baha University, Al-Baha, Saudi Arabia
[3]Deputyship for therapeutic services, General, Administration of Nutrition, Ministry of Health, 11595 Riyadh, Saudi Arabia.
Email: Rlabban@moh.gov.sa
[4]Research Centre, Wadi Sail Agricultural Company, Baljurashi, Al-Baha, Saudi Arabia
Email: dr.o.hesseki@wsc.sa
[5]College of nursing and health sciences, Medical Laboratory Department, Jazan University
Email: nalshaikh@jazanu.edu.sa
[6]Laboratory Technician Al-Tawal General Hospital
Email: hhawajy@moh.gov.sa
[7]Bioinformatics technician, jazan university hospital .
Email: zsmadkhali@jazanu.edu.sa

ABSTRACT

Cardiovascular diseases (CVDs) are the leading cause of death globally, responsible for an estimated 19.8 million deaths in 2022. Coffee beans and their Peels offer beneficial properties due to bioactive compounds like antioxidants and fiber. Aim: Determine the effectiveness of coffee beans and coffee arabica peels in improving the biological condition of hyperlipidemic rats. Materials and methods: Twenty-four male Sprague-Dawley albino rats, aged 10 weeks, weighing 150±10g, were split into 4 groups: The experiment was carried out in two periods. In the first period (three weeks), the first group was fed as a control group and was fed a control diet, while the other groups were fed the hyperlipidemic diets. In the second period (6 weeks), one of the hyperlipidemic rats fed on hyperlipidemic diet (10% animal fat and 1%. cholesterol). While the other groups were fed on a hyperlipidemic diet supplemented with 5% coffee beans and 5% coffee peels ,while one group was given a regular diet to act as a control positive. The experiment concluded with a blood sample and biochemical examination of the excised organs. Results: The mean values of serum triglycerides decreased by 33.88% (G3) and 64.18% (G4). While values of AST decreased by 5.28% (G3) and 31.72% (G4) for rats fed hyperlipidemic diet supplemented with coffee beans and peels as compared with control (+) G2. The gain in body weight per day, there were no significant difference between rats fed hyperlipidemic diet group (G2) and hyperlipidemic diet coffee beans 5% (G3) and coffee peels 5% G4.Conclusion: These findings highlight the potential of coffee beans and coffee arabica peels as functional ingredients in managing obesity and hyperlipidemia, offering a natural and accessible approach to promoting cardiovascular health.

KEYWORDS: Arabica Coffee beans - Coffee arabica peels – hyperlipidemia- bioactive components.

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INTRODUCTION

Cardiovascular diseases are the primary etiology of mortality globally, accounting for approximately 19.8 million mortalities in 2022, which accounts for around thirty-two percent of all worldwide mortalities. Heart attacks and strokes are the most common causes, with 85% of CVD-related deaths attributed to these two conditions. While the global death rate per capita has declined due to improved prevention and treatment, the overall number of deaths continues to rise, largely because of a growing and aging global population **(Petersen and Kris *et al* ., 2021).** Symptoms of cardiovascular disease may differ based on the underlying etiology. Older adults and females might have more nuanced symptoms. Nonetheless, they may still experience serious cardiovascular disease. (**Robson et al ., 2015).** Coffee is extensively known as one of the most preferred beverages worldwide, because of it's accessibility, consumer preferences, and health advantages. Nonetheless, the entire process from coffee generation to consumption produces about 2 billion tons of solid waste each year, with coffee husk constituting about 10 million tons of that waste. Coffee husk is regarded as the main co-product produced throughout the dry processing of coffee, with the majority being directly discarded in landfills. **(Duan *et al*,. 2022).** In the last fifteen decades, the coffee demand has risen significantly. This increase may be related to multiple factors, involving growing populations and urbanization. Moreover, coffee has become as 1 of the most extensively consumed beverages globally. The coffee culture is essential to the global economy, being 1 of the most

preferred beverages, with more than 500 billion cups drank each year. **(Klingel *et al.*, 2024).** The 1st coffee plantation has been founded in Yemen via Arabs in the thirteenth century with seeds obtained from Ethiopia. **(Patil *et al.*, 2023).** Numerous investigations have shown the antioxidant and antimicrobial characteristics of phytochemicals found in coffee by-products. Moreover, there is a growing customer demand for natural ingredients in the food industry and nutrients with proven health advantages. (**Simoes *et al.* 2022).** Coffee husk is regarded as a major co-product produced during the dry processing of coffee beans, constituting forty to forty-five percent of the overall coffee harvest. The dry processing technique is a simple and economical method. **(Ontawong et al ., 2020).** The health advantages of bioactive phenolic compounds have attracted significant worldwide interest. Coffee husk is a rich source of phenolic compounds, resulting in continuous study focused on extracting advantageous compounds from it. The primary phenolic compounds derived from coffee husk involve gallic a\, caffeic a\, chlorogenic a\, ferulic a\, quercetin, syringic a\, caffeine, 5-caffeoylquinic a\, anthocyanins, and tannins. **(Farias et al,. 2019).** Various techniques were utilized for extracting phenolic compounds from coffee husk, involving conventional solvent extraction (utilizing ethanol, methanol, isopropanol, and water), alternative solvent extraction (like ionic liquids and deep eutectic solvents), and advanced methodologies (including supercritical fluid extraction, microwave-assisted extraction, ultrasound-assisted extraction, pulsed electric field-assisted extraction, and pressurized liquid extraction). **(Chang *et al,.* 2023).** The antioxidant and radical scavenging properties of coffee beans can enhance wound healing by regulating excessive oxidative stress in the wound site. The coffee bean press cake has demonstrated diminished commercial value; nevertheless, it may acquire value as an essential biomass source of bioactive substances beneficial to human health applications. The examined residual coffee biomasses enhance the regeneration of damaged skin tissue, facilitating novel product development in the pharmaceutical and cosmetic sectors. **(Silva *et al.*, 2020).** Numerous investigations have demonstrated that the active substances in coffee provide advantageous effects, like antidiabetic and antioxidant effects. Furthermore, the active substances in coffee can inhibit the accumulation of lipids and carbohydrates. Chlorogenic acid in green coffee may enhance the oxidation of fatty acids**. (Cangeloni et al .,2022).**

AIM OF STUDY

Determine the effectiveness of coffee beans and coffee arabica peels in improving the biological condition of hyperlipidemic mice.

MATERIALS & METHODS

3.1- Materials:

Coffee beans and Coffee arabica peels: they were purchased from Al-Baha City, KSA, local market, washed, cleaned, blended, & ground into fine powder utilizing an electric grinder. To reduce oxidation, they were stored in dark-stoppered glass bottles until ready to be used. according to **A.O.A.C (1995).**

Cholesterol: from Morgan Chemical Ind., Cairo, Egypt.

Hyperlipidemic rats: Twenty-four (24) adult male white albino rats (Sparague Dawley strain) weighing between 250 - 260 gm). Provided from the Institute of Nutrition, Cairo, Egypt, were homed individually in wire cages under the normal laboratory conditions and fed he basal diet for a week as adaptation.

Experimental design:

The rats were divided into (4) groups, each of (6) rats. The experiment was carried out in two periods. In the first period (three weeks), the first group was fed as a control group and was fed a control diet, while the other groups were fed the hyperlipidemic diets, as concluded by **(Abdel Maksoud et al., 1996)**. In the second period (6 weeks), one of the hyperlipidemic rats fed on hyperlipidemic diet (10% animal fat and 1%. cholesterol). While the other groups were fed on a hyperlipidemic diet supplemented with different levels of avocado (*Persea americana)* as follows:

Croup 1: control group fed on standard diet.
Group 2: untreated group fed on a hyperlipidemic diet.
Group 3: fed a hyperlipidemic diet with 5% coffee beans .
Group 4: fed a hyperlipidemic diet with 5% coffee arabica peels s

During the condition period and the trial, food and tap water were provided and Lipitum. Rats were weighed twice weekly; feed intake was calculated. The composition of the control and experimental diets are shown in Table (2).

Biological Evaluation:

Body weight gain are feed intake were calculated at the end of the experiments.

Table (1). The composition of the control and hyperlipidemic diet.

Group Ingredient	Control G,	Untreated g2	Heypenlipidemic diet	
			5% Avocado g3	10% Avocado g4
Corn starch	72.8	71.8	66.8	61.8
Casein	12.5	12.5	12.5	12.5
Corn oil	10	-	-	*
* Vit. Mix.	1	1	1	1
** Salt mix	3.5	3.5	5.5	3.5
Animal fat		10	10	10

Cholin chloride	**0.2**	**0.2**	**0.2**	**0.2**
Cholesterol	**-**	**1**	**1**	**1**
Fresh dried avocado			**5**	**10**

** Saltmix **(A.O.A.C, 1990)**

Table (2). The composition of salt mixture according to A.O.A.C(1990).

Ingredients	***Gm***
Sod. Cholorid	139.3
KI	0.790
KH2PO4	389.0
Mg SO4	57.0
CaO3	381.0
Fe SO4.7H2O 27.0	
MuSO4. H2O	4.01
ZnSO4.7H2O	0.548
C11SO4.5H2O	0.470
COC12.6H2O	0.023

Table (3). The composition of vitamin mixture according to first report (1977).

Ingredients	***Gm***
Vitamin D3 acetate (1000 lu / gm)	1.0
Vitamin A palmitate (500.000 In / gm)	0.80
Menadione Sodium Bisul-Fate (62.5% menacione)	0.08
Vitamin E acetate (500 lu / gm)	10.0
Riboflavin	0.60
Thiamine HCI	0.60
Nicotinic acid	3.0
Pyridoxine HCI	0.07
Folic acid	0.20
Calcium Pantothenate	1.60
Cyano Cobalamine 0.01%	1.0
Biotin, 1%	2
Sucrose	978.42
Total	1000

Blood sampling

Following a period of 28 days of testing, the mice have been put to sleep with ether prior to being given anesthesia. By using a retro-orbital technique, serum samples were obtained using a dehydrated centrifuge tube. Centrifuging at 1,500 r.p.m., they were after twenty minutes of being left to coagulate at room temperature. for 1/4 hour. Following collecting serum using a sterile syringe, the samples have been placed in Wisserman tubes & stored at -10 degrees Celsius until biochemical analysis might be conducted. Following the procedures outlined in **(Drury and Wallington, 1967)**, mice have been dissected open, their organs eliminated, washed in a saline solution, and subsequently dried following then weighed.

Biological analysis

Dietary consumption, BWG percent, food efficiency ratio consistent with (**Chapman *et al,*1959).** Utilizing the following equation.

$$BWG\% = \frac{Final\,weight - Initial\,weight}{Initial\,weight} \times 100$$

$$FER = \frac{Gain\,in\,body\,weight(g/day)}{Food\,Intake(g/day)}$$

$$\text{Relative weight of organs} = \frac{\text{Organs weight}}{\text{Animal body weight}} \times 100$$

Biochemical analysis

- **Body weight gain, Food intake,** FER consistent with ***Chapman et al. (1959)***
- **Glucose concentration in the blood serum estimation:** Chemical kits were used to assess glucose levels in serum **(Trinder, 1969).**
- **Triglycerides:** Triglycerides have been estimated using an enzyme calorimeter as defined via **Fassati & Prencipe (1982).**
- **Total cholesterol:** The main use of total cholesterol testing, as indicated via **Allain, (1974)**.

- **Determination of phospholipids:** Phospholipids have been determined based on **Richard et al. (1974).**
- **Determination of free fatty acid:** Free fatty acid or, Nonesterified fatty acid (NEFA) has been determined based on **(Richard et al., 1974).**
- **Determination of serum calcium**: Serum calcium has been measured via a photometric test using cerophthalin complex (CPC). The kits were provided by Diagnostic Systems International GmbH- Germany, according to **Thomas (1998).**
- **Determination of serum iron: A** Colorimetric endpoint is used to determine serum iron. The kits were provided by Greiner Diagnostic Gmblt-Unter Gereuth, Germany.
- **Determination of serum Zinc:** Colormetric determination of Zinc according to **Makino (1991).**
- **Determination of serum Magnesium:** Magnesium was detected by the atomic absorption technique using SP 929 - PYE UNICAM.
- **Calcium and magnesium**:0.2 ml serum + 10 ml lanthanum chloride and dilute to 20 ml with water
- Determination of phosphorus: Phosphorus has been determined based on the technique of' **Hanson (1973).**

liver functions Determination

- **Alanine transferase Determination:** The method of **Tietz (1976)** has been utilized to estimate alanine transferase. This enzyme catalyzes the transfer of an amino group from L-alanine to a-ketoglutarate, leading to the creation of glutamate and pyruvate.
- **Aspartate transferase (AST) Determination:** The measurement of AST has been performed based on the technique of ***Henry (1974) and Yound (1975).***
- **Total Protein measurement:** An analysis of total protein was done employing the colorimetric technique developed by **Henry (1974).**

Kidney function assessment

- **Creatinine Estimation:** Creatinine has been calculated using **Henry's (1974)** kinetic procedure.
- **Evaluation of urea:** Urea has been detected by **Patton and Crouch's (1977)** enzymatic method.

Statistical Analysis: One-way categorization has been utilized for the statistical analysis. Analysis of variance (ANOVA) and least significant distinction (LSD) were performed based on **(Snedcor & Cochran 1967).**

Ethical Approval

The research has been approved via Al-Baha University's Research Ethics Committee (Reference. No. 46123022), Approval date 17 April 2025.

RESULTS & DISCUSSION

Determine the effectiveness of coffee beans and peels in improving the biological condition of hyperlipidemic rats.

Effect of coffee beans and peels on hyperlipidemic rats:

Feed consumption and gain in body weight: Table (4) All rats remained in good health during the study. The outcomes are expressed as mean +standard deviation (Mean + SD).

Table (4) demonstrates mean value of feed consumption, daily gain in body weight of hyperlipidemic rats fed normal and hyperlipidemic rats containing (5% of coffee beans and peels) for 6 weeks. There was no significant variance in the daily feed consumption of normal groups (G1) and untreated group (G2).

Conversely, an insignificant variance has been observed among untreated groups (G2) and the other groups feed (5% of coffee beans and 5% coffee peels). The gain in body weight per day, an insignificant variance has been observed among mice fed hyperlipidemic diet group (G2) (60.25 ± 12.39 g / group) and hyperlipidemic diet coffee beans 5% (G3) (64.0 ± 24.24 gm/group) and coffee peels 5% G4 (58.25+44.83gm/group), respectively.

Table (4). Mean values of feed consumption, body weight gain, daily feed consumption, and daily body weight gain of mice given a hyperlipidemic diet with coffee beans and peels

Variables / Groups	Daily food intake	Daily gain in body weight (g/m)	Food intake in 6 weeks (gm)	Body weight in 6 weeks (gm)
control (-) G1	11.43±1.63	21.75±26.88	480.25±68.69	1 74±76.041
Control(+) G2	11.39±0.481	60.25±12.39	478.5±56.37	482±35.059
5% coffee beans G3	11.1+0.62	64.0+24.24	527.625+39.86	512+68.55
5% coffee arabica peels G4	11.85+1.03	58.25+44.83	536.75+37.579	510+126.796

* $p < 0.05$ G1: Rat fed control diet. G2: Rat fed hyperlipidemic diet G3: Rat fed hyperlipidemic diet with 5% coffee beans, G4:

Rat fed hyperlipidemic diet with 5% coffee peels

Effect of coffee beans and peels consumption on serum lipids of rats fed hyperlipidemic rats:
Figure (1,2,3and4) illustrates the mean values of serum triglycerides, phospholipids, total cholesterol, and serum free fatty acids of rats fed a hyperlipidemic diet with coffee beans and peels.

Serum triglycerides: Regarding serum triglycerides statistical analysis of the information demonstrates that there is significant variance (p-value below 0.01) between the untreated group G2 (3.63 + 0.02 m mol / L) and the other groups under examination. From data, the mean values of serum triglycerides reduced by 33.88% (G3) and 64.18% (G4) for groups of mice given a hyperlipidemic diet supplemented with untreated group (hyperlipidemic diet) G2.

Serum phospholipids: The mean value of Serum phospholipids was (3.75 + 0.02 mmol / L) for animals of mice fed hyperlipidemic diet (G2). There was significant variance (p-value below 0.01) among untreated group (G2) and other groups under examination. From fig (2) the mean value of serum phospholipids reduced by 16.0% (G3), and 48% (G4) for groups of mice given a hyperlipidemic diet supplemented with untreated group (hyperlipidemic diet) G2. From fig (2) the mean value of serum phospholipids reduced by 36% (G3) and 52% (G4) for groups of mice given a hyperlipidemic diet supplemented with untreated group (hyperlipidemic diet) G2.

Serum total cholesterol: Regarding serum total cholesterol statistical analysis of the information show that there were significant variance (p-value below 0.01) between untreated group(G2) (4.88 + 0.01 mmol / L) and G1 (2.31 + 0.02 mmol / L), G3 (3.85 ± 0.05 mmol / L) and G4 (3.25 ± 0.03 mmol / L).From data the mean values of serum TC reduced by 21.1% (G3) and 33.4% (G4) for groups of mice given a hyperlipidemic diet with coffee beans and peels in comparison with untreated group (hyperlipidemic diet) G2.

Serum free fatty acids: The mean value of serum free fatty acids was (2.96 ± 0.03 mmol / L) for animals of mice fed on hyperlipidemic diet (G2). There was significant variance (p-value below 0.01) among untreated group G2 and other groups under examination. From fig (4) the mean value of serum free fatty acids reduced by 45.48% (G3) and 56.06%(G4) for groups of mice given a hyperlipideic diet supplemented with coffee beans and peels as compared with untreated groups (G2).

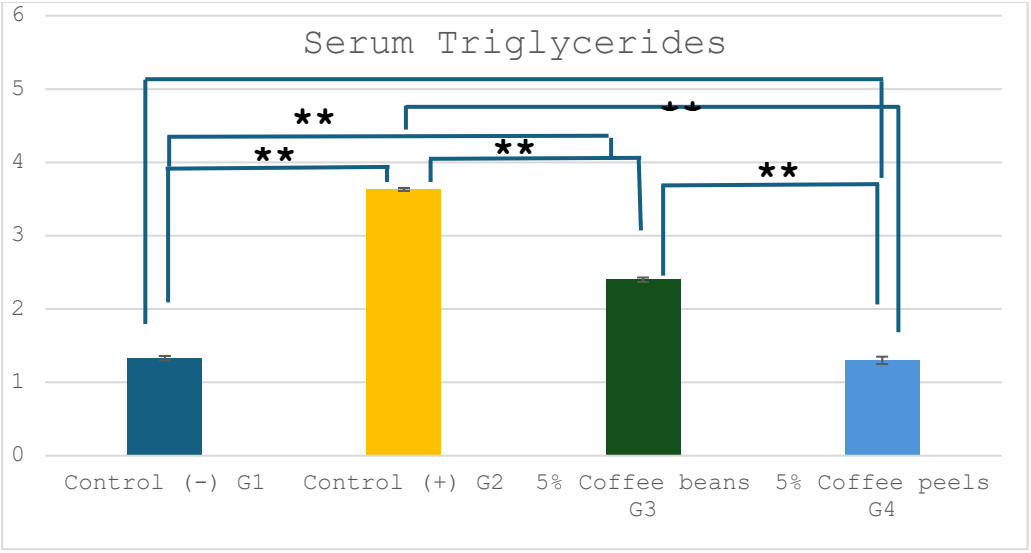

Figure (1). Mean values of Triglycerides of mice given a hyperlipidemic diet with coffee beans and peels.

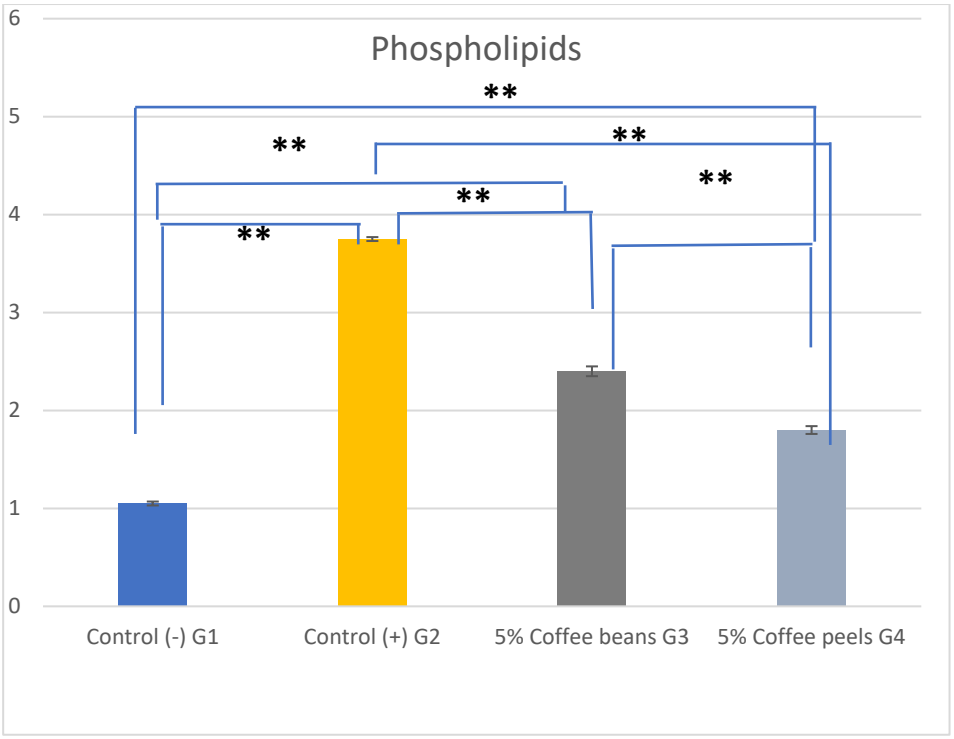

Figure (2). Mean values of phospholipids of mice given a hyperlipidemic diet with coffee beans and peels.

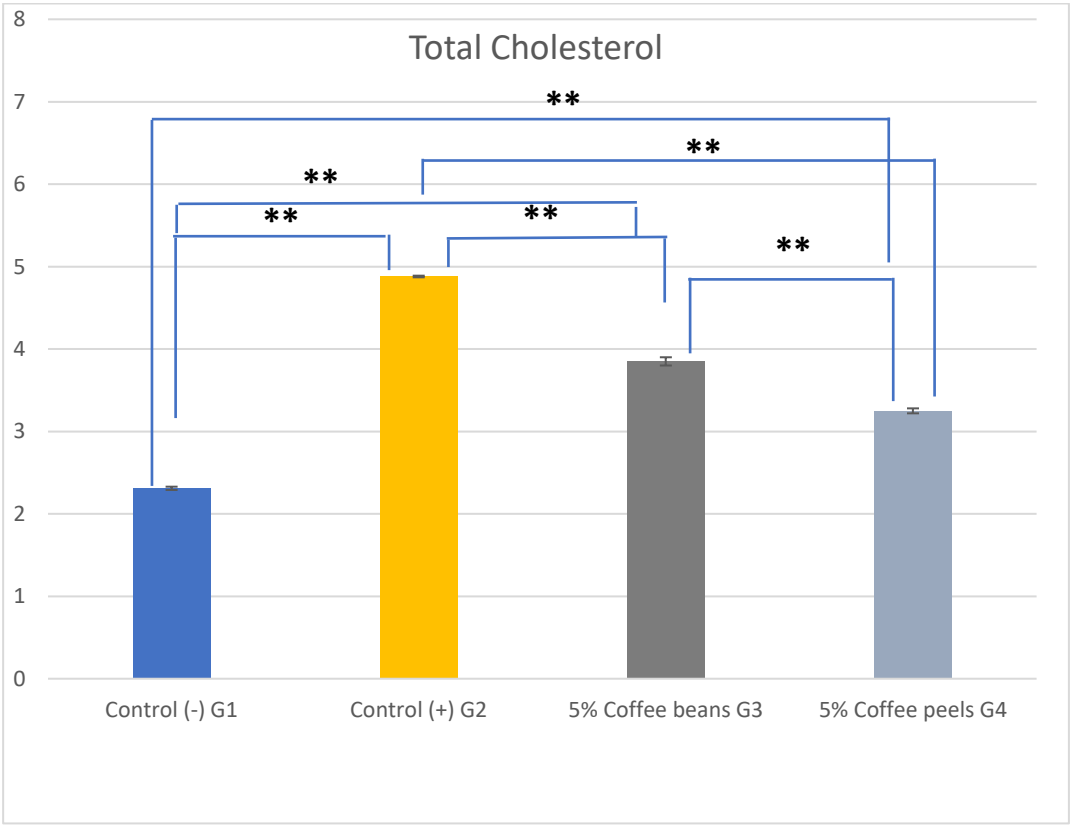

Figure (3). Mean values of Serum total cholesterol of mice given a hyperlipidemic diet with coffee beans and peels.

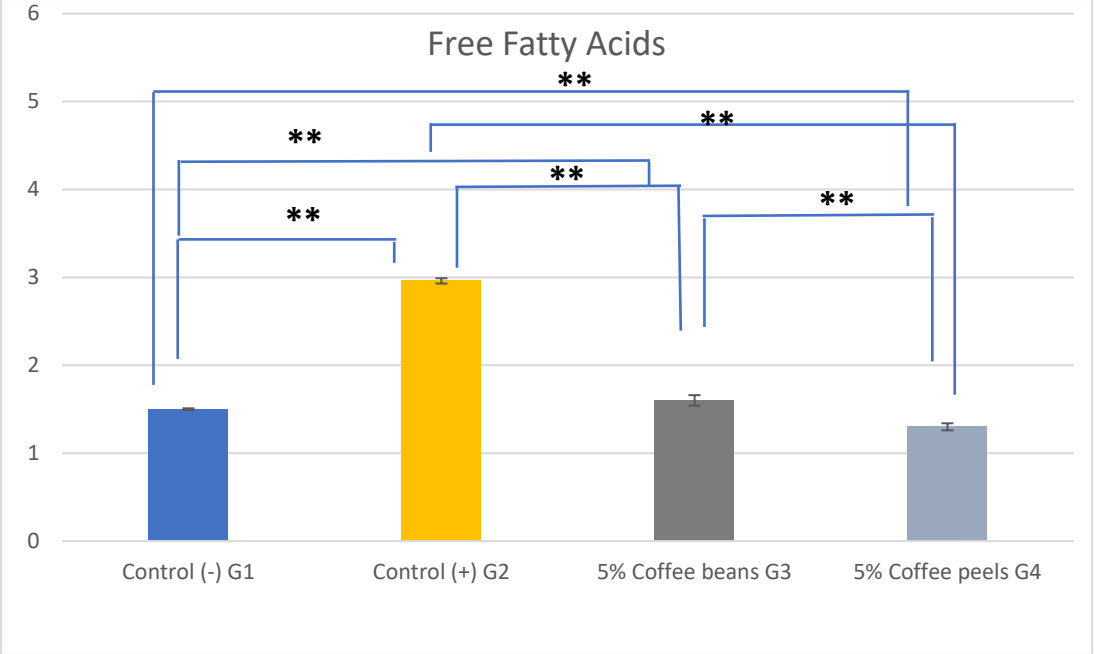

Figure (4). Mean values of Serum free fatty of mice given a hyperlipidemic diet with coffee beans and peels.

Effect of coffee beans and peels consumption on liver enzymes of rats fed a hyperlipidemic diet:
Figure (5,6 and 7) shows mean value ± SD of serum liver enzymes, alkaline phosphatase (ALP u / 1), Aspartate aminotransferase (AST u /1), and Alanine aminotransferase (ALT u / I) for the studied group of rats fed on coffee beans and peels for 6 weeks.

As demonstrated in fig (5) the mean **values of Aspartate aminotransferase** in control positive group (untreated group) G2 was increased significantly at (p-value less than 0.001) than control negative group (G1) that were 85.1 ± 6.11 and 28.1 ± 3.35 (u / 1), respectively. From data the mean values of AST decreased by 5.28% (G3) and 31.72% (G4) for rats fed hyperlipidemic diet supplemented with coffee beans and peels as compared with untreated group (hyperlipidemeic diet) G2.

The mean value of ALT in untreated group G2 was increased significantly at (p-value below 0.001) control negative group G1 which were 98.8 ±3.2 and 38.6 ± 5.25 (u / 1), correspondingly. The mean values of (G5) have been reduced significantly at (p-value less than 0.05) in comparison with control positive (untreated group) G2, which 85.5 ±1.15 (u / 1) respectively. On the other hand, the mean value of (G5) were decrease significantly at (p-value under 0.01) in comparison with control positive group G2 which were 65.8 ± 3.35 (u / I), respectively. From above data in fig (6) the mean values of Alanine amino-transferase (ALT) decreased by 13.46% (G3) and 33.40% (G4) for groups of rats fed hyperlipidemeic diet with coffee beans and peels as compared with untreated group (hyperlipidemic diet) G2.

The mean value of ALP in control positive (untreated group) (G2) was increased significantly at (p-value less than 0.001) than control negative group (G|) that were 105.1 ± 1.16 and 70 ± 2.43 (u / 1) respectively. The mean values of G3 were reduced significantly at (p-value less than 0.05) in comparison with control positive group (untreated group) G2, which were 90.5 ± 5.45 (u /1) The mean value of (G3) has been decreased significantly at (p-value below 0.001) compared to control positive that was 75 ±1.15 (u /1). From data the mean value of alanine aminotransferase reduced by 13.46% (G3) and 28.25% (G4) for groups of mice given a hyperlipidemic diet with coffee beans and peels in comparison with with untreated group (control positive group) G2.

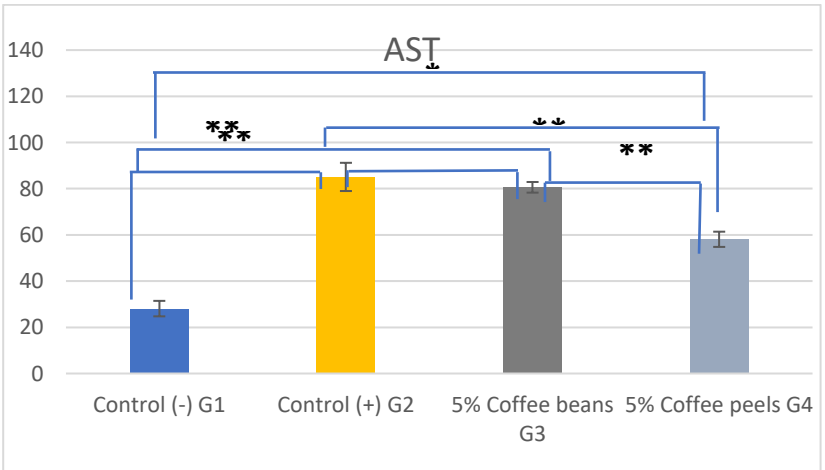

Figure (5). Mean values of AST of mice fed hyperlipidemic diet with coffee beans and peels.

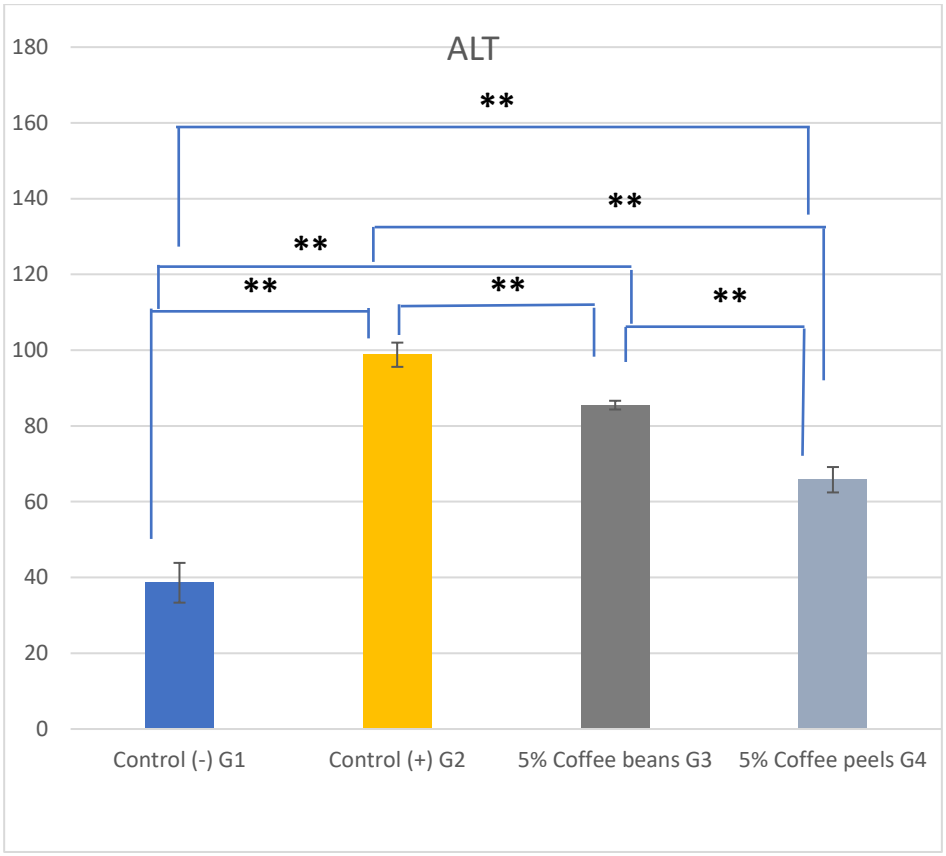

Figure (6). Mean values of ALT of mice fed hyperlipidemic diet with coffee beans and peels.

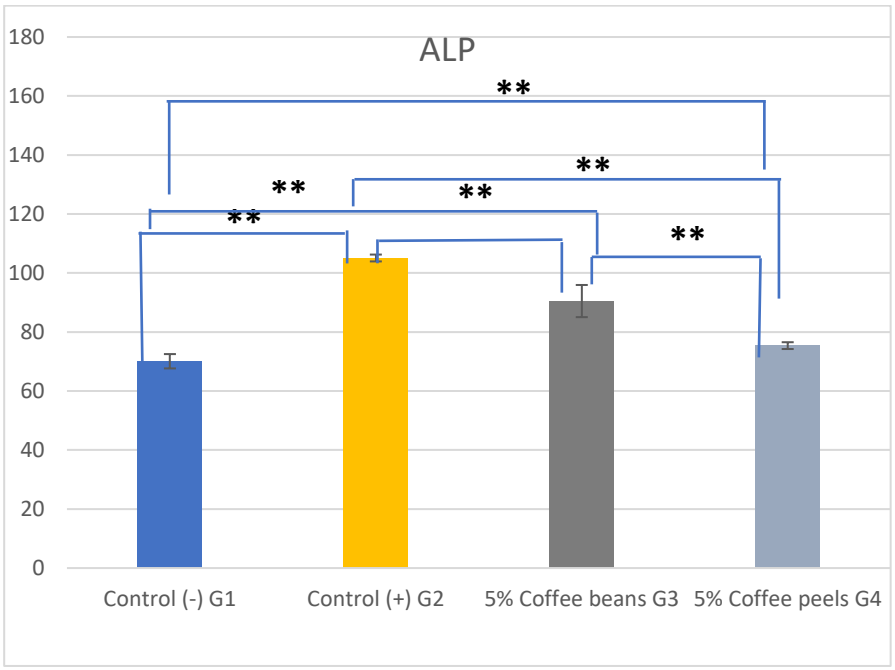

Figure (7). Mean values of ALP of mice fed hyperlipidemic diet with coffee beans and peels.

Effect of coffee beans and peels consumption on kidney function of rats fed on hyperlipidemic diet:
Figure (8 and 9) shows mean value + SD of kidney function of mice fed on hyperlipidemic diet.

Fig (8) illustrated the mean value of renal functions in hypercholesterolemic mice. As shown in this table, the mean values of creatinine in untreated group G2 was increased significantly at (p-value below 0.01) than control negative G1, by means 1.10 ± 0.2 and 0.65 ± 0.3 mg / 100 ml respectively. The mean value of (G3), were reduced significantly at (p-value below 0.05) than untreated group G2, by means 0.88 ± 0.1 mg / 100 ml respectively. Also the mean value of G4 has been decreased significantly at (p-value below 0.01) compared to untreated group G2, this was 0.73 ± 0.1 mg / 100 ml.

From above data the mean values of creatinine reduced by 20.0% (G3) and 33.63% (G4) for mice given a hyperlipidemic diet supplemented with 5% coffee beans and 5% coffee peels with untreated group (hyperlipidemic diet) G2.

In fig (9) the mean values of urea in untreated group (G2) was increased significantly at (p-value below 0.01) than control negative (G1), by means 58.50 ± 0.1 and 36.20 ± 0.2 mg / 100 ml, respectively. The mean values of G3 were reduced than untreated group (G2), by means 54.25 ± 0.1 mg / 100 ml, respectively. Additionally, the mean values of G4 have been decreased significantly at (p-value below 0.05) than untreated group G2, by means 48.25 ± 0.3 mg / 100 ml, respectively. From data the mean values of serum urea reduced by 7.26% G3 and 17.52% G4 for mice fed hyperlipidemic diet supplemented with coffee beans and peels as compared with untreated group (hyperlipidemic diet) G2.

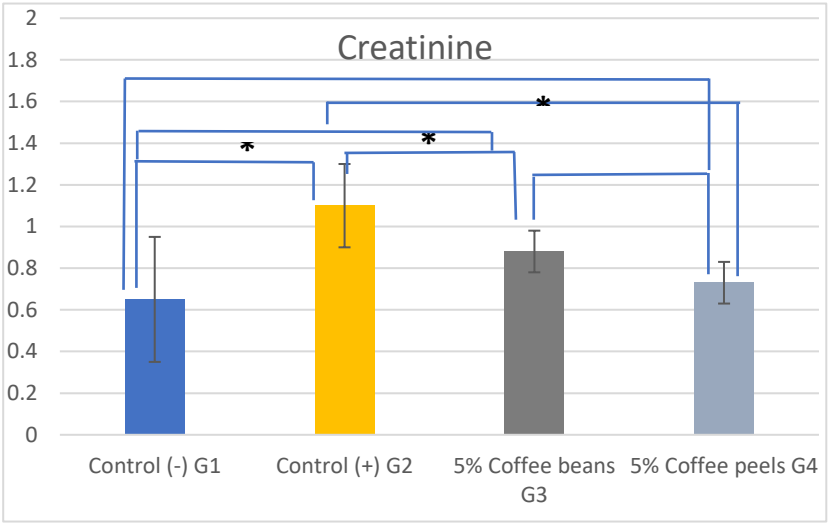

Figure (8). Mean values of serum creatinine of mice given a hyperlipidemic diet with coffee beans and peels.

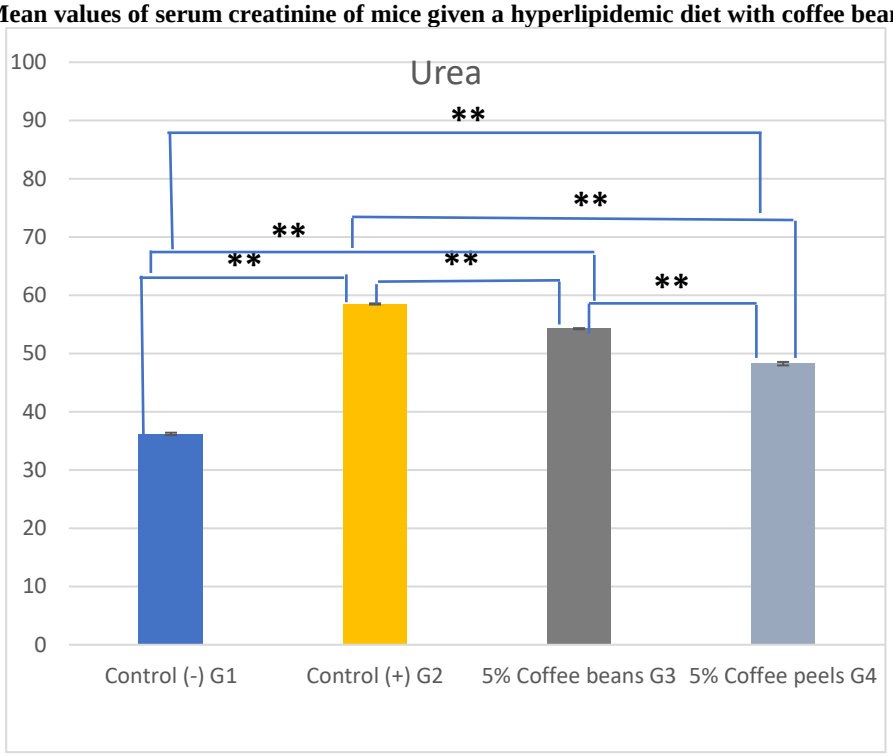

Figure (9). Mean values of Urea of mice fed hyperlipidemic diet with coffee beans and peels.

Effect of coffee beans and peels on some minerals of rats fed hyperlipidemic

Figure (10,11,12, 13and 14) illustrates the mean values of some minerals in hypercholesterolemic rats.

Serum Ca in fig (10) untreated group (G2) was reduced significantly at (p-value below 0.01) than control negative G|, by means 1.6 ± 0.01 and 2.4 ± 0.01 mmol / L, respectively. While the mean values of G3 and G4 have been increased significantly at (p-value below 0.05) than untreated group G2, by means 2.1 ± 0.02 and 2.1 ± 0.03 mmol / L, respectively.

Serum P in fig (11) untreated group (G2) was decreased significantly at (p-value under 0.01) than control negative G1, by means 0.51 ± 0.1 and 0.69 ± 0.2 mmol / L, respectively. Additionally, the mean values of G4 have been increased significantly at (p-

value below 0.01) than untreated group G2, by means 0 0.69 ± 0.3 mmol / L, respectively.

Serum Mg in fig (12) untreated group (G2) was decreased significantly at (p-value under 0.01) than control negative (G1), by means 0.61 ± 0.02 and 0.75 ± 0.02 m mol / L, respectively. The mean values of G4 have been increased significantly at (p-value below 0.01) than untreated group (G2), by means 0.70 + 0.04m mol / L.

Serum Fe in fig (13) untreated group (G2) was decreased significantly at ($p < 0.05$) than control negative G1, by means 60.2 ± 2.3 and 68.3 ±3.3 pg / dl, respectively. The mean values of G3 were reduced compared to control positive, by means 58.29 ± 1.5 pg / dl, respectively. While the mean values of G4 have been increased significantly at (p-value under 0.05) than control positive, by means 65.10 ± 4.5 pg / dl.

Serum Zn in fig (14) untreated group (G2) was reduced significantly at (p-value less than 0.01) than control negative G1, by means 10.4 ± 0.1 and 12.4 ± 0.2 p mol / dl, respectively. The mean values of G3 were reduced compare to control positive, by means 10.3 ±0.1 p mol / dl, respectively.

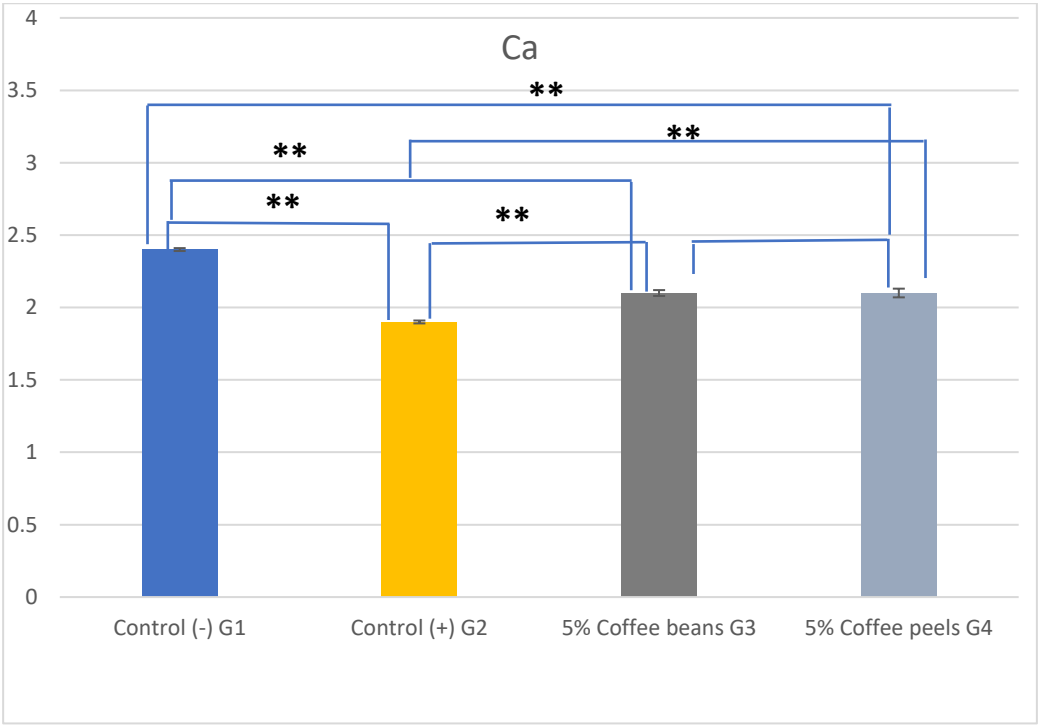

Figure (10). Mean values of serum calcium of mice fed hyperlipidemic diet with coffee beans and peels.

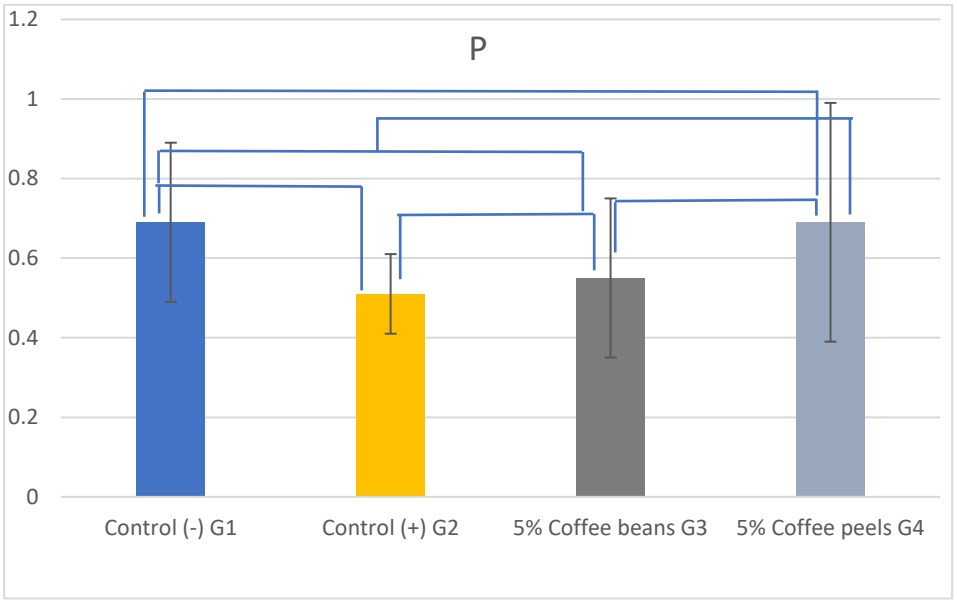

Figure (11). Mean values of phosphorus of mice fed hyperlipidemic diet with coffee beans and peels.

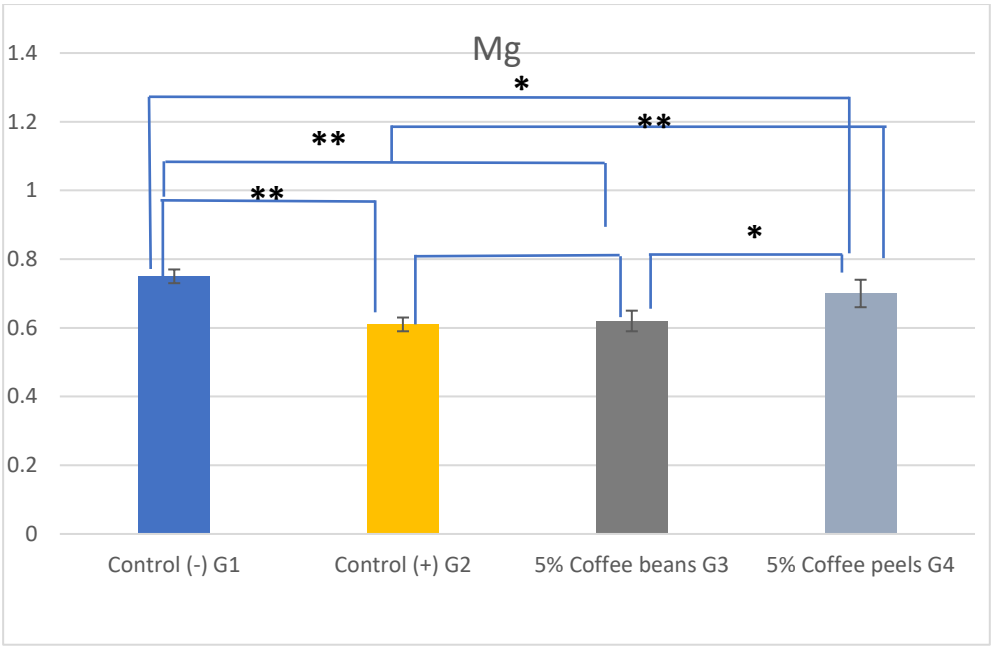

Figure (12). Mean values of magnesium of mice fed hyperlipidemic diet with coffee beans and peels.

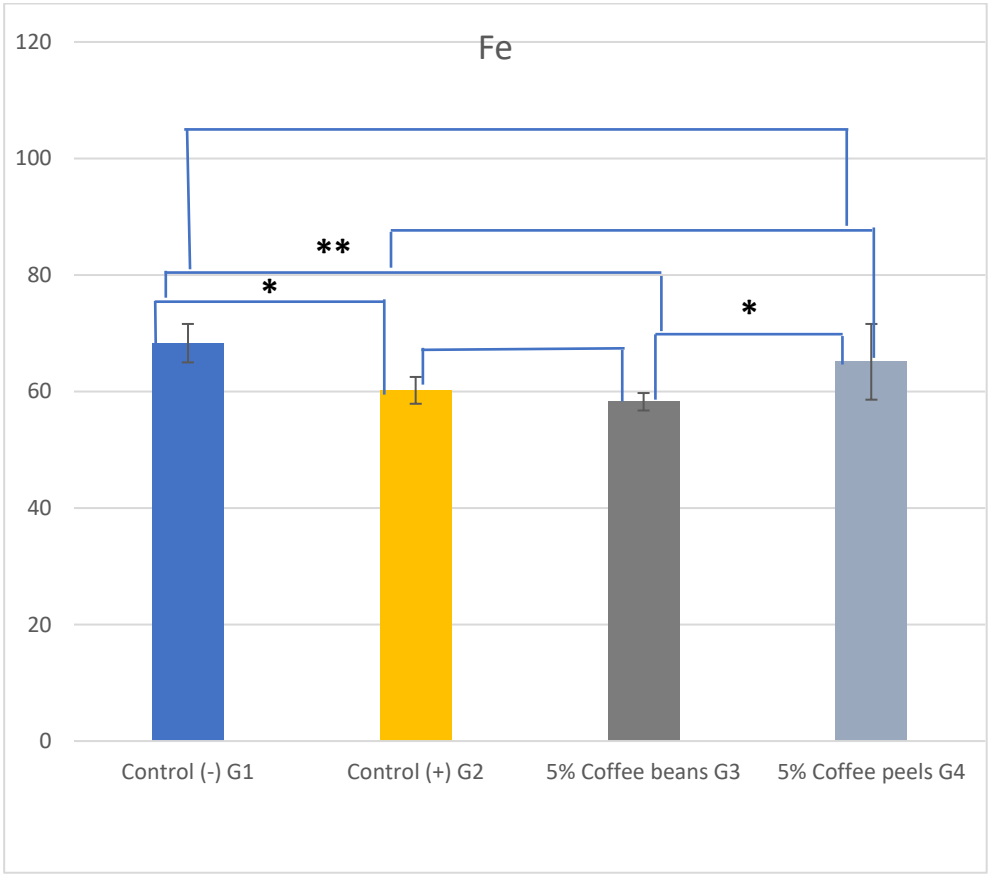

Figure (13). Mean values of iron of mice fed hyperlipidemic diet with coffee beans and peels.

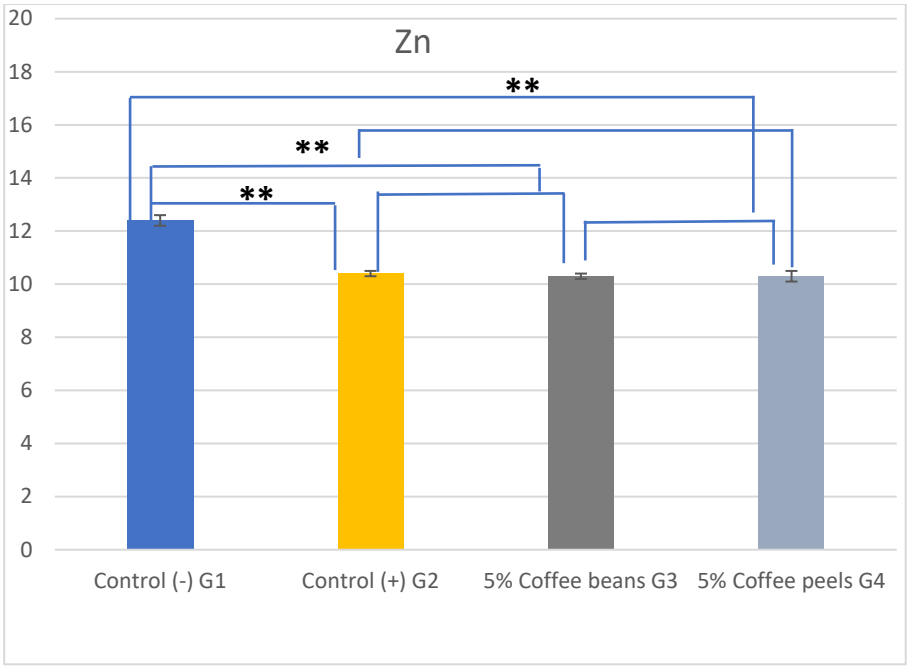

Figure (14). Mean values of zinc of mice fed hyperlipidemic diet with coffee beans and peels.

Effect of coffee beans and peels on serum glucose of rats fed hyperlipidemic diet

The results in fig. (15) showed that the level of serum glucose for control untreated group (G2) has been significantly increased to reach the highest value which being 115.9 ± 2.2 milligrams per deciliter at p-value under 0.05, while the corresponding level for control negative Gi was 95.5 ± 3.5 mg / dl. Serum glucose (mg / dl) values decreased in hypercholestrolemic rat G3 which were 110.4 ± 2.0 mg / dl. But rat groups which consumed 5% coffee peels G4 were decreased significantly at $p < 0.05$ than untreated group G2, by means 98.2 ± 3.5 mg / dl.

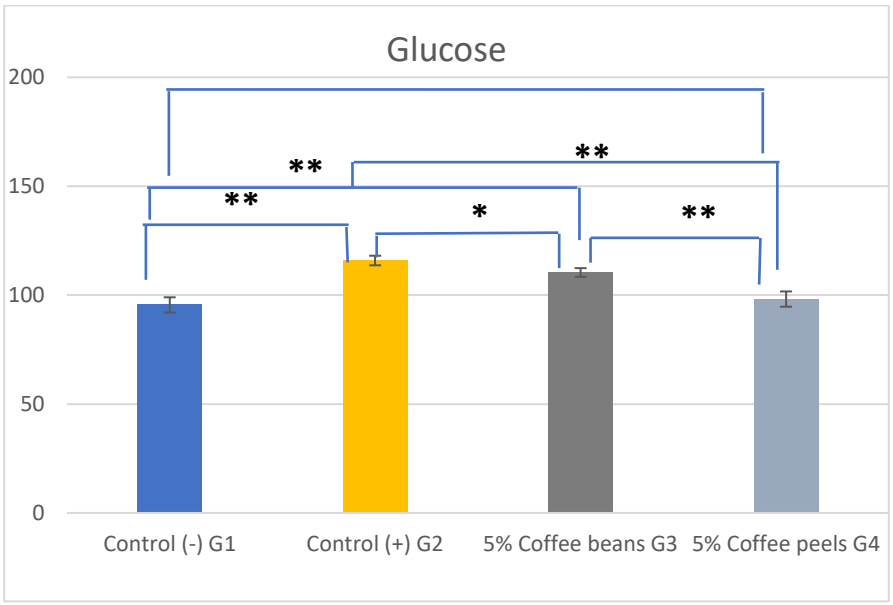

Figure (15). Mean values of serum glucose of mice given a hyperlipidemic diet with coffee beans and peels.

Coffee beans and peels show potential protective effects in hyperlipidemic rats by improving lipid profiles, lowering cholesterol and triglycerides, and increasing HDL levels. Studies indicate that coffee bean extracts can significantly reduce total cholesterol, LDL, and triglycerides, while also decreasing body weight and improving antioxidant status. Coffee peels also demonstrated beneficial effects on biochemical changes, suggesting a potential use in therapeutic formulations. **(Yuniarti et al., 2019).** Coffee peels could be incorporated into dietary supplements or functional foods aimed at supporting heart health and managing lipid levels. Their antioxidant properties may also enhance the body's ability to combat oxidative stress. Additionally, formulations containing coffee peels might be developed to target specific metabolic disorders, offering a natural and holistic approach to treatment. **(Surma et al., 2023).** Coffee extracts may downregulate the expression of Acetyl-CoA carboxylase (ACC), thereby reducing the synthesis of fatty acids. They can also improve the activity of Carnitine Palmitoyltransferase 1 (CPT1), enabling the transport of fatty acids into the mitochondria for oxidation. Additionally, the suppression of fatty acid synthase (FAS) by these extracts could further decrease lipid biosynthesis, contributing to the overall reduction in lipid levels. **(Schoeneck *et al.*,2021).**

Coffee peels contain bioactive compounds, such as polyphenols and antioxidants, that may help regulate glucose and lipid metabolism. These compounds interact with enzymes and pathways involved in sugar and fat breakdown, potentially reducing serum glucose and improving lipid profiles. Additionally, their anti-inflammatory properties may alleviate diabetes-related organ damage, such as liver and kidney disorders. **(Zhang *et al* .,2011)**. Roasted coffee can reduce beneficial compounds like chlorogenic acid, making green coffee bean extracts potentially more effective for hyperlipidemia treatment. While studies show a general trend of improvement, individual results may vary based on factors like the specific coffee type, roasting degree, and extract used **(Kwon et al ., 2011)** Coffee contain of chlorogenic acid is an antioxidant which have a significant role in reducing inflammation and regulating blood sugar levels. It helps to inhibit glucose absorption in the small intestine, which can lead to better blood sugar control. Additionally, chlorogenic acid may help in weight loss through elevating metabolism and improving fat burning processes (**Nihei *et al*. 2018)**. Influence of coffee beans because of the existence of compounds such as diterpenes, which are naturally occurring substances found in coffee beans. These compounds can influence cholesterol levels by affecting the body's production of bile acids and other lipid-regulating processes. **(Feng *et al*. 2010)**. Caffeine contributes to increased lipolysis (fat breakdown), improved blood pressure, and anti-inflammatory responses. (**Christianty *et al*. 2020)**. Chlorogenic Acid (CGA) Most abundant in green (unroasted) coffee beans and peels, CGA is a primary driver of the hypocholesterolemic, cardioprotective, and hepatoprotective effects observed. **(Wan *et al*. 2012**). Moreover, the extracts have been observed to diminish lipid peroxidation in both aorta and plasma during in vivo investigations. Although considerable study has been conducted on coffee pulp and coffee bean extracts regarding the digestion and absorption of lipids, the influence of coffee leaves has mostly been uninvestigated. The knowledge gap is significant, especially as the primary bioactive compounds, like caffeine and chlorogenic acids (CGAs), differ in concentration across coffee leaves and different portions of the coffee plant. **(Wanderley Dong Affoso *et al*. 2017**). Avocados are generally healthy for people with healthy kidneys, but individuals with kidney disease should be cautious because avocados are high in potassium. For those with kidney disease, a doctor or renal dietitian can help determine appropriate portion sizes to manage potassium intake, which is crucial for heart and muscle function. **(Wanderley Dong *et al*. 2015**). Although coffee extracts, involving those derived from pulp, leaves, and beans, are helpful in lowering levels of cholesterol, regular coffee consumption doesn't result in reduced blood cholesterol levels in comparison with non-consumption. Moreover, specific investigations have found that those who drink coffee without sugar and milk generally show elevated cholesterol levels in comparison with non-coffee consumers. This correlation can be related to the diterpenes in coffee oil, particularly kahweol and cafestol, present in coffee beans. The precise mechanism by which kahweol and cafestol affect cholesterol levels remains unclear. In vitro investigations have yielded inconsistent findings across various cell lines. Consequently, to optimize the cholesterol-lowering efficacy of coffee, processing, special extraction, or appropriate brewing techniques can be required. **(Affonso et al .,2016)**

CONCLUSION

In conclusion, the outcomes showed a significant improvement in blood lipids in rats with hyperlipidemia, as well as an improvement in overall functional status in the affected rat where. These results facilitate the utilization of coffee beans and coffee arabica peels as functional ingredients in dietary strategies for the management of hyperlipidemia and obesity, providing a natural and available method for enhancing cardiovascular health.

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