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### Effects of Alcoholic Extracted and Dry Eggplant (*Solanum Melongena*) on Hyperlipidemia Treatment in Rats

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#### Abstract

This study was carried out to investigate the potential of crude ethanolic extracts of eggplant (*Solanum melongena*) peels, fruit, and seeds, as well as dry eggplant, in the treatment of hyperlipidemia in rats. Forty-nine adult female Sprague Dawley rats were used with a weighting between (280-340) grams. Following the establishment of hyperlipidemia by providing them with a high-fat diet consisting of 4% cholesterol with 5% egg yolk for a period of 30 days in all groups except the control negative. Afterward, the rats were divided into seven groups of 7 rats as followed: The first group control negative was given standard pellets and water only, and the second group control positive induction hyperlipidemia this applied to all groups. Other groups (third, fourth, and five) were administered with alcoholic extracts of *Solanum Melongena* parts including the peel group, fruit group, and seed group, at a dose of 400 mg/kg/B.W. orally once a day, and group six received dry eggplant without extract at a dose of 200 mg/kg/diet once daily. The seven groups received atorvastatin at a dose of 20 mg/ B.W. orally once daily for a period of 45 days for all groups. The results of the study on serum lipid profile in rats indicated that the peel and atorvastatin groups exhibited a significant decrease in levels of total cholesterol (TC), triglyceride (TG), low-density lipoprotein (LDL), and low-density lipoprotein (VLDL). Furthermore, the peel and atorvastatin groups had substantially elevated high-density lipoprotein (HDL) levels. The study suggests that eggplant peel extract and atorvastatin, a common drug, can potentially treat hyperlipidemia in rats. **Keywords: Atorvastatin, Cholesterol, Egg yolk, Extract alcoholic eggplant and dry, Hyperlipidemia.**

#### Introduction

In terms of nutrition, eggplant is low in calories and abundant in vitamins, bioactive chemicals, and phenols. Potassium, Calcium, Magnesium, Phosphorus, Sodium, Iron, Copper, and Zinc are among the minerals found. Brinjal is a good source of antioxidants such as flavonoids, anthocyanins, ascorbic acid, and proteins polyphenylene peroxidases (PPO), and it has a high moisture content and low caloric value [1,2].

Medicinally the extracts of *Solanum melongena* are effective against several diseases, Antidiabetic, antioxidant,

hypolipidemic agent, Anti-inflammatory, and Vasodilator[3].

The condition known as hyperlipidemia or atherosclerosis, which is one of the biggest causes of death globally and is recognized to be the main risk factor for cardiovascular disease, is characterized by abnormally high lipid levels in the blood, such as fat, triglycerides, and cholesterol. High blood lipid levels, or hyperlipidemia may be brought on by several things, such as heredity, nutrition, and certain medical problems or medications [4]. Lipoproteins, such as HDL, LDL, chylomicrons, and VLDL, are

responsible for carrying lipids in the bloodstream, and their accumulation can lead to the development of hyperlipidemia. Atherosclerosis, the buildup of fatty deposits in blood vessels, is primarily caused by LDL-bound cholesterol, whereas HDL-bound cholesterol is beneficial for heart health as it helps to remove excess lipids or even retards the buildup of such a condition. Often elevated levels of both LDL and triglycerides result in hyperlipidemia [5]. The present study aimed to treatment of hyperlipidemia by crude ethanolic extracts of peels, fruit, and the seed of *Solanum melongena* and dry eggplant comparing with atorvastatin in rats.

### Materials and Methods

#### Animal ethical approval

All procedures used in this study were reviewed and approved by the Scientific Committee of the College of Veterinary Medicine, University of Kufa in compliance with the ethical principles of animal welfare with reference number UK.VET.2023.11202.

#### Collection of Plant Material and Preparation of Extract

The study focuses on the eggplant, which is a seasonal herb from the Solanaceae family with the scientific name *Solanum melongena*. It has a dark purple or black appearance and was obtained from the local market in Kufa, Najaf Governorate, Iraq on 7/27/2022. The eggplants were washed, separated into peels, fruits, and seeds, and left to dry at room temperature for 15 days. Finally, they were ground into a fine powder using a blender, ready for alcoholic extraction.

Fifty grams of peels, fruits, and seeds eggplant powder was added to 500 ml of 70% ethanol and mixed thoroughly using a magnetic stirrer for 24 hours according to [6]. The extract was first purified using gauze, then filtered using Whatman No. 1 filter paper, and then concentrated using a rotary evaporator at reduced pressure and 40°C. The resulting yield was stored in the refrigerator for further analysis.

#### Dry Eggplants Without Extraction

The whole eggplant was cut into pieces and left to dry at room temperature for 20 days and then ground into a fine powder using a blender [7].

### Animals

A total of 49 adult female white albino rats, Sprague Dawley Strain with body weights ranging from 280 to 340 grams were used in the study. It was purchased from the Faculty of Veterinary Medicine, University of Tikrit. The rats were kept in clean cages within the animal housing facility at the College of Science, University of Kufa. They were maintained in an 8–16-hour dark/light cycle and allowed full access to normal laboratory food and water. The animals were given two weeks to acclimate to optimum conditions before the start of the experiment.

#### Induction Hyperlipidemia

Hyperlipidemia was induced in (42 female rats) Sprague Dawley Strain by providing them with a high-fat diet consisting of 4% cholesterol [8] with 5% egg yolk for four weeks [9].

#### Therapeutic Study

49 adult female rats were divided into 7 groups, with each group consisting of 7 rats. The period of treatment was (45 days). **G.1:** The control negative group, received only standard pellets and water. **G.2:** The positive control group, induced hyperlipidemia and was not treated. **G.3:** The peel group, was administered an alcoholic extract of peel eggplant at dose 400 mg/kg/B.W. orally once daily. **G.4:** The fruit group, was administered alcoholic extract of fruit eggplant at dose 400 mg/kg/B.W. orally once daily. **G.5:** The seed group, was administered alcoholic extract of seed eggplant at dose 400 mg/kg/B.W. orally once daily. **G.6:** The dry group, was administered dry eggplant without extract at dose 200 mg/kg/diet. orally once daily. **G.7:** The atorvastatin group, was administered atorvastatin at dose 20 mg/kg/B.W. orally once daily.

The groups that were treated with alcoholic extracts (peel, fruit, and seed of eggplant) *solanum melongena* were administered orally daily after induction hyperlipidemia with a concentration at dose 400 mg/kg body weight of the three extracts [10]. Dry eggplant was given at dose 200g/kg of diet powder, dry eggplant is collection of peel, fruit, and seed [11]. Atorvastatin was administered at a dose of 20 mg/BW [12].

After the final treatment period, the rats were anesthetized by giving a mixture of xylazine and ketamine. This allowed for the safe and efficient collection of (3ml) blood samples from each rat via the cardiac puncture technique, using a disposable syringe. The blood was then transferred into a gel tube to separate the serum. The serum was obtained through the process of centrifugation (3000 rounds/10 minutes) of the blood sample and was subsequently stored in a freezer until it was needed for measuring the designated parameters.

#### **Lipid profile assay**

The concentrations of triglycerides (TG), very low-density lipoprotein cholesterol (VLDL), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), and total cholesterol (TC) in serum were measured according to Biolabo and Biosystem kit.

The concentration of serum very low-density lipoprotein-cholesterol was determined by multiplying serum TG by 5 (VLDL-C concentration(mg/dL) = TAG/5)[13].

The following formula was used to determine the serum low-density lipoprotein-cholesterol concentration: LDL-C concentration(mg/dL) =TC-(HDL-C+VLDL-C)[13].

#### **Statistical analysis**

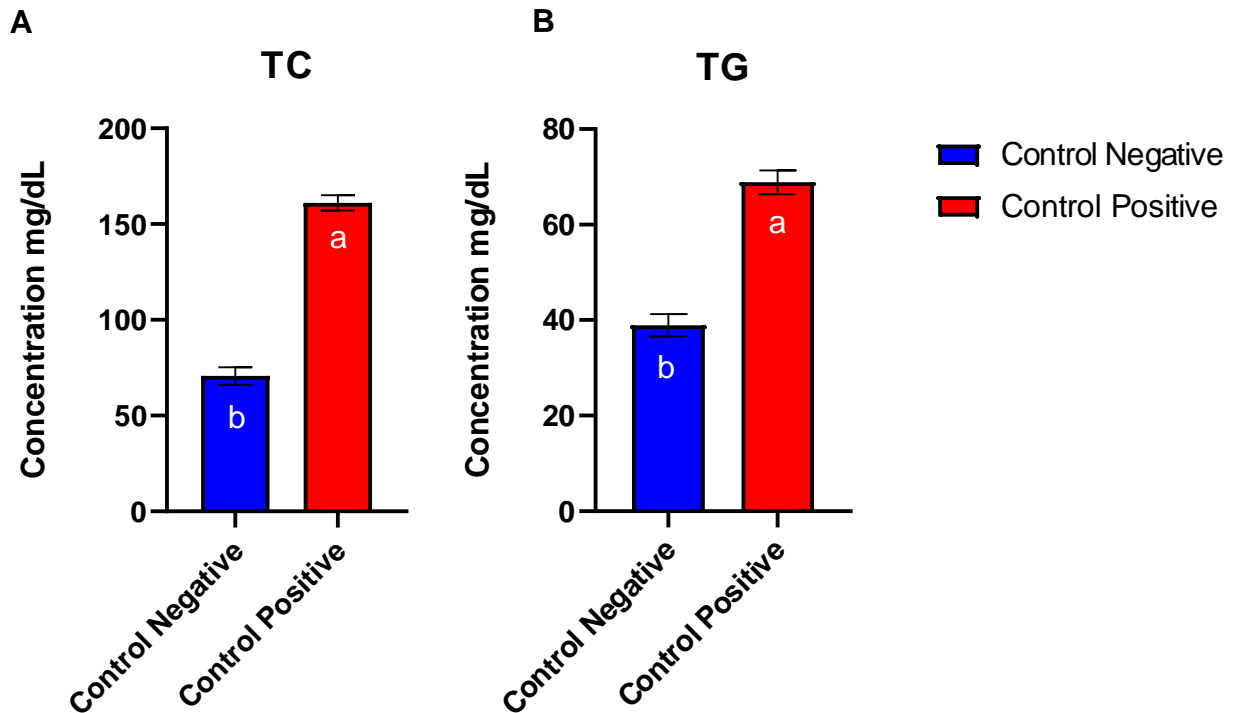
GraphPad Prism version 8.0.2 (263) was used to do the statistical analysis of the experimental data. One-way ANOVA were employed to assess the significant differences within and between groups. The results were presented as mean  $\pm$  standard errors (SE), and statistical significance was defined as a  $P < 0.05$ .

#### **Results**

##### **Induction of Hyperlipidemia:**

##### **Measurement of total cholesterol and triglyceride in positive group and control negative.**

The results shown an increase significant difference ( $P \leq 0.05$ ) in all groups of rats that induce hyperlipidemia compared with the control negative as in (figure 1)



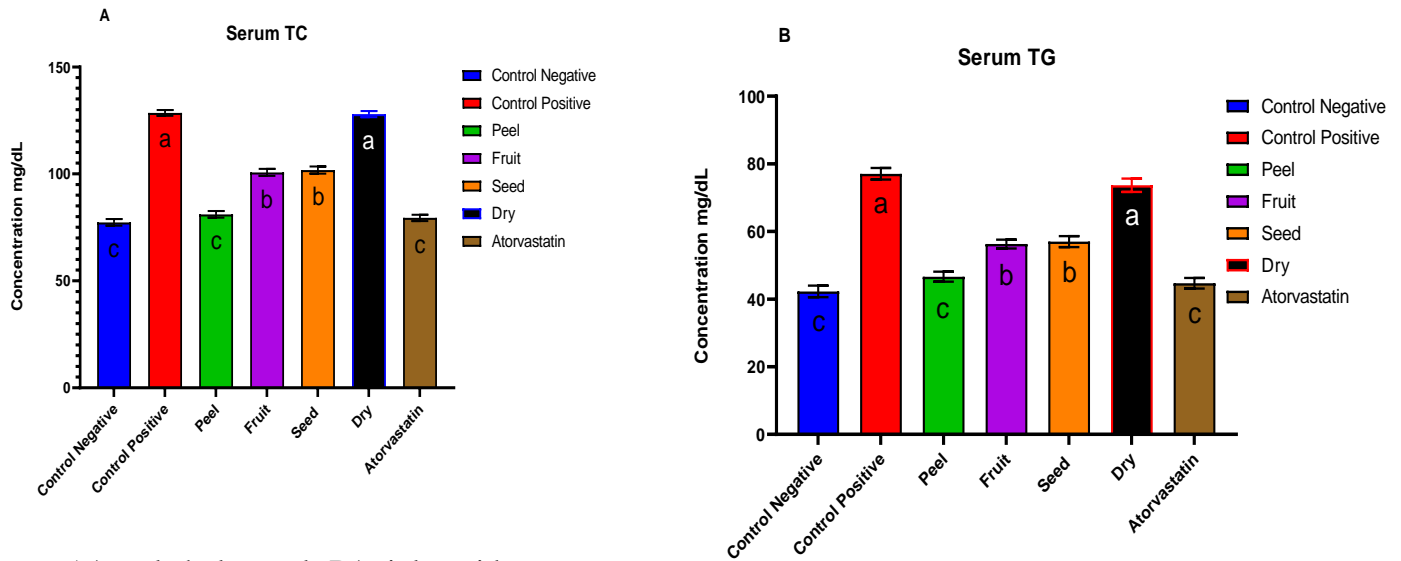
-A/ total cholesterol -B/ triglyceride -The different small letters denoted significance between groups,  $P < 0.05$ .

**Figure 1.** The concentration of total cholesterol and triglyceride in positive group and control negative, presenting a significant difference ( $P \leq 0.05$ ) positive group of rats that induce hyperlipidemia compared with the control negative using GraphPad Prism One-way ANOVA

**Determination of serum lipid profile:  
Measurement of total cholesterol and triglyceride in all hyperlipidemic groups and control negative.**

The results shown more a significant decrease ( $P \leq 0.05$ ) in the level of TC and TG of peel and atorvastatin groups rat than fruit and

seed groups compared with the positive group and when comparing the dry eggplant group with the control positive there is a non-significant difference while the compared the peel and atorvastatin groups, with control negative group there is no any significant difference as in (figure 2).



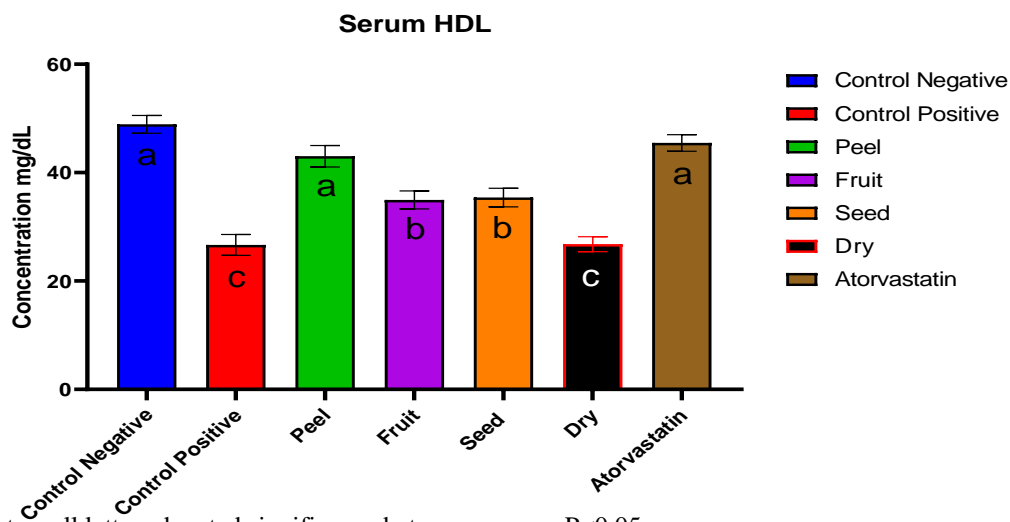
-A/ total cholesterol -B/ triglyceride

-The different small letters denoted significance between groups,  $P < 0.05$ .

**Figure 2.** The concentrations of total cholesterol and triglyceride in all hyperlipidemic groups and control negative, a significant decrease ( $P \leq 0.05$ ) in the level of TC and TG of peel and atorvastatin groups rat than fruit and seed groups compared with the positive group and when comparing the dry eggplant group with the control positive there is a non-significant difference using GraphPad Prism One-way ANOVA.

**Measurement of high-density lipoprotein in all hyperlipidemic groups and control negative.**

The results showed a significant increase ( $P < 0.05$ ) in the level of HDL of peel and atorvastatin groups compared to control positive and dry eggplant. while comparing the treated group's fruit and seed increase significantly from the peel group, when compared with the negative group (figure 3).



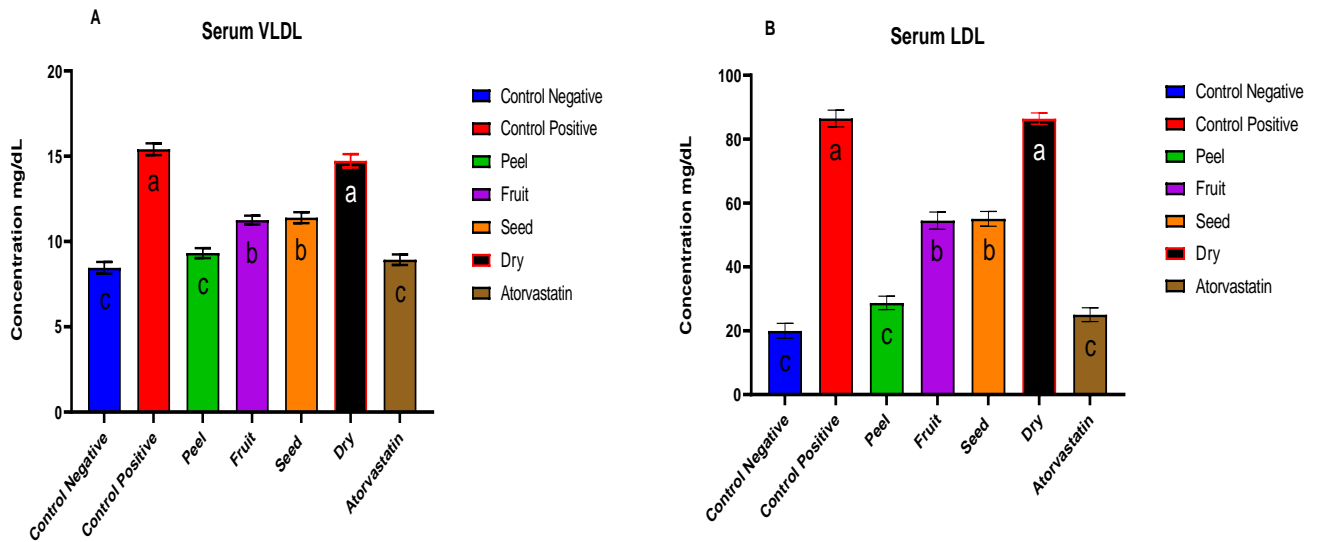
-The different small letters denoted significance between groups,  $P < 0.05$ .

**Figure 3.** The concentrations of high-density lipoprotein in all hyperlipidemic groups and control negative, a significant increase ( $P < 0.05$ ) in the level of HDL of peel and atorvastatin groups compared to control positive and dry eggplant. while comparing the treated group's fruit and seed increase significantly from the peel group, when compared with the negative group.

**Measurement of low-density lipoprotein and very low-density lipoprotein in all hyperlipidemic groups and control negative.**

The results showed more a significant decrease ( $P < 0.05$ ) in the level of TC and TG of peel and atorvastatin groups rat than fruit and seed groups compared with the positive group and when comparing the dry eggplant group

with the control positive there is a non-significant difference while the compared the peel and atorvastatin groups, with control negative group there is no any significant difference (figure 4).



-A/ very low-density lipoprotein -B/ low-density lipoprotein  
 -The different small letters denoted significance between groups,  $P < 0.05$ .

**Figure 3.** The concentrations of low-density lipoprotein and very low-density lipoprotein in all hyperlipidemic groups and control negative, a significant decrease ( $P < 0.05$ ) in the level of TC and TG of peel and atorvastatin groups rat than fruit and seed groups compared with the positive group and when comparing the dry eggplant group with the control positive there is a non-significant difference.

**Discussion**

cholesterol ( $C_{27}H_{46}O$ ) is used to induce hyperlipidemia, it is induced easily, uses of ( $C_{27}H_{46}O$ ) because it is perfect, easy, available, and less dangerous than other chemicals and it gets results during four weeks. Leading to changes in hepatic lipid metabolism. Specifically, the activity and mRNA expression of the enzymes involved in lipid metabolism were found to be affected by dietary cholesterol. they recorded that the ( $C_{27}H_{46}O$ ) in addition to egg yolk will induce hyperlipidemia perfectly[14]. These changes in hepatic lipid metabolism may contribute to the development of hyperlipidemia and its associated complications [15]. The mechanism by which cholesterol induces hyperlipidemia in rats is complex and involves multiple pathways. One of the primary mechanisms is the upregulation of the activity and expression of enzymes involved in lipid metabolism in the liver. This leads to increased production of

very-low-density lipoprotein (VLDL) particles in the liver, which transport lipids to other tissues in the body. The increased production of VLDL particles, coupled with impaired clearance of lipids from the circulation, results in an accumulation of lipids in the blood, leading to hyperlipidemia [16,17].

The study aimed to evaluate the antihyperlipidemic activity of eggplant alcohol extract, dry eggplant non-extract, and atorvastatin in hyperlipidemic rats. Hyperlipidemia is a medical condition characterized by elevated levels of lipids (fats) in the bloodstream, particularly cholesterol, and triglycerides. It is a major risk factor for cardiovascular diseases such as heart attack and stroke [15]. The study found that hyperlipidemic rats treated with eggplant peel extract exhibited significant improvement in their lipid levels. Specifically, there was a

reduction in total cholesterol, triglycerides, and low-density lipoprotein (LDL) cholesterol levels, and an increase in high-density lipoprotein (HDL) cholesterol levels [18]. These changes are considered beneficial for cardiovascular health, as high LDL and triglyceride levels and low HDL levels are associated with an increased risk of cardiovascular disease. The researchers attributed the antihyperlipidemic activity of the eggplant peel extract to its high content of anthocyanins, which are natural pigments with antioxidant and anti-inflammatory properties. Anthocyanins are primarily found in the skin of fruits and vegetables, and the eggplant peel is particularly rich in these compounds [19,20]. The eggplant fruit and seed extracts also exhibited some antihyperlipidemic activity, although the effect was less significant than that observed with the eggplant peel extract [21]. However, the study also found that dry eggplant replacement therapy did not demonstrate any significant improvement in lipid levels compared to the positive control group. This result contradicts previous findings that suggested dry eggplant might have beneficial effects on lipid levels [11]. Finally, atorvastatin is a conventional therapy for hyperlipidemia. Atorvastatin more common drug inhibits HMG-CoA reductase, an enzyme responsible for the synthesis of cholesterol in the body. By reducing cholesterol production, atorvastatin can effectively lower lipid levels in the bloodstream [22].

### Conclusions

Based on the findings and analysis presented in this study, it can be inferred that cholesterol ( $C_{27}H_{46}O$ ) that use with fat food to induce hyperlipidemia in rats. The study suggests that alcoholic extract of peel and atorvastatin have the potential to treat hyperlipidemia in rats while the fruit and seed extract has less effects and no effect by eggplant dry compartment with atorvastatin.

### Conflict of interest

The researchers declare that there is no conflict of interest in the publication of this paper.

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