# THERAPEUTIC EFFECTS OF DRIED PERSIMMON CONSUMPTION WITH DIET AGAINST TRITON X-INDUCED HYPERLIPIDEMIA IN MALE RATS

*By*


*Abd El-Ghany, M.A*
*Department of Home Economics,*
*Faculty of Specific Education,*
*Mansoura University, Egypt*

*Ramadan,Afaf-Haniem.M*
*Department of Home Economics,*
*Faculty of Specific Education,*
*Mansoura University, Egypt*

*Nagib, R.M*
*Department of Home Economics,*
*Faculty of Specific Education,*
*Mansoura University, Egypt*

*Fayza. M. EL-Ezaly*
*Department of Home Economics,*
*Faculty of Specific Education,*
*Mansoura University, Egypt*



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# Therapeutic effects of dried persimmon consumption with diet against Triton X-induced hyperlipidemia in male rats

*Abd El-Ghany, M.A** *Ramadan,Afaf-Haniem.M**

*Nagib, R.M** *Fayza. M. EL-Ezaly**

## *Abstract*

The present investigation assessed the effect of consuming dried whole persimmon , pulp and peel on blood lipid-lowering in male rats .Thirty six adult male Sprague Dawley rats weighting (128 ± 5 g) were divided into six groups (6 rats each) : six was acted as negative control group receiving only a basal diet and other rat groups were injected with Triton X 100 (100 mg/kg) plus diet and redivided into a positive control group fed on basal diet and four groups which treated with 4.5 mg/kg atorvastatin drug , treatment group by given (100 mg/kg basal diet) of dried persimmon whole, pulp, and peel for 60 days. Compared with the negative control, Triton X 100 group(+ve) showed that the significantly reduced in weight gain , feed efficiency, HDLc , total protein, globulin, and activities of superoxide dismutase and glutathione peroxidase, while significant elevating in total cholesterol, triglycerides, LDLc, VLDLc, total lipids, phospholipids, AST, ALT, albumin/globulin ratio, and malondialdehyde. However, all groups consumed persimmon exhibited marked improvements in weight gain, feed efficiency, HDLc, total protein, globulin, and antioxidant enzyme activities, increased, whereas serum lipids, liver enzymes, albumin/globulin ratio, and MDA levels declined toward normal, this results were similar to group treated with hyperlipidemic drug. Histopathological examination confirmed biochemical results. The cardiac examinations of all groups that consumed persimmon, pulp, and peel showed significant improvement compared to positive control group. These findings suggest that dried whole persimmon, pulp, and peel may help manage hyperlipidemia and oxidative stress, supporting their inclusion in heart-healthy diets.

**Key words:** Persimmon, Triton x100, Hyperlipidemic rats

* Department of Home Economics, Faculty of Specific Education, Mansoura University, Egypt

## INTRODUCTION

Hyperlipidaemia constitutes a significant risk factor for cardiovascular diseases, contributing to considerable morbidity and mortality on a global scale. Hyperlipidemia is a term that encompasses various genetic and acquired disorders that describe elevated lipid levels within the body. It is a very common disorder, especially in the Western hemisphere, but also throughout the world. Hyperlipidemia itself does not typically lead to critical symptoms itself, however, having this underlying pathology will often lead to serious illnesses that may ultimately lead to death. To lower morbidity and mortality rates associated with this disorder, it is critical to establish an early diagnosis and prevent the progression of the disease this chronic condition is characterized by elevated plasma lipoprotein levels. Notably, patients who have undergone hematopoietic stem cell transplantation (HSCT) exhibit a markedly high incidence of hyperlipidaemia., hyperlipidaemia has been demonstrated to induce alterations in the pharmacokinetic and pharmacodynamic profiles of lipoprotein-bound pharmaceuticals. **(Khalil et al.,2017 and Haonan Qian et al., 2025).)** Hyperlipidemia, amedical condition characterized by an elevation of one or all lipid profile in blood. This medical condition divided into two subtypes which are: primary and secondary hyperlipidemia at primary hyperlipidemia which is usually taken place as a result of genetic problems such as mutation within receptor protein, while secondary hyperlipidemia will arises as a result of other underlining diseases like diabetes. Alteration or abnormality in the metabolism of lipid and lipoproteins is a very common condition that taken place within general population, and it consider as one of the main risk factor in the incidence of cardiovascular disease due to their influence on atherosclerosis **(Bassam Abdul Rasool Hassan., 2013)**

**Triton X-100**, a non-ionic surfactant, is not a drug itself, but it's used in research to induce hyperlipidemia in animal models. It works by inhibiting lipoprotein lipase, which is responsible for breaking down lipoproteins in the blood, leading to a buildup of lipids and increased

cholesterol and triglyceride levels and promotes increased cholesterol synthesis in the liver and enhanced fat absorption from the gut through emulsification, leading to elevated blood lipid levels by preventing the absorption of lipoproteins by extra hepatic tissues This makes Triton X-100 useful for studying the effects of hyperlipidemia and testing potential treatments for the condition. Triton X-100 is not typically used as a direct drug but can be used in the formulation and manufacturing of some drugs and vaccines (**Kumar,et al.,(2010)**

Diospyros kaki is a fruit abundant in high-value biomolecules, both in its pulp and foliage, which exhibit a plethora of beneficial properties, including anti-inflammatory, anti-atherosclerotic, hypocholesterolemic, antioxidant, antidiabetic, and anticancer activities Dried persimmons in various forms institute the most significant processed products derived from persimmons. They captivate consumers and global markets alike due to their versatility as both a valuable ingredient in diverse culinary preparations and as a convenient snack. The drying process effectively inhibits the proliferation of microorganisms and curtails biochemical reactions, thereby extending the availability of this fruit year-round. Dried persimmons have been the subject of extensive research, with various persimmon formats and drying techniques employed to produce items that boast excellent sensory and nutritional qualities. **(.Lydia Ferrara 2021 and Hosseininejad et al., 2022).** The Persimmons have been shown to significantly improve lipid metabolism and manage cholesterol levels, diet supplemented with persimmon significantly reduced plasma cholesterol, LDL-c, triglycerides and lipid peroxides compared to cholesterol-only diet. The persimmon-supplemented diet also mitigated the decrease in HDL phospholipids (HDL-PH) caused by dietary cholesterol, the persimmon tannin, a high molecular weight component, played a crucial role in reducing serum triglycerides and free fatty acids, enhancing triglyceride and cholesterol excretion, and improving hepatic steatosis in rats fed a high-fat diet (**Bo Zou.,et al 2014**)

## MATERIALS AND METHODS

### A – Materials

**1-:** Triton x100 drug, Methanol, diethyl salphoxid, physiological saline solution and Distilled water were purchased from El-Gomhoria Company for chemicals, El-Mansoura city, Egypt

**2**- Atorvastatin drug was obtained from Egyphar Company, Obour City. Egypt as tablets drug is white yellow, carrier of starch. Each tablets contains 40 mg of atorvastatin .The human therapeutic dose of drug was 40 mg daily which converted to animal dose (4.5 mg/kg) according to previous studies as that recorded by **Paget and Barnes, (1964).**

**3**-Persimmon fruits (*Diospyros kaki L*), were purchased from the local market of Meet Ghamr city, Egypt

**4-Experimental animals:**

Thirty adult albino male rats Sprague –Dawley strain were purchased from the Agricultural Research Center, Giza, Egypt. The average weight was 128 ±5 g. The animals were kept under observation for five days before experiment and fed on basal diet according to **NRC, (1995**) and water *ad-libitum*. The basal diet comprised of casein (200g/kg), corn starch (497g/kg), sucrose (100g/kg), cellulose (30 g/kg), corn oil (50g/kg), mineral mixture (100g/kg), vitamins mixture (20g/kg) and DL-methionine (3g/kg).

### B- Methods:

**1- Preparation of persimmon samples;**

Persimmon cultivars "Hachiya " The samples whole were washed, cleaned, and cut with a plastic knife ,and also samples of pulp were cut with a plastic knife while samples of peel were washed, cleaned and cut with a plastic knife and all samples dried Electric oven at 50°C and ground In mill to convert it into powder **[AOAC]. (2005).**

**2- hyperlipidemic albino rats**

hyperlipidemia was induced in Wistar albino rats by single intra peritoneal injection of freshly prepared solution of Triton-X-100 (100

mg/kg) in physiological saline solution after overnight fasting for18 h for 7 days **(Vasu Keshetty et al., 2009)**

**3-** Grouping of rats and experimental design:

The rats were randomly classified into six groups (6 rats each) and fed on the basal diet. The rats classified into control negative (–ve) group and five rat groups which injected triton x100 (100 mg/kg ip) and reclassified into untreated control positive (+ve),and treated groups which were atorvastatin tablets (4.5 mg/kg b.w) dissolved in 10 ml of normal saline daily, whole pulp , peel and persimmon dry (100g/kg basal. diet). The study was assigned for 60 day. The rats were subjected daily to physical examination for observation of healthy condition such as external appearance, color of hair, body condition and activity of rats. The food intake was calculated daily and the body weight gain was recorded weekly Feed efficiency ratio was determined according to the method of **Chapman et al., (1950)** All biological experimental procedures were conducted in accordance with internationally accepted ethical guidelines for the care and use of laboratory animals. Approval for the experiment was obtained from the Research Ethics Committee at the Faculty of Specific Education, Mansoura University.

**4- Collection of blood and heart samples:**

At the end of the experiment period, the rats were anaesthetized by diethyl ether and sacrificed to obtain blood samples of each rat were withdrawn in test tubes The tubes of blood were left for coagulation then centrifuged at 3000 rpm for 15 minutes to obtain serum for each individual sample and then stored at -20 °C for some laboratory analyses. Heart of male rats was rapidly removed.

**5-Determination of some of serum biochemical parameters:**

Estimation of serum total cholesterol, triglyceride (TG), high density lipoprotein cholesterol (HDLc) and total .lipids were estimated by using the spin react enzymatic kits according to **Young (2001), David and Buccolo (1973) ,Tietz (1976), Lee and Nieman (1996)** respectively Serum Low density lipoprotein cholesterol (LDL-c) and very low density lipoprotein

cholesterol (VLDL-c) were calculated by the equation described by **Friedwald et al. (1972).**While Phospholipids and Atherogenic indices were calculated according to **Lee & Nieman (1996)** and **Castelli & levitar, (1977)** respectively**.**Determination of some serum antioxidants enzymes as glutathione peroxidase GSH-PX , superoxide dismutase SOD, Malondialdehyde (MDA) according to **Paglia and Valentine et al ., (1967**),**Nishikimi et al.,( 1972) and Satoh (1978*).***respectively alanine and aspartate aminotransferase enzymes activity (ALT & AST) **,** Serum total protein **,** Serum albumin(A) , serum globulin (G) **,** A/G ratio according to **pappas (1989), Henry (1964) ,Doumas and Waston (1971) ,Coles (1974) , Friedwald et al.,(1972).** respectively serum creatnine and uric acid was determined by enzymatic colorimetric method according to Young **(2001) and Fossati et al., (1980) ,** Serum globulin (G) was determined by subtracting the albumin from the total proteins according to **Coles (1974).**

**7-Histopathological examination of the heart**

The heart sample was fixed in 10% neutral buffered formaldehyde solution at pH 7.5 and cleared in xylol and embedded in paraffin. 4-5 µm thick section were prepared and stained with Hematoxylin and Eosin (H&E) for subsequent histopathological examination according to **Bancroft et al, (1996)**.

***C-Statistical analysis***

All the obtained data were statistically analyzed by SPSS computer soft ware. The calculated occurred by analysis of variance ANOVA and follow up test LSD by SPSS ver.11 according to **Artimage and Berry (1987)**.

**RESULTS AND DISSCUSION**

**1-**Nutritional outcomes, including feeding and growth performance indicators such as feed intake, body weight gain, feed efficiency ratio, and the relative weights of the liver, kidney, and heart, are presented in figure 1 (a, b, and c). These parameters were evaluated in hyperlipidemic rat groups treated with atorvastatin, whole persimmon, persimmon pulp, and persimmon peel. Compared to the negative control group, the

hyperlipidemic control group (+ve) exhibited a significant reduction in body weight gain, feed intake, and the relative weights of the liver, kidney, and heart. However, when compared to the untreated hyperlipidemic group, all treatment groups showed significant improvements in these parameters, indicating the positive effects of dietary interventions using whole persimmons, pulp, and peel. observed improvements in feeding and growth performance indicators among the treated hyperlipidemic rat groups can be attributed to the bioactive compounds present in persimmon fruit, including dietary fiber, polyphenols, flavonoids, and carotenoids. These components are known to exert beneficial effects on lipid metabolism, enhance nutrient absorption, and improve overall metabolic function. The significant increase in feed intake and body weight gain, along with the improved feed efficiency ratio, suggests an enhanced appetite and better utilization of nutrients. Additionally, the recovery of the relative weights of vital organs such as the liver, kidney, and heart may reflect reduced lipid accumulation and oxidative stress, leading to improved organ function and structural integrity. Notably, the beneficial effects observed with persimmon peel were comparable to those of the pulp and whole fruit, highlighting the nutritional value of fruit by-products that are often discarded.

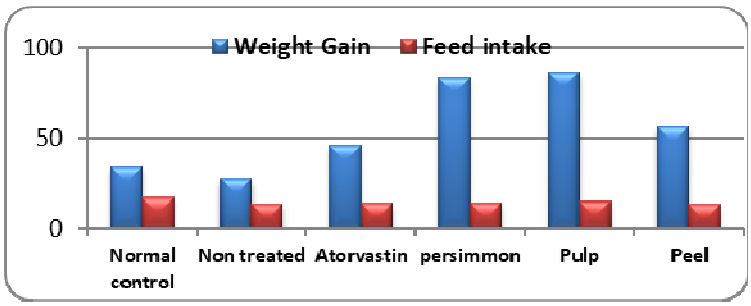
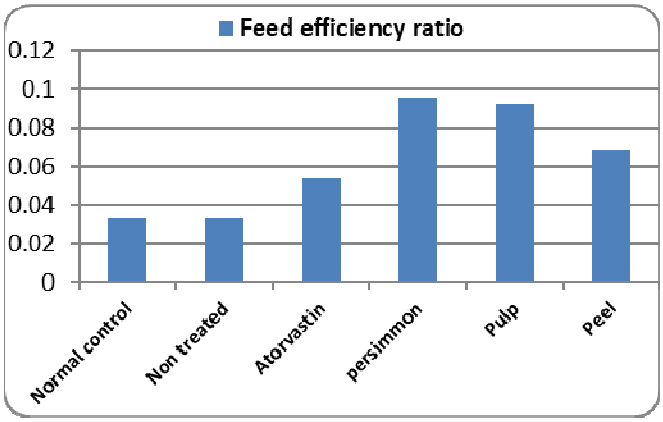



**Fig (1a) Impact of atorvastatin, as well as the whole fruit , pulp, and peel of dried persimmon,on weight gain and**




**Fig(1b) Impact of atorvastatin, as well as the whole fruit,, pulp, and peel of dried persimmon,on feed deficiency ratio**

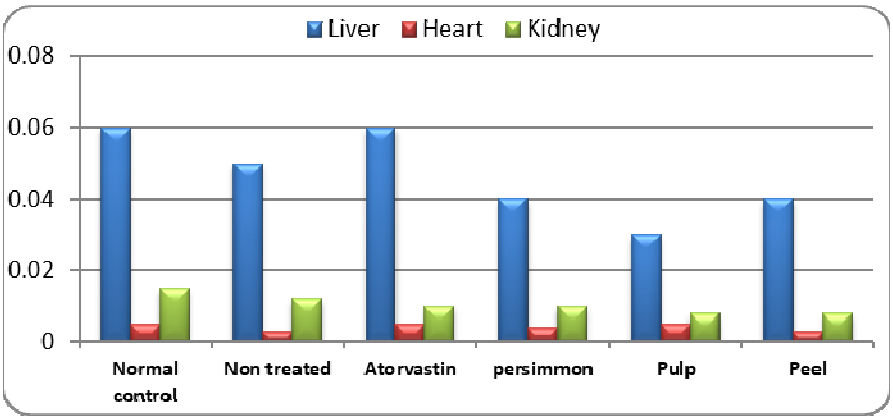



**Fig (1c) Impact of atorvastatin, as well as the whole fruit , pulp, and peel of dried persimmon,on relative organs weight (Liver, Kidney and Heart)**

## 2-Biochemical Results

Figures (2a,b, and c) illustrate significant changes in serum lipid profile parameters across the experimental groups. in comparison to the negative control group, the positive control group exhibited a significant elevation in total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-c), very low-density lipoprotein cholesterol (VLDL-c), total lipids, phospholipids, and atherogenic indices (TC/HDL-c and LDL-c/HDL-c) at **P < 0.001 and 0.01,** along with a significant reduction in high-density lipoprotein cholesterol (HDL-c**)** at **P < 0.001.** Conversely, no statistically significant differences were observed in these

parameters among the groups treated with whole persimmon, persimmon pulp, or persimmon peel, when compared to the negative control group. However, statistical analysis using ANOVA followed by the LSD post-hoc test demonstrated a significant reduction in serum TC, TG, LDL-c, VLDL-c, total lipids, and phospholipids, as well as a significant increase in HDL-c levels in the treated groups compared to the positive control group. These findings suggest a potential hypolipidemic effect of persimmon and its components. these findings are consistent with previous studies. **Un Ju Jung et al**. (**2012**) reported that plasma triglyceride and total cholesterol levels were significantly lower in the group supplemented with persimmon leaf (PL) compared to the control group, while HDL-cholesterol levels were significantly higher. Similarly, **Yeon-Jeong et al**. (**2010**) found that the consumption of vinegar, particularly persimmon vinegar, may enhance body carnitine levels, thereby promoting lipid oxidation and reducing blood lipid profiles associated with high-fat diet intake. **Matsumoto *et al***. (2010) also demonstrated that persimmon intake significantly reduced plasma cholesterol concentrations. In line with these results, **Soon-Teck Jung *et al.* (2005)** observed that diets supplemented with persimmon fruit led to reduced plasma lipid levels and increased antioxidant activity in rats, especially those fed a cholesterol-rich diet. Furthermore, **Gorinstein *et al***. (2000) investigated the effects of whole persimmon and phenol-free persimmon fruit on lipid profiles and antioxidant activity, showing beneficial effects in rats fed a cholesterol-enriched diet.

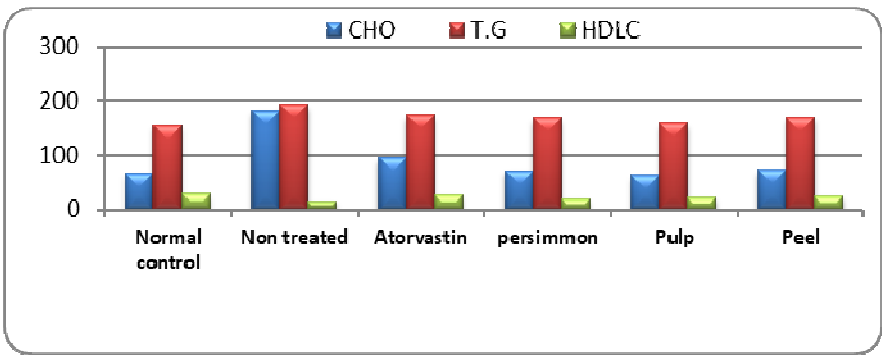



**Fig (2a) Effect of atorvastatin, whole persimmon, pulp and peel on some lipid pattern fraction (T.C, TG and HDL) in hyperlipidimic rat groups**

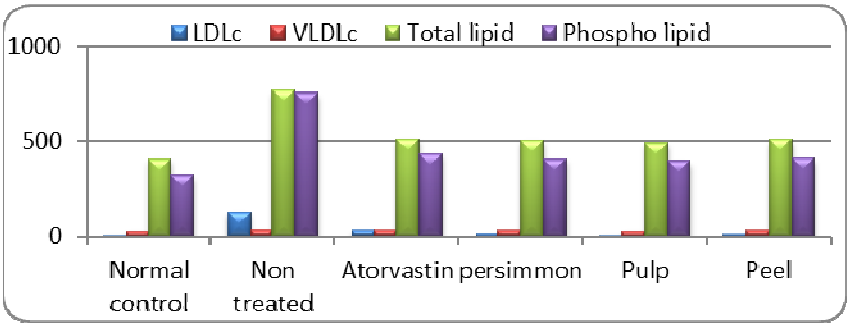
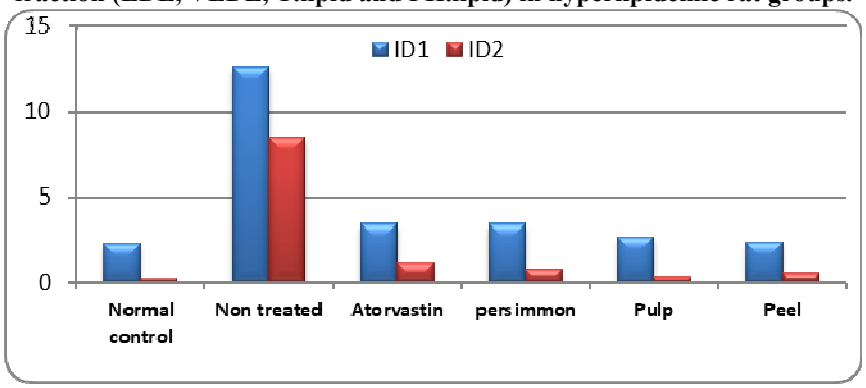


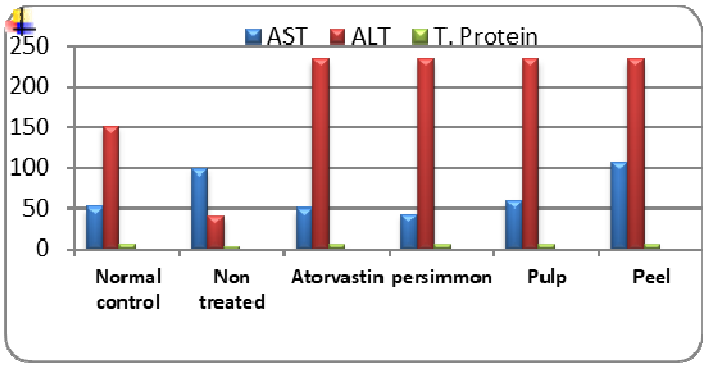

**Fig (2b) Effect of atorvastatin, whole Persimmon, Pulp and Peel on some lipid pattern fraction (LDL, VLDL, T.lipid and PH.lipid) in hyperlipidemic rat groups.**




**Fig( 2c) Effect of Atorvastatin, whole Persimmon, Pulp, Peel, Methanol extract and Water extract on ID1 and ID2 in Hyperlipidemic rat groups.**

Figure 3 (a, b, and c) illustrates the effect of the drug and persimmon (whole, pulp, and peel) on hepatic enzymes and selected renal function markers in serum. The levels of AST, albumin/globulin (A/G) ratio, creatinine, and uric acid were significantly elevated in the positive control group compared to all treated groups ($P < 0.01$ and $P < 0.05$). In contrast, ALT, total protein, albumin, and globulin levels were significantly reduced in the positive control group when compared to the negative control group ($P < 0.001$) Notably, no significant differences were observed in serum levels of ALT, AST, total protein, globulin, creatinine, or uric acid between the treated groups (whole persimmon, pulp, and peel) and the negative control group. Analysis of variance (ANOVA) followed by the LSD post hoc test demonstrated a significant reduction in serum levels of ALT, AST, albumin, A/G ratio, creatinine, and uric acid, alongside a significant increase in total protein and globulin levels in the treated rat groups compared to the

positive control group.these findings are consistent with those reported by **Jia et al. (2007)**, who observed that treatment with methanol extracts of persimmon leaves and fruit significantly reduced the serum activities of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) compared to the ethanol-treated control group. Similarly, **Lee et al. (2006)** and **Abd El-Ghany et al. (2016)** reported that the dietary supplementation with persimmon leaf powder significantly decreased plasma total cholesterol and triglyceride levels, increased the HDL-C/ total cholesterol ratio, and improved the atherogenic index. They also noted increased fecal excretion of triglycerides, cholesterol, and acidic sterols, which was attributed to the hypolipidemic effect of persimmon leaf powder. These beneficial effects are likely related to its rich content of phenolic compounds (1.15 g/100 g) and dietary fiber (63.48 g/100 g).




**Fig(3a) Effect of atorvastatin, whole persimmon, pulp and peel on amino transferees' (AST & ALT) and total protein in hyperlipidemic rat groups.**

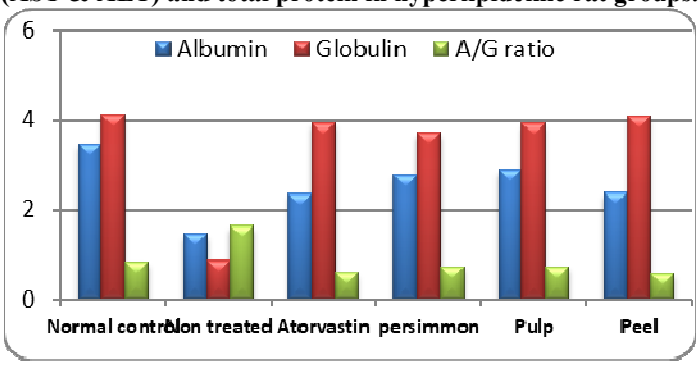



**Fig (3b) Effect of atorvastatin, whole persimmon, pulp and peel on (albumin & globulin) and A/G in hyperlipidemic rat groups**

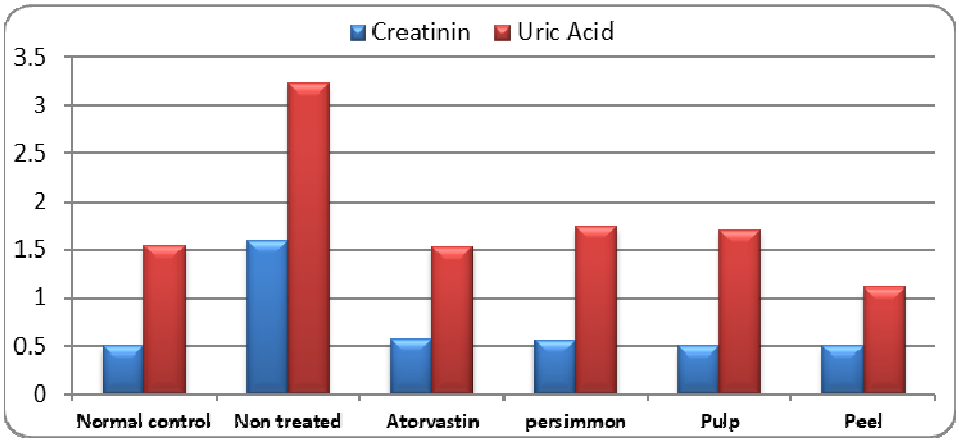
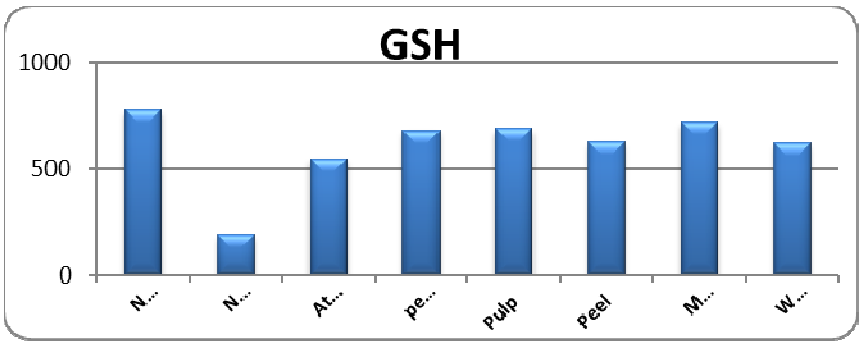


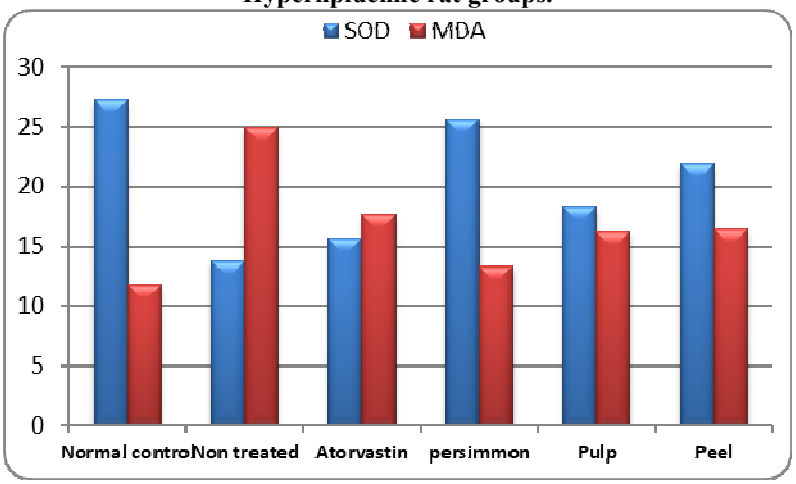

**Fig (3c) effect of atorvastatin, whole persimmon, pulp and peel on (Creatinine and Uric Acid) in hyperlipidemic rat groups**

Figure 4 (a and b) demonstrates that the positive control group exhibited a significant decrease in the activities of superoxide dismutase (SOD) and glutathione peroxidase (GSH) compared to the negative control group ($P < 0.01$ and $P < 0.001$). Treatment with persimmon (whole fruit, pulp, and peel) led to a significant increase in both SOD and GSH levels compared to the positive control group ($P < 0.01$ and $P < 0.001$), while showing no significant differences when compared to the negative control group. On the other hand, serum levels of malondialdehyde (MDA) were significantly elevated in the positive control group compared to both the treated groups and the negative control group ($P < 0.001$). Analysis of variance (ANOVA) and LSD post hoc tests revealed a significant increase in the levels of superoxide dismutase (SOD) and glutathione peroxidase (GSH), along with a significant decrease in malondialdehyde (MDA) levels in the treated groups compared to the positive control group.these findings are in agreement with those of **Hai-Feng et al. (2008)**, who demonstrated the antioxidant properties of persimmon tannins through hydroxyl radical scavenging activity using the 2-deoxyribose oxidation and salicylic acid systems, as well as superoxide anion scavenging and inhibition of linoleic acid peroxidation. Similarly, **Takako Yokozawa et al. (2007)** reported that both low and high molecular weight polyphenols extracted from persimmon possess antioxidant effects, particularly against oxidative stress induced by

high glucose levels. Furthermore, Hong **Seok et al. (2002)** and **Abd El-Ghany (2007)** observed an increase in catalase and SOD activities following administration of persimmon seed extract (PSE) and grape seed extract (GSE). However, they noted no significant differences in fatty acid composition of phosphatidylcholine and phosphatidylethanolamine among the control and treated groups. Additionally, **Yong-Feng et al. (2009) and Abd El-Ghany,& Nanees, (2024)** found that total flavonoids from persimmon leaves exerted significant hypoglycemic effects, further supporting the bioactive potential of persimmon-derived compounds.



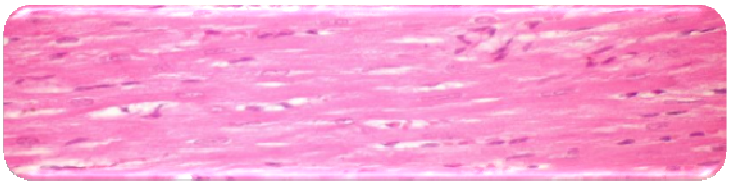

**Fig(4a) Effect of Atorvastatin, whole Persimmon, Pulp and Peel on MDA in Hyperlipidemic rat groups.**



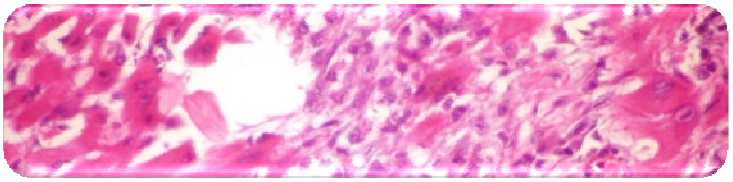

**Fig(4b) Effect of Atorvastatin, whole Persimmon, Pulp and Peel on some antioxidant(SOD&GSH) in Hyperlipidemic rat groups.**

**3-Histopathological Examination of Heart**-:

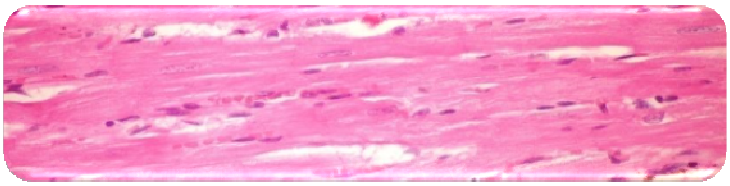
Microscopic examination of the heart tissue from the negative control group (–ve) revealed normal myocardial muscle fibers without any pathological alterations (pic. 1). In contrast, the heart tissue of hyperlipidemic non-treated rats (positive control group, +ve) exhibited focal necrosis of myocardial fibers, accompanied by infiltration of inflammatory and leukocytic cells, as well as intermuscular edema (pic. 2). However, heart sections from rats treated with atorvastatin, and persimmon in its whole form, pulp, or peel, showed no remarkable histopathological changes (pics. 3, 4, 5, and 6), indicating a protective effect. Although some minor changes were observed, they were considerably less severe than those seen in the untreated hyperlipidemic group. Elevated plasma cholesterol, particularly low-density lipoprotein cholesterol (LDL-c) is a key risk factor for cardiovascular disease. Oxidized or modified LDL-c particles are taken up by macrophages along with infiltrating leukocytes and become deposited in the arterial intima, contributing to the formation of atheromatous plaques. In contrast, high-density lipoprotein cholesterol (HDL-c) functions as an antioxidant that inhibits LDL-c oxidation and facilitates its removal from circulation, thereby lowering the risk of atherosclerosis.These findings are in agreement with **Shela Gorinstein et al. (2011),** who reported that a cholesterol-rich diet induced significant histological changes in the aorta, particularly in the aortic arch, with the most pronounced lesions observed in the cholesterol-fed group compared to the control and treatment groups. Based on the obtained biochemical and histopathological results, it can be recommended to increase the consumption of persimmon due to its potential in mitigating the adverse effects of hyperlipidemia. The improvements observed in lipid profiles and heart tissue morphology support its inclusion in dietary plans and functional beverages for hyperlipidemic individuals. Further research is warranted to translate the effective doses from animal models to appropriate human.



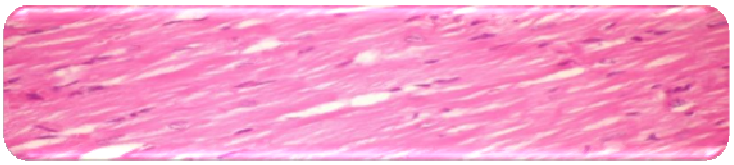
**Pic(1) Heart of the control group (negative) demonstrating normal cardiac myocytes.(H and E ×400).**



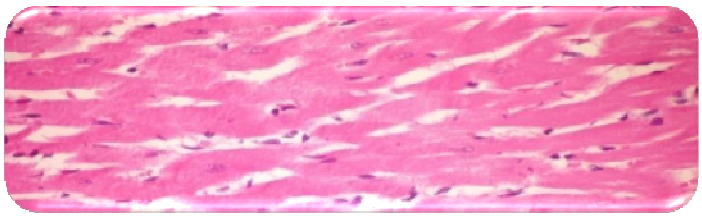
**Pic(2) Heart of a non-treated rat exhibiting focal necrosis of cardiac myocytes, accompanied by the infiltration of inflammatory cells (H and E ×400).**



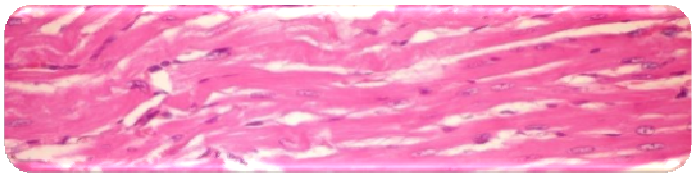
**Pic (3) The cardiac tissue of the rat, subjected to atorvastatin treatment, exhibited no discernible histopathological alterations. (H and E × 400).**



**Pic (4)The cardiac tissue of the rat, subjected to treatment with whole persimmon, exhibited no discernible histological variations. (H and E × 400).**



**Pic. (5)The heart of the rat, when subjected to treatment with pulp, exhibited no discernible histological variations. (H and E × 400).**



**Pic. (6): The heart of the rat treated with Peel exhibits no discernible histological variations. (H and E × 400)**

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# التأثيرات العلاجية لتناول الكاكا المجفف ضد ارتفاع دهون الدم الناتجه من مركب تريتون إكس في ذكور الفئران

عبد الغني محمود عبدالغنى ـ عفاف هانم محمود رمضان ـ رشا محمد نجيب - فايزة محمد محمود الازلي*

**الملخص العربي**

تمت هذه الدراسة، لتقييم تأثير تناول الكاكا المجفف كامله و لبها وقشرتها على خفض دهون في الدم في ذكور الفئران. تم تقسيم ستة وثلاثين من ذكور الفئران من فصيلة سبراج داولي والتي يتراوح اوزنهم (١٢٨ ± ٥ جم) إلى ست مجموعات (٦ فئران لكل مجموعة) خصصت ستة من الفئران كمجموعة ضابطة سالبة تتلقى نظامً غذائيً قياسيً فقط وتم حقن مجموعات الفئران الأخرى( بـ 100) Triton X 100 مجم / كجم) بالإضافة إلى النظام الغذائي وتم إعادة تقسيمها إلى مجموعة ضابطة موجبة تتغذى على نظام غذائي قياسي وأربع مجموعات عولجت بـ ٤,٥ مجم / كجم من عقار أتورفاستاتين وباقي المجموعات الثلاثة تناولت الكاكا المجفف كامله ولبها وقشرتها (١٠٠ مجم / كجم من النظام الغذائي القياسي) واستمرت الدراسة لمدة ٦٠ يومًا. بالمقارنة مع المجموعة الضابطة السالبة، أظهرت مجموعة الموجبة المتناولة تريتون إكس ١٠٠ انخفاضًا معنوي في زيادة الوزن وكفاءة التغذية وHDLc والبروتين الكلي والجلوبيولين وأنشطة سوبر أكسيد ديسميوتاز وجلوتاثيون بيروكسيديز، بينما اظهرت ارتفع بشكل كبير في الكوليسترول الكلي والدهون الثلاثية وLDLc وVLDLc والدهون الكلية والفوسفوليبيدات وAST وALT ونسبة الألبومين / الجلوبيولين والمالونديالديهايد. ولكن أظهرت جميع المجموعات التي استهلكت الكاكا تحسنً معنوي ملحوظً في زيادة الوزن وكفاءة التغذية وHDLc والبروتين الكلي والجلوبيولين وأنشطة إنزيمات مضادات الأكسدة، بينما انخفضت مستويات دهون الدم وإنزيمات الكبد ونسبة الألبومين / الجلوبيولين وMDA واقتربت بالمعدل الطبيعي، وكانت هذه النتائج مماثلة للمجموعة التي عولجت بدواء خافض للدهون. وأكد الفحص النسيجي النتائج الكيميائية الحيوية.حيث أظهرت الفحوصات النسيجية القلبية لجميع المجموعات التي استهلكت الكاكا واللب والقشر تحسنً معنوي كبير بالمقارنة بالمجموعة الضابطة الموجبة . وتشير هذه النتائج إلى أن المكملات الغذائية التي تحتوي على الكاكا المجفف الكامل واللب والقشر تخفف بشكل فعال من زيادة دهون الدم والإجهاد التأكسدي الناتج عن تريتون إكس ١٠٠ ويمكن التوصية بوضع الكاكا واللب والقشر ضمن خطة النظام الغذائي لمرضى القلب والأوعية الدموية وزيادة دهون الدم

**الكلمات المفتاحية:** الكاكا - فئران التجارب – زيادة دهون الدم و تريتون إكس ١٠٠

* قسم الاقتصاد المنزلي، كلية التربية النوعية، جامعة المنصورة، مصر