#### Studying the Effect of Different Types of Garlic Without peeling on Hypercholesterolemia Rats: A Comparative Study

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#### Abstract

Garlic (Allium sativum) is an edible tuber belonging to the family Liliaceae. Garlic has been studied for its medicinal and therapeutic effects in the treatment of various human diseases for a long time. Hypercholesterolemia is a known risk factor for cardiovascular diseases atherosclerosis, ischemic stroke, thrombosis and affects a high proportion of the population and affects a high proportion of the population. The present study is intended to study to compare the effect of different Types of garlic with and without peel on rats with high cholesterol levels, their role on oxidative Stress as an antioxidant, and Free Radicals. Forty-eight male rats were divided into two main groups as follows: The first basal group: (number = 6): It was fed the basal diet (as a negative control group). The second primary group: (number = 42): after the Induction of Hypercholesterolemia Then, rats were reclassified into (seven subgroups), each group consisting of (6 rats). Subgroup (1): They were fed the high cholesterol diet only (as a positive control group)., Subgroup(2, 3) were fed the high cholesterol diet and fortified with (5% - 10% garlic cloves powder / kg of diet), Subgroup(4, 5) were fed the high cholesterol diet and fortified with (5% - 10% peels garlic powder / kg of diet) and Subgroup(6, 7) were fed the high cholesterol diet and fortified with (5% - 10% garlic whole powder / kg of diet). Results showed that rats fed Types of garlic with and without peel had improved of body weight accompanied by a significant decrease in levels of glucose, insulin, liver functions (ALT and AST) Kidney Functions (U.A., Cr and UN ) Lipid Profile (TC, TG, LDL and VLDL) while were recorded a significant increase in a high-density lipoprotein-cholesterol (HDL)In addition, significantly reduced malondialdehyde (MDA) while the antioxidants enzymes (SOD, GPx and CAT) was significantly (P<0.05) increased compared to Hypercholesterolemia rats and fed on basal diet alone. Finally, the existing study illustrated that Garlic (Allium sativum) improve the Hypercholesterolemia.

**Keywords :** Garlic - Garlic peels – Hypercholesterolemia - Cholesterol - liver functions - Kidney Functions - Antioxidant activity.

#### **INTRODUCTION**

Garlic (Allium sativum) is an edible tuber belonging to the family Liliaceae. It has been used since ancient times as a spice to enhance the sensory characteristics of food and as a household remedy for the treatment of a variety of ailments. Garlic has been studied for its medicinal and therapeutic effects in the treatment of various human diseases for a long time. Health benefits associated with the consumption of garlic are attributed to the various sulfur compounds present in it such as allicin, ajoene, vinyl-dithiin, and other volatile organosulfur compounds are metabolized which all from alliin (Verma et al., 2023).

Have studied the effects of garlic consumption on decreasing total cholesterol (TC) and low-density lipoprotein (LDL) is more pronounced with a lower dosage and longer duration, especially in individuals with cardiovascular diseases alliin (Li *et al.*, 2023). Raw garlic and garlic extract in the form of oil or powder can be utilized as functional and therapeutic food. There is significant evidence that indicates preventive and therapeutic roles of garlic in improving the immune system, anti-tumor properties and antioxidant activity of garlic protects the body against free radicals (Cheng *et al.*, 2020). Human health has been found to benefit from a balanced diet rich in functional foods prepared with garlic. Garlic can alter blood anticoagulant levels and boost the activity of various organs in the body mainly of respiratory and digestive systems (Lee *et al.*, 2015).

Garlic wastes such as leaf blades (GLf), flower stalks (GSt), garlic peels (Gp) and roots (GRt) obtained from garlic harvest process have been used as bio resource, feed alimentation, soil amendment and may be used as a potential source of bioactive components (Kallel and Ellouz Chaabouni, 2017).

Garlic cloves have been extensively used as a spice and for medicinal purposes for thousands of years (**Bayan** *et al.*, **2014**). The bulb of garlic is made of multiple cloves surrounded by a papery, transparent outer peel; each clove is covered by a thick layer of inner peel. Both the outer and the inner peels are dead at maturity and provide a defense layer that protects the reproductive cloves from potential pathogens and abiotic stresses. Indeed, extracts of garlic skin possess antimicrobial substances as well as antioxidants with strong radical scavenging activity (**Phan** *et al.*, **2019**).

Hypercholesterolemia is a known risk factor for cardiovascular diseases and affects a high proportion of the population. Unhealthy lifestyle factors and change in traditional dietary pattern were positively associated with hypercholesterolemia (**Song et al., 2017**). Abnormal lipid metabolism is an important risk factor for cardiovascular diseases (CVD). It has been shown that one unit increase of logarithmic serum total cholesterol will triple the risk of CVD in men and women. Hypercholesterolemia has been confirmed as an independent risk factor for atherosclerosis and thrombosis, coronary heart disease and ischemic stroke (**Saeed** *et al.*, **2015**).

Cholesterol plays a vital role in maintaining the human health, but elevated serum cholesterol level is positively associated with cardiovascular disease (CVD), which is the leading cause of death and disability in the world (Wadhera *et al.*, 2016). hypercholesterolemia, is characterized by severely elevated low-density lipoprotein (LDL) cholesterol levels that lead to premature and progressive atherosclerotic plaque deposition in the coronary arteries and proximal aorta (Vallejo-Vaz and Ray, 2018). Dietary fat is an important part of the diet for humans to obtain lipids and energy. However, it is well known that excessive fat intake could lead to an accumulation of adipose tissue in the body and finally results in obesity and the development of a cluster of metabolic. High-fat diet (HFD) was widely used in animal disease models, including obesity, diabetes, liver disease, and cardiovascular disease (An *et al.*, 2022).

#### Aim of the study

- 1- The present study was designed to study to compare the effect of different Types of garlic with and without peel on rats with high cholesterol levels, their role in Oxidative Stress as an antioxidant, and Free Radicals. By the biological activities of garlic and garlic waste the objectives were achieved aim by
- Malondialdehyde (MDA) and Antioxidant enzymes (CAT, SOD, GPx).
- Total Cholesterol, TG, HDL, LDL and VLDL
- Glucose level , Insulin level, Catalase , Concentration of aspartate aminotransferase(AST) ,Alanine aminotransferase ,concentration(ALT) , Uric acid , Urea , Creatinine.
- **2-** Awareness and food culture for greater nutritional benefit for a healthier life.

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#### Materials and Methods

#### 1- Materials

- **1.1.** Casein, vitamins, mineral salts, cellulose, choline chloride, sodium selenite and zinc carbonate were purchased from Al-Gomhoria Company Cairo Egypt.
- **1.2.** Cholesterol and bile salts was obtained as a pure white powder from Infinity Company Cairo Egypt
- **1.3.** Garlics were purchased from the market Giza Egypt.
- **1.4.** Adult male albino rats (Spragio-Dawley breed) (number 48 rats) weight approximately  $(150 \pm 5 \text{ g})$  was purchased from Helwan Experimental Animal Farm Helwan Cairo.
- **1.5.** The used chemicals were purchased from Gamma Trade Company Cairo Egypt.

#### 2. Methods

Experimental study was conducted according to the guidelines of Animal Care and Ethics Committee of the RNC as well as the biochemical analysis at the Postgraduate Lab of Home Economics Faculty – Helwan University.

#### 2.1. Experimental Design

#### 2.1.1. Preparation of Basal Diets:

Basal diet was prepared according to the method of **Reeves** *et al.*, (1993). It consisted of 20% protein (casein), 10% carbohydrate, 5% fat (corn oil), 2% choline chloride, 1% vitamin mixture, 3, 5% salt mixture and 5% fibers. The remainder was cornstarch up to 100%.

**2.1.2. Preparation of Garlics Powder:** The basic technique for preparing garlic Powder is Sorting, Peeling, dried at 65 °C in an oven for 48 h, mixing by mixer or blender.

**2.1.3. Induction of Hypercholesterolemia:** Inducted of Hypercholesterolemia: Hypercholesterolemia was induced in rats accorded to **Rodas** *et al.*, (1995) by added (1.5% cholesterol and bile salts 0.25%) to basal diet for four weeks.

#### 2.1.4. Experimental and Grouping of Rats:

This study were conducted on forty-eight adult male rats, who were placed in suitable cages under hygienic conditions and fed on the basal diet for a week, which is the acclimatization period in the Biological Studies Laboratory at the Faculty of Home Economics. The basal diet is prepared accorded to (**Reeves** *et al.*,1993) and its added. Each of garlic clove powder, peel garlic powder and garlic whole powder, at the expense of starch and oil, to reach the balance of the meal provided to the rats. After that week, the rats were divided into two main groups as follows:

**The first basal group:** (number = 6): It was fed the basal diet (as a negative control group).

**The second primary group:** (number = 42): They were fed for four weeks on diets with added cholesterol to cause an increased in the level of cholesterol in the blood. Then the rats were divided into (seven sub-groups), each group consisting of (6 rats).

**Subgroup** (1): They were fed the high cholesterol diet (as a positive control group).

**Subgroup (2):** It were fed the high cholesterol diet and fortified with (5% garlic clove powder / kg of diet).

**Subgroup (3):** It were fed the high cholesterol diet and fortified with (10% garlic clove powder / kg of diet).

Subgroup (4): It were fed the high cholesterol diet and fortified with (5% peel garlic powder / kg of diet).

**Subgroup (5):** It were fed the high cholesterol diet and fortified with (10% peel garlic powder / kg of diet).

**Subgroup (6):** It were fed the high cholesterol diet and fortified with (5% garlic whole powder / kg of diet).

**Subgroup (7):** It were fed the high cholesterol diet and fortified with (10% garlic whole powder / kg of diet).

#### **2.1.5. Biological Evaluation:**

The biological evaluation of the diet was carried out by determination of feed intake, body weight gain percent (BWG %) and feed efficiency ratio (FER) according to **Chapman**, (1959) using the following equation:

**BWG** = Final Body Weight - Initial Body Weight

Change of body weight gain %= BWG/IBW X 100

**FER** = Weight gain (g) / Feed intake (g)

At the end of the experimental period (6 weeks), the rats were fasted overnight before sacrificing, and blood samples were collected from each rats and separated to obtain serum. Serum was separated by centrifugation at 3000 rpm for 15 min. The obtained serum will be used immediately for routine laboratory investigation.

#### **2.1.6. Biochemical analysis:**

Glucose was determined according to Trinder, (1969) and Insulin was determined according to Matthews *et al.*, (1985).

#### 2.1.6.1. Serum Lipid Profile:

According to (Allain,1974), Fassati and Prencipe, (1982) and (Brunzell *et al.*, 1983), the serum total cholesterol (TC), triglycerides (TG), and cholesterol contents of high-density lipoprotein (HDL-c) were measured,

respectively. Low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) were calculated according to (**Friedewald** *et al.*, **1972**).

LDL-c = TC- [HDL-c + (TG/5)] VLDL-c = TG/5

#### **2.1.6.2. Liver Function:**

Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to (**Bergmeyer** *et al.* 1978),

## **2.1.6.3.** Estimation of Malondialdehyde and Activities of Antioxidant Enzymes:

The serum concentration of MDA and the activity of catalase (CAT), superoxide dismutase (SOD), and glutathione peroxides (GPx) enzymes were determined using commercial assaying kits (Cayman Practice ELISA Kits). The principal method for the determination of oxidative stress depends on colorimetric by quantifying thiobarbituric acid (TBA) reactivity as malondialdehyde (MDA) in a spectrophotometer adjusted at 532 nm according to the described method by **De-Zwart** *et al.*, (1999). The procedure that is used for the evaluation of CAT activity depends on the reaction of the enzyme with methanol in the presence of an optimal concentration of H2O2. The formaldehyde produced is measured spectrophotometrically at 540 nm as described by (Wheeler *et al.*, 1990).

The standard technique to assay the activity of SOD is that the kits used use an enzyme linked immunosorbent assaydouble antibody principle. The color change is measured spectrophotometrically at 450 nm as described by (Wheeler *et al.*, 1990). The serum activity of GPx was assayed according to the kit's instructions as described by Ceballos-Picot *et al.*, (1992) using spectrophotometrically at 340nm.

#### 2.1.6.4. Estimation of Kidney Functions

Quantitative ELISA-based colorimetric Kits assay were used for the measurements of serum levels of urea nitrogen (UN), Creatinine (Cr) and uric acid (UA) based on colorimetric assay. The absorbance of the 28 colored solutions was recorded by using a spectrophotometer (Hum star 200, automatic biochemistry analyzer, Germany) adjusted at 540,530 and 750 nm, respectively, according to Kits procedures describe by (**Friedman and Young 1997**).

#### **2.1.7. Statistical analysis**

All data obtained results were analyzed used Statistical Package for the Social Sciences (SPSS) for Windows, version 20 (SPSS Inc., Chicago, IL, USA). Collected data were presented as mean $\pm$  standard deviation (SD). Analysis of Variance (ANOVA) test was used for determined the significances among different groups accorded to(**Armitage and Berry, 1987**). All differences was consider significant if P-values were (P< 0.05).

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#### **RESULTS AND DISCUSSION**

1- The Effects of Different Types of Garlic with and without peel on Initial Body Weight (IBW), Final Body Weight (FBW), Feed Intake (FI), Feed Efficiency Ratio (FER), Body Weight gain (BWG) and body weight gain percent (BWG %) on Hypercholesterolemia Rats.

Recorded results in table (4) interpreted the effect of fed supplemented diet with different Types of garlic with and without peel on FBW, FI, FER, BWG and BWG % on Hypercholesterolemia rats. Rats It showed that the Hypercholesterolemia rat (positive control group) had a significant (P<0.05) increase in FBW, FI, FER, BWG and BWG %, compared to normal rats (negative control group). Whereas, fed rats on a different Types of garlic with and without peel has a significant (P<0.05) reduction in FBW, FI, FER, BWG and BWG % in comparison to Hypercholesterolemia rats (positive control group). The superior results in FBW, FI, FER, BWG and BWG % were established in treated group by 10% garlic whole powder.

Consumption of a high-fat diet (HFD) causes increased lipid accumulation and contributes to various metabolic diseases such as obesity, hyperlipidemia, atherosclerosis, cardiovascular disease, type 2 diabetes mellitus and nonalcoholic fatty liver disease (NAFLD) (**Bharathi** *et al.*, **2018**) These results are in agreement with our results in this study where increase in body weight gain in the Hypercholesterolemia rats positive control group which fed high-fat diet (HFD) Apart from these roles, garlic has a positive effect on lipid profile, diabetes, and body weight and seems to reduce cardiovascular risks (**Ashraf** *et al.*, **2005**). **Joo.**, (**2013**) reported that dietary supplementation with garlic significantly reduced adipose tissue mass in rats fed a high-fat diet. our results in this study where reduction in body weight gain the rats which fed supplemented diet with different Types of garlic with and without peel The superior results in FBW, FI, FER, BWG and BWG % were established in treated group by 10% garlic whole powder. Data are expressed as mean  $\pm$  SE.

	groups garlic whole powder		groups peel garlic powder		groups garlic clove powder	Positive con	Negative con		Param
10% garlic whole powder	5% garlic whole powder	10% garlic clove powder	5% garlic clove powder	10% peel garlic powder	5% peel garlic powder	trol group	itrol group	- Les	eters
$152.50 \pm 1.87$ a	152.50 ± 1.87 ª	152.50 ± 1.87 ª	152.50 ± 1.87 ª	$152.50 \pm 1.87$ a	152.33 ± 1.63 ª	$152.33 \pm 2.07$ a	$151.50 \pm 2.07$ a	IBW (g)	
$184.17 \pm 3.97$ g	$196.67 \pm 3.88$ f	227.67 ± 5.05 °	$239.66 \pm 7.12$ <sup>d</sup>	$274.50\pm7.18^{\mathrm{c}}$	$290.00 \pm 7.07$ <sup>b</sup>	352.33 ± 2.07 a	$154.17\pm1.33$ h	FBW (g)	
14.83 ± 1.17°	16.33 ± 1.21 <sup>bc</sup>	15.00 ± 1.41 °	16.83 ± 1.47 <sup>b</sup>	14.83 ± 1.17°	16.83 ± 1.47 <sup>b</sup>	$19.67 \pm 0.52$ a	$18.83 \pm 1.17$ a	FI (g)	Parameter <i>i</i>
$2.15\pm0.29$ °	$2.71\pm0.32$ d	$5.07\pm0.48^{\circ}$	$5.21\pm0.65^{\circ}$	$8.25\pm0.55~^{\rm b}$	$8.21\pm0.65$ b	$10.17 \pm 0.21^{a}$	$0.14\pm0.10~^{\rm f}$	FER	ıs Mean±SD
$31.67 \pm 2.42$ g	$44.17 \pm 3.66$ f	75.17 ± 4.07 e	$87.16 \pm 8.04$ <sup>d</sup>	$122.00 \pm 7.24$ °	137.67 ± 7.66 <sup>b</sup>	200.00 ± 3.16 ª	$2.67\pm1.86^{\rm h}$	BWG (g)	
20.63 ± 1.43 9	$28.90 \pm 2.48$ f	49.28 ± 2.52 °	$57.19\pm5.74~^{\rm d}$	$80.02 \pm 5.02^{\circ}$	$90.40 \pm 5.59$ <sup>b</sup>	131.6 ± 3.71 a	$1.76\pm1.24^{\mathrm{h}}$	BWG (%)	

### 2- The Effects of Different Types of Garlic with and without peel on serum glucose and insulin on Hypercholesterolemia Rats

Results describe the effect of a fortified diet by different Types of garlic with and without peel on serum glucose and insulin on Hypercholesterolemia Rats. The results exhibited a significant (p<0.05) increase in serum glucose and insulin in Hypercholesterolemia Rats (positive control group), compared to normal rats (negative control group). However, the results showed that there was a significant decrease in serum glucose and insulin of the treated groups given fed on a different Types of garlic with and without peel , compared to the Hypercholesterolemia Rats (positive control group) fed on basal diet alone. The best amelioration in serum level of glucose and insulin is shown in the treated groups by 10% garlic whole powder. compared to the other treated levels.

Often known as diabetes mellitus, is a fatal metabolic disorder characterized by high blood sugar levels mainly due to the body either cannot use insulin effectively or does not produce enough of it (Zhu et al., 2018). Preclinical research demonstrated that garlic's active sulfur-containing compounds lowered hyperglycemia by enhancing the antioxidant capacity in diabetic rat circulatory systems (Sujithra et al., 2019). Furthermore, the garlic component functions as donor of hydrogen sulfide, which regulates type diabetes а 2 (Melino et al., 2019). Garlic (300 mg garlic two times per day for 12 weeks) significantly improved blood triglycerides, LDL and lower glucose parameters (Shabani et al., 2019). Furthermore, compared to placebo diabetic patients uncontrolled dyslipidemia, decreased with serum lipid levels (Verma et al., 2023). These results are in agreement with our results in this study where reduction in serum glucose and insulin of the treated groups given fed on a different Types of garlic with and without peel The best amelioration in serum level of glucose and insulin is shown in the treated groups by 10% garlic whole powder.

Param	eters	Parameter as Mean ± SD		
	<b>P</b> 2	Glucose (mg/dl)	Insulin (mg/dl)	
Negative con	trol group	$104.83 \pm 3.97^{\rm h}$	$2.99~\pm~0.01~^{\rm h}$	
Positive control group		195.50 ± 3.73 °	$3.18 \pm 0.10$ <sup>a</sup>	
groups garlic clove powder	5% peel garlic powder	$184.17 \pm 3.06$ <sup>b</sup>	$3.14\pm0.01~^{\text{b}}$	
	10% peel garlic powder	174.17 ± 3.19°	$3.11\pm0.01$ °	
groups peel garlic powder	5% garlic clove powder	$165.83 \pm 3.19$ <sup>d</sup>	$3.08\pm0.01^{\text{d}}$	
	10% garlic clove powder	153.67 ± 2.73 °	$3.06\pm0.01~^{\text{e}}$	
groups garlic whole powder	5% garlic whole powder	$144.8 \pm 3.31 \ {\rm f}$	$3.03\pm0.01~{\rm f}$	
	10% garlic whole powder	134.83 ± 3.31 g	$3.02\pm0.01$ g	

 Table 2. The Effects of Different Types of Garlic with and without peel on serum glucose and insulin on Hypercholesterolemia Rats.

Data are expressed as mean  $\pm$  SE.

## 3- The Effects of Different Types of Garlic with and without peel on serum AST and ALT on Hypercholesterolemia Rats

The tabulated results in table (3) explained that untreated rats with Hypercholesterolemia rats have a significant increase in the serum activity of AST and ALT enzymes, compared to normal rates. Whilst the treatment of Hypercholesterolemia in rats by fed on a supplemented diet with different Types of garlic with and without peel caused significant (P<0.05) reductions in the serum activity of AST and ALT enzymes, compared to untreated Hypercholesterolemia rats. The best improved results were reported in rats treated with high levels 10% garlic whole powder.

El-Saber et al., (2020).reported that the frequent intake of garlic can enhance the production of endogenous antioxidants or repress the generation of oxidizers; these actions promote antioxidant activity and reduce oxidative adverse effects .Garlic is an antioxidant that can be used to treat alcoholic diseases. Marker enzymes for liver function and integrity include ALT and AST. The activity of ALT was greatly lowered after draining garlic (Ajayi et al., 2009). garlic extract dramatically reduced serum aspartate aminotransferase, and alanine aminotransferase (Eidi et al., 2006). In line with these results different Types of garlic with and without peel caused reductions in the serum activity of AST and ALT The best improved results were reported in rats treated with high levels 10% garlic whole powder.

Р	arameters	Parameter as Mean ± SD		
	Groups	AST	ALT	
		(µ /L)	(µ /L)	
Negativ	ve control group	$32.50 \pm 1.87$ h	$18.83 \pm 1.17$	
Positive control group		$71.50 \pm 1.87$ a	$41.00 \pm 0.89$ a	
groups garlic	5% peel garlic powder	$64.00 \pm 2.3.7$ <sup>b</sup>	$38.50 \pm 1.05^{\text{b}}$	
clove powder	10% peel garlic powder	$58.33 \pm 1.63$ °	$35.00 \pm 0.89$ °	
groups peel garlic powder	5% garlic clove powder	$53.50 \pm 1.87$ <sup>d</sup>	$31.67 \pm 1.21$ <sup>d</sup>	
	10% garlic clove powder	48.33 ± 1.63 °	28.67 ± 1.21 °	
groups garlic	5% garlic whole powder	$43.33 \pm 1.63$ f	$25.00 \pm 0.89$ f	
whole powder	10% garlic whole powder	38.33 ± 1.63 g	$21.17 \pm 1.17$ g	

Table 3. The Effects of Different Types of Garlic with and without peel on
serum AST and ALT on Hypercholesterolemia Rats.

Data are expressed as mean  $\pm$  SE.

## 4- The Effects of Different Types of Garlic with and without peel on serum U.A , Cr and UN on Hypercholesterolemia Rats

Results in table 4 describe the effect of a fortified diet by different Types of garlic with and without peel on serum concentration of UA, Cr and UN in Hypercholesterolemia rats. The results exhibited a significant (p<0.05) increase Cr serum UA. and UN concentrations in rats treated with in Hypercholesterolemia rats and fed on basal diet alone (positive control group), compared to normal rats. However, the results showed that there was a significant decrease in serum UN, Cr and UA concentrations of the Hypercholesterolemia rats treated groups given the different Types of garlic with and without peel in combination, compared to the treated rats with Hypercholesterolemia rats and fed on basal diet alone. The best amelioration in serum level of UA, Cr and UN is shown in the treated groups by 10% garlic whole powder compared to the other treated levels.

The significant antioxidant properties of garlic have been attributed to its high phenolic and organosulfur contents, which gives it high antioxidant properties (**Parham** *et al.*, 2020). garlic extract dramatically reduced serum urea and uric acid (**Eidi** *et al.*, 2006). These results are in agreement with our results in this study the results showed that there was a decrease in serum UN, Cr and UA Hypercholesterolemia rats fed on different Types of garlic with and without peel The best amelioration in serum level of UA, Cr and UN is shown in the treated groups by 10% garlic whole powder compared to the other treated levels.

Parameters Groups		Parameter as Mean ± SD			
	aps	U.A (mg/dl)	Cr (mg/dl)	UN (mg/dl)	
Negative control group		$2.28~\pm~0.17~{}^{\mathrm{f}}$	$0.65 \pm 0.02$ g	$23.48 \pm 1.21$ h	
Positive control group		$4.98 \pm 0.23$ °	$0.92\pm0.01^{\rm a}$	$46.88 \pm 1.18$ <sup>a</sup>	
groups garlic clove powder	5% peel garlic powder	$4.17\pm0.50~^{\rm b}$	$0.89\pm0.02^{\mathrm{b}}$	44.55 ± 2.07 b	
	10% peel garlic powder	$3.75\pm0.10^{\circ}$	$0.87\pm0.01$ °	$39.43\pm0.98$ °	
groups peel garlic powder	5% garlic clove powder	$3.41\pm0.15^{\rm d}$	$0.83\pm0.02^{\rm d}$	$36.65\pm0.92^{\text{d}}$	
	10% garlic clove powder	$3.17\pm0.16~^{\rm d}$	$0.81\pm0.02~^{\rm d}$	$32.63\pm0.83~^{\circ}$	
groups garlic whole powder	5% garlic whole powder	$2.72\pm0.15$ °	0.77± 0.02 °	$30.33 \pm 0.76 ~{\rm f}$	
	10% garlic whole powder	$2.45 \pm 0.10^{\text{ e f}}$	$0.71\pm0.01^{\rm f}$	27.57 ± 0.92 g	

## Table 4. The Effects of Different Types of Garlic with and without peel on serum U.A , Cr and UN on Hypercholesterolemia Rats

Data are expressed as mean  $\pm$  SE.

## 5- The Effects of Different Types of Garlic with and without peel on serum TC , TG , HDL , LDL and VLDL on Hypercholesterolemia Rats.

Table 5 represents describe the effect of a fortified diet by different Types of garlic with and without peel on serum concentration of TC , TG , HDL , LDL and VLDL in Hypercholesterolemia rats. The results exhibited a significant (p<0.05) decrease in serum HDL and increase in serum TC , TG , LDL and VLDL concentrations in rats treated with Hypercholesterolemia rats and fed on basal diet alone (positive control group), compared to normal rats. However, the results showed that there was a significant increase in serum HDL and decrease in serum TC , TG , LDL and VLDL concentrations of the Hypercholesterolemia rats treated groups given the different Types of garlic with and without peel in combination, compared to the treated rats with Hypercholesterolemia rats and fed on basal diet alone. The best amelioration in serum level of TC , TG , LDL and VLDL is shown in the treated groups by 10% garlic whole powder compared to the other treated levels.

HFD contains lipids that are metabolised into triglycerides and cholesterol through exogenous and endogenous pathways in the intestine and liver, respectively (Feingold., 2024). HFD promotes metabolism via exogenous pathways that results in elevated levels of low-density lipoprotein (LDL) that can be converted to oxidised LDL (oxLDL). oxLDL interactions with blood vessel walls cause endothelium dysfunction (Zheng et al., 2018). These results are in agreement with our results in this study where The results exhibited decrease in serum HDL and increase in serum TC, TG, LDL and VLDL concentrations in rats treated with Hypercholesterolemia rats and fed on basal diet alone. In addition, GE administrated at 400 mg per day for three months modified the markers of endothelial function cholesterol (total, LDL, HDL) and triglycerides as well as suppressed chronic inflammation in obese individuals (Szulińska et al., 2018). Our results indicated a significant, administration of garlic clove for 30 days in type 2 diabetic patients reduced blood glucose and lipids metabolism and reduced the serum lipid such as cholesterol, TG, and LDL but improved HDL fraction (Mirunalini et al., 2011).

In this context, the consumption of raw crushed garlic at 100 mg two times per day for four weeks significantly decreased several risk factors of metabolic syndrome, including triglyceride levels, as well as improved serum high-density lipoprotein cholesterol (**Choudhary** *et al.*, **2018**).These results are in agreement with our results in this study. the results showed that there was a significant increase in serum HDL and decrease in serum TC , TG , LDL and VLDL concentrations of the Hypercholesterolemia rats treated groups given the different Types of garlic with and without peel in combination, compared to the treated rats with Hypercholesterolemia rats and fed on basal diet alone. The best amelioration in serum level of TC , TG , LDL and VLDL is shown in the treated groups by 10% garlic whole powder compared to the other treated levels.

Negative control group 71	Positive control group 100	s 700 peet 1( groups garlic garlic powder 100% peel 90 garlic powder 90
71.15 ± 1.32 h		106.50 ± 0.89 ª 103.17± 1.0™ <sup>b</sup> 99.25 ± 1.54 °
$82.00 \pm 4.73$ h	171.33 ± 4.32 ª	157.6 <sup>v</sup> ± 3.33 <sup>b</sup> 145.83 ± 3.49 <sup>c</sup>
$59.53 \pm 0.45$ a	$47.20\pm0.42~^{\rm h}$	50.10 ± 0.51 9 51.71 ± 0.43 f
$4.78 \pm 0.88$ f	25.03 ± 0.66 ª	21.53 ± 0.75 <sup>b</sup> 18.36 ± 1.54 <sup>c</sup>
$16.40 \pm 0.95^{h}$	34.27 ± 0.86 ª	31.53 ± 0.67 <sup>b</sup> 29.17 ± 0.70 <sup>c</sup>
$\frac{1}{2} \frac{1}{2} \frac{1}$		$ \begin{array}{c c c c c c c c c c c c c c c c c c c $
Source control group       Source control group       Trous control group       Trous control group       Trous control group       Source control group       S	S% peel103.17± 1.0°b157.6° ± 3.33 b50.10± 0.51 g21.53 ± 0.75 b31.53 ± 0.67 b	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{c c c c c c c c c c c c c c c c } \mbox{garlic} & \mbox{S% peel} & \mbox{103.17$\pm$1.0$^{rb}} & \mbox{157.6$^{V}$\pm$3.33$^{b}} & \mbox{50.10$\pm$0.51$^{g}} & \mbox{21.53$\pm$0.75$^{b}} & \mbox{31.53$\pm$0.67$^{b}} \\ \mbox{clove powder} & \mbox{10\% peel} & \mbox{99.25$\pm$1.54$^{c}} & \mbox{145.83$\pm$3.49$^{c}} & \mbox{51.71$\pm$0.43$^{f}} & \mbox{18.36$\pm$1.54$^{c}} & \mbox{29.17$\pm$0.70$^{c}} \\ \mbox{5\% garlic} & \mbox{94.50$\pm$1.87$^{d}} & \mbox{133.00$\pm$3.03$^{d}} & \mbox{53.18$\pm$0.59$^{c}} & \mbox{14.71$\pm$2.56$^{d}} & \mbox{26.60$\pm$0.61$^{d}} \\ \end{tabular} $	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{l lllllllllllllllllllllllllllllllllll$	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{c c c c c c c c c } \hline S\% \ \ peel \\ garlic \ powder \\ \hline clove \ powder \\ \hline garlic \ powder \\ \hline s\% \ garlic \\ clove \ powder \\ \hline 10\% \ garlic \\ clove \ powder \\ \hline s9.33 \pm 1.75 \ \ s8.33 \pm 5.05 \ \ s6.27 \pm 0.66 \ \ s6.15 \pm 1.87 \ \ s1.53 \pm 0.67 \ \ \ s1.53 \pm 0.67 \ \ s1.53 \pm 0.57 \ \ s1.55 \ \ \ s1.55 \ \ s1.55 \ \ s1.55 \ \ s1.55 \$	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $

VLDL on Hypercholesterolemia Rats. Table 5. The Effects of Different Types of Garlic with and without peel on serum TC, TG, HDL, LDL and

Data are expressed as mean  $\pm$  SE.

# 6- The Effects of Different Types of Garlic with and without peel on serum concentration of MDA and the activity of SOD , GPx and CAT on Hypercholesterolemia Rats

Table 6 represents describe the effect of a fortified diet by different Types of garlic with and without peel on serum concentration of MDA and the activity of SOD, GPx and CAT in Hypercholesterolemia rats. The results exhibited a significant (p<0.05) increase in serum MDA and decrease in serum SOD, GPx and CAT concentrations in rats treated with Hypercholesterolemia rats and fed on basal diet alone (positive control group), compared to normal rats. However, the results showed that there was a significant decrease in serum MDA and increase in serum SOD, GPx and CAT concentrations of the Hypercholesterolemia rats treated groups given the different Types of garlic with and without peel in combination, compared to the treated rats with Hypercholesterolemia rats and fed on basal diet alone. The best amelioration in serum level of MDA and the activity of SOD, GPx and CAT is shown in the treated groups by 10% garlic whole powder compared to the other treated levels.

Flavonoids may prevent injury due to free radicals in a variety of ways and one of these is by direct scavenging of free radicals. Flavonoids enter reactions with the reaction compound of the radical stabilizing reactive oxygen species. Due to the high reactivity of the hydroxyl group on flavonoids, radicals are inactivated (Panche et al., 2016). Garlic contains high levels of organ sulfur compounds flavonoids which act according their biological functions and to (Schafer and Kaschula., 2014). In this study determined that clove of garlic exhibits the highest total antioxidant activity, followed by garlic husks and garlic stems. All samples (garlic cloves, garlic husk and garlic stem parts) showed antioxidant activities (Kahyaoğlu., 2021). All samples (garlic cloves, garlic husk and garlic stem) contain flavonoid in their composition and total flavonoid significant effect content have а on in the samples (Kahyaoğlu., 2021). Moreover, in diabetic patients after 30 days of supplementation with 3.6 g garlic clove per day, enhanced antioxidant activities, such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) activities, significantly increased in circulating human erythrocytes compared with control (Mirunalini et al., 2011).Recent metaanalysis of clinical trials demonstrated that garlic supplementation modulates malondialdehyde oxidative stress markers, including (MDA) (Moosavian et al., 2020). These results are in agreement with our results in this

study the results showed that there was a significant decrease in serum MDA and increase in serum SOD, GPx and CAT concentrations of the Hypercholesterolemia rats treated groups given the different Types of garlic with and without peel The best amelioration in serum level of MDA and the activity of SOD, GPx and CAT is shown in the treated groups by 10% garlic whole powder compared to the other treated levels.

Par	ameters	Parameter as Mean ± SD					
G	Toups	MDA SOD (u/ml) (u/ml)		GPx (u/ml)	CAT (u/ml)		
Negative	control group	$1.70 \pm 0.13$ f	45.58 ± 0.84 ª	18.67 ± 0.70 ª	30.97 ± 0.59 ª		
Positive control group		3.11 ± 0.23 ª	$24.98 \pm 0.71 \ ^{\rm h}$	$8.66\pm0.29~^{\rm h}$	$18.02\pm0.60~^{\rm h}$		
groups garlic clove powder	5% peel garlic powder	$2.85\pm0.04~^{\rm b}$	$27.75 \pm 0.94$ g	$9.75\pm0.59~^{\rm g}$	$19.93 \pm 049$ g		
	10% peel garlic powder	$2.71\pm0.03$ $^\circ$	$30.53 \pm 0.71 \ {\rm f}$	$11.10 \pm 0.29 ~{\rm f}$	$21.68 \pm 0.23 ~{\rm f}$		
groups peel garlic	5% garlic clove powder	$2.59\pm0.04$ °	$33.25\pm0.94~^{\circ}$	$12.40 \pm 0.51$ °	$23.36\pm0.56$ °		
powder	10% garlic clove powder	$2.46\pm0.05~^{\rm d}$	$37.33 \pm 1.47 \ ^{\rm d}$	$13.97\pm0.36~^{d}$	$24.80\pm0.43~^{\rm d}$		
groups garlic whole	5% garlic whole powder	$2.34\pm0.04~^{\rm d}$	$40.61\pm0.77~^{\circ}$	$15.52 \pm 0.47$ °	$26.58\pm0.41~^{\circ}$		
powder	10% garlic whole powder	2.15 ± 0.15 °	$43.15 \pm 0.80$ <sup>b</sup>	16.88 ± 0.35 b	27.97 ± 0.68 <sup>b</sup>		

Table 6. The Effects of Different Types of Garlic with and without peel on serum concentration of MDA and the activity of SOD, GPx and CAT on Hypercholesterolemia Rats.

Data are expressed as mean  $\pm$  SE.

Means with different superscript letters in the column are significantly differences at (P < 0.05).

#### Conclusion

In accordance with The results presented in our study Improve in rats fed different Types of garlic (*Allium sativum*) with and without peel compared to the Hypercholesterolemia Rats fed on basal diet alone in the eventual we need more researches specifically on garlic (*Allium sativum*) studies.

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الثوم هو درنة صالحة للأكل تنتمي إلى عائلة البصل . وقد تمت دراسة الثوم لتأثيراته الطبية والعلاجية في علاج العديد من الأمراض البشرية لفترة طويلة. ارتفاع الكوليسترول في الدم هو عامل خطر معروف لأمراض القلب والأوعية الدموبة وتصلب الشرايين والسكتة الدماغية والتخثر وبؤثر على نسبة عالية من السكان. تهدف الدراسة الحالية إلى دراسة مقارنة تأثير أنواع مختلفة من الثوم مع وبدون قشر في الفئران ذات مستوبات الكوليسترول المرتفعة ودورها في الإجهاد التأكسدي كمضاد للأكسدة والجذور الحرة. تم تقسيم ثمانية وأربعين فأ أ ذكرًا إلى مجموعتين رئيسيتين على النحو التالي: المجموعة الأساسية :(العدد = ٦): تم تغذيتها على النظام الغذائي الأساسي ( مجموعة تحكم سلبية). المجموعة الثانية:(العدد = ٤٢): بعد إحداث ارتفاع الكوليسترول في الدم. ثم اعاده تصنيف الفئران إلى (سبع مجموعات فرعية)، تتكون كل مجموعة من (٦ فئران). المجموعة الفرعية (١): تم تغذيتهم على نظام غذائي عالى الكوليسترول فقط (كمجموعة التحكم الإيجابية).، المجموعة الفرعية (٢، ٣) تم تغذيتهم على نظام غذائي عالى الكوليسترول ومدعم بـ (٥٪ - ١٠٪ مسحوق فصوص الثوم / كجم من النظام الغذائي)، المجموعة الفرعية (٤، ٥) تم تغذيتهم على نظام غذائي عالى الكوليسترول ومدعم بـ (٥٪ – ١٠٪ مسحوق قشور الثوم / كجم من النظام الغذائي) والمجموعة الفرعية (٢، ٧) تم تغذيتهم على نظام غذائي عالى الكوليسترول ومدعم بـ (٥٪ – ١٠٪ مسحوق الثوم الكامل / كجم من النظام الغذائي). أظهرت النتائج أن الفئران التي تغذت على أنواع من الثوم مع أو بدون قشر قد تحسن وزن الجسم مصحوبًا بانخفاض كبير في مستويات الجلوكوز والأنسولين ووظائف الكبد(AST و AST) ووظائف الكلى (U.A و Cr و UN) والملف الدهني، (TC و TG و LDL و VLDL) بينما تم تسجيل زيادة كبيرة في كوليسترول البروتين الدهني عالى الكثافة (HDL) بالإضافة إلى انخفاض كبير في مالونديالديهايد (MDA) بينما زادت إنزيمات مضادات الأكسدة (SOD و GPx و CAT) بشكل ملحوظ (O.05> P) مقارنة بالفئران التي تعانى من ارتفاع الكوليسترول في الدم والتي تغذت على النظام الغذائي الأساسي وحده. وأخيرًا، أوضحت الدراسة الحالية أن الثوم يحسن ارتفاع الكوليسترول في الدم. الكلمات المفتاحية : الثوم – قشور الثوم – ارتفاع الكوليسترول في الدم – الكوليسترول – وظائف الكبد - وظائف الكلي - مضادات الأكسدة.