



**Napata College**  
**Pharmacy program**



## **Effect of Garlic juice on Cholesterol Level in Albino Rats**

A graduation project submitted to Napata collage in partial fulfillment of Bachelor of  
Pharmacy

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# الآية

قال تعالى:

﴿اللَّهُ لَا إِلَهَ إِلَّا هُوَ الْحَيُّ الْقَيُّومُ لَا تَأْخُذُهُ سِنَّةٌ وَلَا نَوْمٌ لَهُ مَا فِي السَّمَاوَاتِ وَمَا فِي الْأَرْضِ مَنْ ذَا الَّذِي يَشْفَعُ عِنْدَهُ إِلَّا بِإِذْنِهِ يَعْلَمُ مَا بَيْنَ أَيْدِيهِمْ وَمَا خَلْفَهُمْ وَلَا يُحِيطُونَ بِشَيْءٍ مِّنْ عِلْمِهِ إِلَّا بِمَا شَاءَ وَسِعَ كُرْسِيُّهُ السَّمَاوَاتِ وَالْأَرْضَ وَلَا يَئُودُهُ حِفْظُهُمَا وَهُوَ الْعَلِيُّ الْعَظِيمُ ﴿٢٥٥﴾﴾

صدق الله العظيم

"سورة البقرة: الآية 255"

## **Declaration**

I declare that the subject matter presented in this graduation project is original and has only been submitted to Napata College to obtain of Bachelor of Pharmacy

## Dedication

*This work is dedicated to:*

*The sake of Allah, my Creator and my Master, My great teacher and messenger **Dr. Ali Awadallah***

*who taught us the purpose of life . And to our parents who have never failed to give us financial and moral support , for giving all our needs during the time we developed our system and for teaching us that even the largest task can be accomplished if it is done one step as a time.*

*And we dedicate this Project to all the people who have worked hard to help us complete thisproject.*

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Special thanks to ***Dr. Ayman Bakheet Musa*** for his efforts and helping as in our experiment because without him the research would not be completed.

Finally, my thanks are also extended to all my friends for their moral support.

## **Abstract**

The main objective of this research work is to investigate the effect of garlic in changing the cholesterol level in albino rats.

18 rats were sub divided into 3 groups (each group contain 6 rats ) ,then groups are control group, statin group and garlic group.

Control group of rats is administered a normal diet, group two rats were administered high cholesterol diet with one ml of prepared statin daily for one month Group 3 rats were administered to high cholesterol diet with 1 ml of prepared garlic juice daily for one month.

Then after one month blood was collected from each rat separately and the cholesterol level was investigated by colorimeter.

We found the garlic juice affect mainly Triglyceride level , 105mg/dl in normal group to 50.5mg/dl in garlic group and 117.5mg/dl in statin group.

We recommend for further investigate the garlic effect on HDL and LDL levels.

## ملخص البحث

الهدف الرئيسي من هذا البحث هو معرفة تأثير الثوم في تغيير مستوى الكوليسترول في الجرذان البيضاء.

تم تقسيم 18 جرذاً إلى 3 مجموعات (كل مجموعة تحتوي على 6 فئران)، المجموعات الضابطة ومجموعة الستاتين ومجموعة الثوم.

تم إعطاء مجموعة التحكم من الجرذان نظاماً غذائياً طبيعياً ، وتم إعطاء المجموعة الثانية من الجرذان نظاماً غذائياً عالي الكوليسترول مع 1 مل من الستاتين المحضر يومياً لمدة شهر واحد المجموعة الثالثة اعطيت نظام غذائي عالي الكوليسترول مع 1 مل من عصير الثوم المحضر يومياً لمدة شهر.

ثم بعد شهر تم جمع الدم من كل جرذ على حدة وفحص مستوى الكوليسترول بواسطة مقياس الألوان.

وجدنا أن عصير الثوم يؤثر بشكل رئيسي على مستوى الدهون الثلاثية ، 105 مجم / ديسيلتر في المجموعة العادية إلى 50.5 مجم / ديسيلتر في مجموعة الثوم و 117.5 مجم / ديسيلتر في مجموعة الستاتين.

نوصي بمزيد من البحث عن تأثير الثوم على مستويات HDL و LDL.

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# **Chapter One**

## **Introduction and Literature Review**

# Chapter One

## Introduction and Literature Review

### 1. Introduction

#### 1.1 Background

Fats and lipids are common components of food and may perform essential roles. Their types may be more important with regard to health and disease than their amount. New research has linked functional lipids to the prevention and treatment of many diseases. Functional lipids such as omega-3 and omega-6 fatty acids, conjugated linoleic acids, medium chain triglycerides, and phytosterols have many beneficial effects on human health such as in obesity, bone health, and in treating and managing depression, blood pressure, cardiovascular health, etc. The ratio of omega-3 and omega-6 polyunsaturated fatty acids regulates the production of eicosanoids, which are the metabolites of these series of fatty acids. Scientific evidence has shown encouraging improvements in patients and beneficial effects in healthy persons with the use of supplemental and dietary forms of functional lipids.[19]

#### 1.2 Cholesterol

Cholesterol modulates the fluidity of mammalian cell membranes. It is also a precursor of the steroid hormones and bile salts. It is a sterol (has hydroxyl group at C-3). The fused ring system makes cholesterol less flexible than most other lipids.

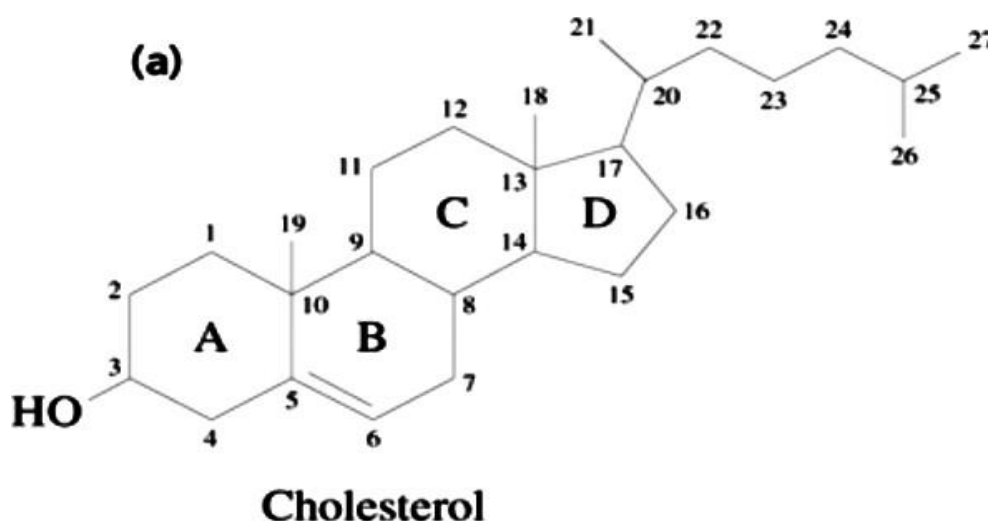


Figure 1.1

### 1.2.1 Cholesterol esters

Cholesterol is converted to cholesteryl esters for cell storage or transport in blood. Fatty acid is esterified to C-3 OH of cholesterol. Cholesterol esters are very water insoluble and must be complexed with phospholipids or amphipathic proteins for transport. [20]

### 1.2.2 Cholesterol ester

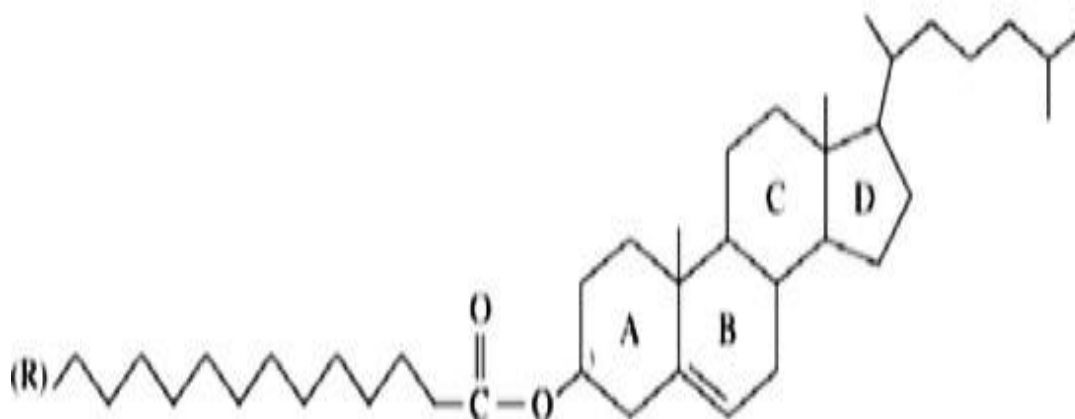


Figure 1.2

### 1.2.3 Importance of cholesterol

- 1- Helping to make the outer coating of cells
- 2- Making up the bile acids that work to digest food in the intestine
- 3- Allowing the body to make Vitamin D and hormones, like estrogen in women and testosterone in men [21].

### 1.2.4 Classes of lipoproteins:

There are four main classes of lipoproteins existed, and each has a different important function:

#### 1.2.5 Chylomicrons (CMs):

Are produced in the small intestines and deliver energy-rich dietary fats to muscles (for energy) or fat cells (for storage). They also deliver dietary cholesterol from the intestine to the liver.

#### 1.2.6 Very low density lipoproteins (VLDLs)

Take triglycerides, phospholipids, and cholesterol, from the liver and transport them to fat cells.

### **1.2.7 Low density lipoproteins (LDLs):**

Carry cholesterol from the liver to cells that require it. In aging people, LDL often transports cholesterol to the linings of their arteries where it may not be needed.

LDL is known as -badll cholesterol because having high levels can lead to plaque buildup in your arteries and result in heart disease and stroke.

### **1.2.8 High density lipoproteins (HDLs):**

Transport excesses cholesterol from cells back to the liver, where it can be re-processed from the body as bile salts. HDL removes excess cholesterol from the arterial wall. HDL is known as good cholesterol because having high levels can reduce the risk for heart disease and stroke] . [22]

### **1.2.9 Complication of high cholesterol on thebody:**

Cholesterol moves through your bloodstream via lipoproteins. Low-density lipoproteins (LDL) and High-density lipoproteins (HDL). Too much LDL and not enough HDL makes it more likely that the arteries will develop plaque that lead to coronary arteries narrow, it's harder for blood to make it through to the heart. If an area of plaque breaks open, it can result in a blood clot, which can block blood flow all together. This creates a great risk of having a heart attack. High cholesterol can create a bile imbalance, leading to gallstones Symptoms include abdominal pain, nausea, vomiting, and bloody stools.[23]

### **1.2.10 Some diseases Linked to high Cholesterol include:**

#### **- Coronary heart disease**

The main risk associated with high cholesterol is coronary heart disease (CHD) .If the cholesterol is too high, it builds up on the walls of the arteries. Over time, this buildup is known as atherosclerosis. This condition causes arteries to become narrowed, and the narrowed blood vessels reduce blood flow to the heart. This can result in angina (chest pain) from not enough blood flow getting to the heart, or a heart attack in cases when a blood vessel is blocked completely and the heart muscle begins to die.

#### **- Stroke**

A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain becomes blocked or bursts. A stroke can result if the blood supply to the brain is reduced. When stroke occurs, part of the brain cannot get the blood and oxygen it needs, so it starts to die.

### **- Peripheral arterial disease**

High cholesterol also has been linked to peripheral arterial disease (PAD), which refers to diseases of blood vessels that are outside the heart and brain. In PAD, fatty deposits build up along artery walls and affect blood circulation, mainly in arteries leading to the legs and feet. The arteries of the kidney can also be affected.

### **- Type 2 diabetes**

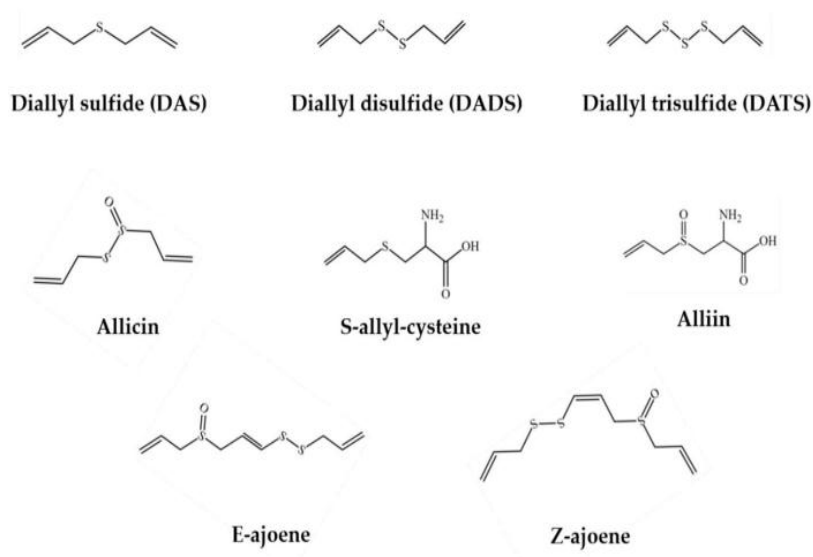
Type 2 diabetes is another disease linked to high cholesterol because diabetes can affect the different cholesterol levels. Even if blood sugar control is good, people with diabetes tend to have increased triglycerides, decreased high-density lipoprotein (HDL), and sometimes increased low-density lipoprotein (LDL). This increases the likelihood of developing atherosclerosis.

### **- High blood pressure**

High blood pressure (hypertension) and high cholesterol also are linked. When the arteries become hardened and narrowed with cholesterol plaque and calcium (atherosclerosis), the heart has to strain much harder to pump blood through them. As a result, blood pressure becomes abnormally high.

## **1.3 Garlic**

Garlic has a variety of bioactive compounds, including organosulfur compounds, saponins, phenolic compounds, and polysaccharides [24,25,26,27]. The major active components of garlic (Figure 1) are its organosulfur compounds, such as diallyl thiosulfonate (allicin), diallyl sulfide (DAS), diallyl disulfide (DADS), diallyl trisulfide (DATS), E/Z-ajoene, S-allyl-cysteine (SAC), and S-allyl-cysteine sulfoxide (alliin) [28,29]. In general, organosulfur compounds in raw garlic have higher digestibility than those in cooked garlic [30]. In addition, saponins were found to be more stable in the cooking process [31]. The total amount of saponin in purple garlic was almost 40 times higher than that in white garlic, and several saponin compounds were only found to exist in purple garlic, such as desgalactotigonin-rhamnose, proto-desgalactotigonin, proto-desgalactotigonin-rhamnose, voghieroside D1, sativoside B1-rhamnose, and sativoside R1. Moreover, garlic contained more than 20 phenolic compounds, with higher contents than many common vegetables [32]. The main phenolic compound was  $\beta$ -resorcylic acid, followed by pyrogallol, gallic acid, rutin, protocatechuic acid, as well as quercetin [33]. Furthermore, garlic polysaccharides were reported to contain 85% fructose, 14% glucose, and 1% galactose [34].



**Figure 1.3**

## 1.4 Objective:

### 1.4.1 General Objective:

To investigate the effect of Garlic in cholesterol level in the plasma of the experimental animals

### 1.4.2 Specific Objective:

- To assess the effect of garlic on cholesterol level in Albino rats using normal control and hyperlipidemic control.
- To evaluate effect of definite dose of garlic on cholesterol level in albino rats.
- To evaluate effect of drug dose of lipid lowering agent on cholesterol level in albino rats.
- To compare between drug dose of lipid lowering agents and garlic effect in albino rats.

## 1.5 Justification

Many people believe that traditional medicines are safe. However, traditional medicines and practices can cause harmful, adverse reactions if the product or therapy is of poor quality or it taken inappropriately or in combination with other medicines. Increased patient awareness about safe usage is important.

Although many studies were conducted on the effect of garlic in decreasing serum cholesterol levels and have protective properties against

## 2. Literature Review:

Garlic (*Allium sativum* L.) is a common spice with many health benefits, mainly due to its diverse bioactive compounds, such as organic sulfides, saponins, phenolic compounds, and polysaccharides [1–3]. Garlic is commonly consumed and has a long history of being utilized as a traditional medicine in China [4]. In recent decades, numerous studies have demonstrated the remarkable biological functions of garlic, including antioxidant, cardiovascular protective, anticancer, anti-inflammatory, immunomodulatory, anti-diabetic, anti-obesity, and antibacterial properties [5–11]. Investigations have increasingly focused on black garlic, a processed garlic product with increased polyphenol and flavonoid contents, as well as better antioxidant properties, compared to the fresh garlic [12].

For several years, garlic (*Allium sativum*) and onion (*Allium cepa*) have enjoyed special reputation as therapeutic and prophylactic agents among the species in the genus *Allium* [13]. They are widely used as food supplements and have many health benefits that are related to their bioactive components [14]. Their role in preventing diseases of the cardiovascular system is widely recognized. Studies show that the consumption of garlic regulate plasma lipid and antioxidant levels [15]. Garlic and onion are known to possess hemodynamic and hemostatic as well as antiplatelet activities

[16]. Among the lipid regulating effects, reduction of serum cholesterol and triacylglycerols have been documented. Studies on onion are less advanced. Some investigations have demonstrated that onion also has compounds with capacity to reduce blood triacylglycerols levels and to inhibit rat hepatic cholesterol biosynthesis *in vitro* [17]. There is no doubt that garlic and onion preparations possess lipid regulating abilities. However, there is still

controversy regarding which of them has better lipid regulating properties. No further studies have been conducted to elucidate possible effects of garlic and onion extract consumption on the relationship between haematological indices and lipid profile. Therefore, this paper compared the effects of aqueous garlic and onion extracts on some haematological and lipid indices of rats.

Garlic produces a chemical called allicin. This is what seems to make garlic work for certain conditions, Allicin also makes garlic smell, some products are made “odorless” by aging the garlic, but this process can also change the effects of garlic. [18]

cardiovascular disease (CVD).

## 2.1 Biological functions of Garlic in cholesterol

Anti-hyperlipidemic Activity Studies demonstrate that garlic can lower blood lipids in animals and people. A study showed that high temperature and high pressure processing could remove the pungency of garlic, and this garlic effectively reduced the levels of total cholesterol, low-density lipoprotein cholesterol, and triglyceride in high-cholesterol diet-fed Sprague–Dawley rats [35]. Another study found that adding 1.5% black garlic extract in high-fat diet for male Sqrague-Dawley rats could significantly modulate the metabolism of lipids and cholesterol and decrease the total levels of blood lipids, triglyceride, and cholesterol, which could be due to the reduction of the mRNA expression of sterol regulatory element binding protein-1c [36]. In a cross sectional study, the intake of garlic (300 mg/day, 8 weeks) was shown to reduce the levels of cholesterol and low-density lipoprotein and elevate the level of high-density lipoprotein, but garlic had no effect on the level of triglycerides in patients with diabetic dyslipidemia [37]. Additionally, a supplement of aged garlic for 13 weeks was found to reduce the activities of myeloperoxidase and lipid hydroperoxide in serum and to decrease the concentrations of F2-isoprostanes in plasma and urine in 41 patients with hypercholesterolemia. Moreover, aged garlic had better effects than raw garlic [38]

## 2.2 Phytochemical screening of garlic:

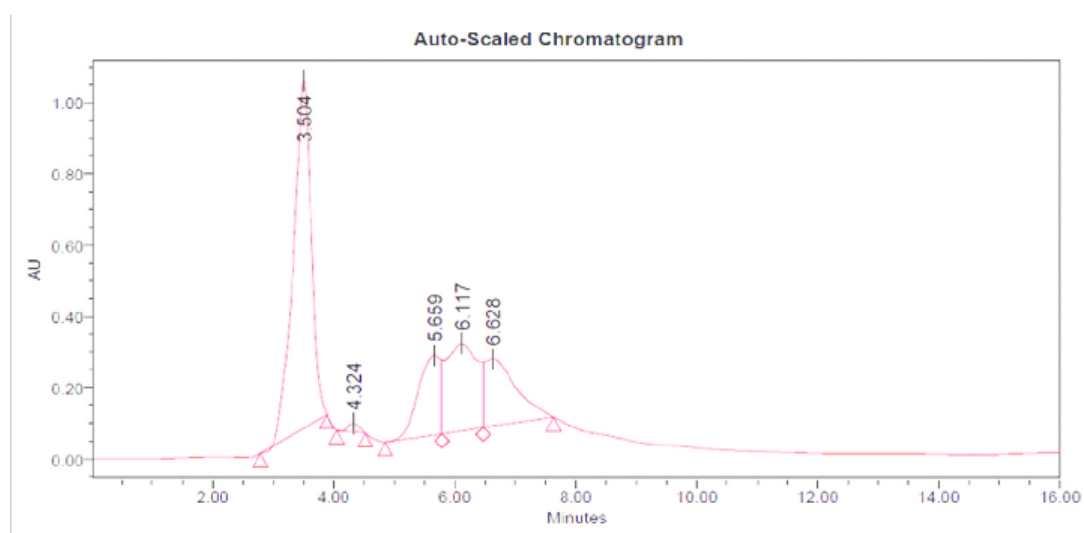


Figure 1.4 [39]

# **Chapter Two**

## **Materials and Methods**

## Chapter Two

### Materials and Method

#### 2.1 Study design:

Experimental case control study

#### 2.2. Study area:

The experiment was done in lab no. FF-5 and albino rats was kept and fed in the animal house in the roof of the main building in National University-Sudan

**2.3. Study population:** White albino rats selected with weight ranged between (186-211 g).

#### 2.4. Material:

##### 2.4.1 .Garlic use:

Garlic juice (*Allium chinense*) was use, brought from souk helat koko in bahri area.

##### 2.4.2 . Food of rats:

**Hyperlipidemia were induced to two groups (Group2,and3) by administration of food containing:**

Bran 1g per 100 g, Flour 62 g per 100g, Meat 10g per 100 g, Vitamin powder per 1g 100 g, Cholesterol powder 1g per 100 g(Alpha chemika, India), Sugar 5g per 100 g , Coconut oil 16g per 100 g . (all material brought from Alarabi)

This induction was carried by administering this food for two groups for 30 days early morning orally.

For normal group normal feeding was done.

##### 2.4.3. Reagents and equipment's used:

Beaker, Measuring cylinder, Gastric gavage , Sensitive balance , Syringes , Distilled water , Cholesterol powder 99%, Heparinized capillary tube, Lithium heparinized vacuum , Automatic micropipette, Eppendorf tubes , Centrifuge,Rack , Clorometer, HDL precipitating reagent (biosystem), Cholesterol standard reagent (biosystem), LDL precipitating reagent (biosystem), TG precipitating reagent (biosystem) , cholesterol – LS (Biomed ,Egypt)

### **3. Methods**

#### **3.1. General methodology**

Animals were divided into 4 groups with 6 animals per group.

**Group1:** Normal control.

**Group2:** Hyperlipidemic treated with Atorvastatin by gastric gavage (**5mg/kg, p.o.**).

**Group3:** Hyperlipidemic treated with garlic juice by gastric gavage (**300mg/kg, p.o.**).

The animals were administered with corresponding treatments for one month. [40]

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

High Cholesterol diet was prepared by mixing pure cholesterol powder and coconut oil , with standard animal food. The diet which was prepared as fingers and placed in the laboratory carefully for drying to minimize the risk of fungal infection and was administered for 30days.

#### **3.3 . Preparation of garlic :**

100 g of garlic was weighed and added to 200ml of distilled water , then crushed by mixer to form a juice.

#### **3.4 Preparation of statin:**

0.1 mg of pure atorvastatin powder was weighted and added to 200ml of distilled water.

#### **3.5 blood collection**

The blood was collected in heparinized vacuum tubes from eyes of rats by heparinized capillary tubes in each group and centrifuged at 50 rpm/min for 25 minuits and the plasma was collected. Plasma level of total cholesterol was determined by using colorimeter .

# **Chapter Three**

## **Results and Discussions**

## Chapter Three

### Results and Discussion

#### 3.1 Results:

**Table 3-1: blood lipid profile in control group (mg/dl)**

Group name	Total cholesterol	LDL	HDL	TG
Normal control				
1	25	21	19	105
2	20	16	14	103
3	25	21	7	109
4	22	18	22	102
5	27	20	15	109
6	25	16	20	107

**Table 3-2: blood lipid profile in Atorvastatin group (mg/dl)**

Atorvastatin	Total cholesterol	LDL	HDL	TG
1	40	32	17	124
2	33	29	18	69
3	50	36	17	151
4	44	36	11	107
5	70	63	22	143
6	35	27	18	111

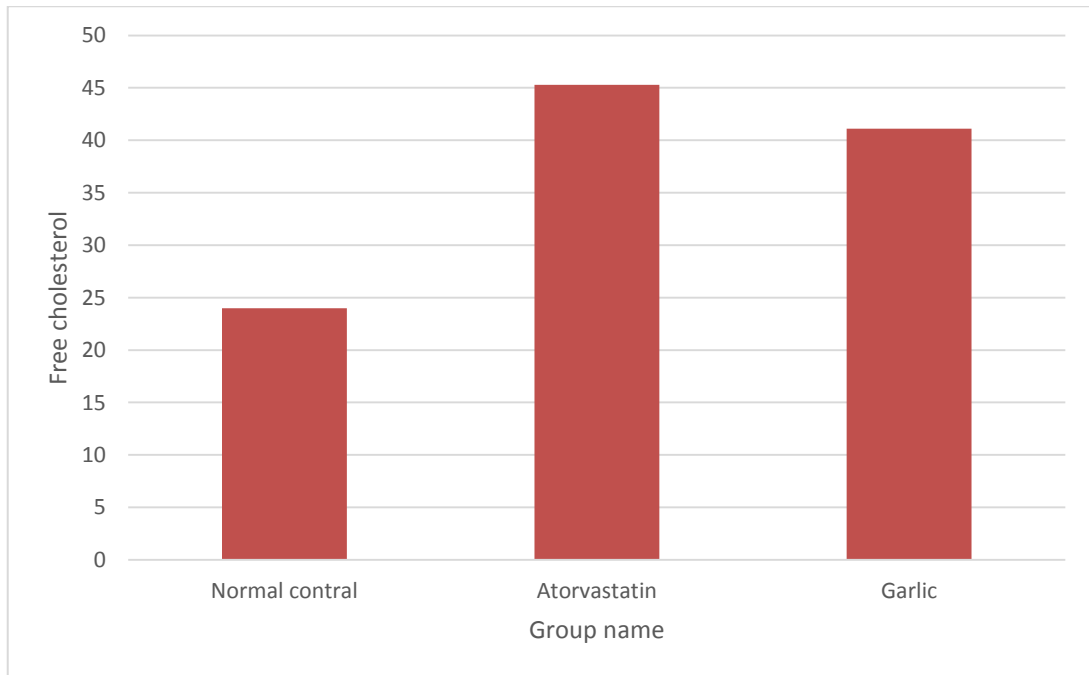
**Table 3-3: blood lipid profile in garlic group (mg/dl)**

<b>Garlic</b>	<b>Total cholesterol</b>	<b>LDL</b>	<b>HDL</b>	<b>TG</b>
1	38	34	12	48
2	48	44	12	48
3	40	36	10	34
4	41	35	9	34
5	38	34	8	86
6	42	37	14	53

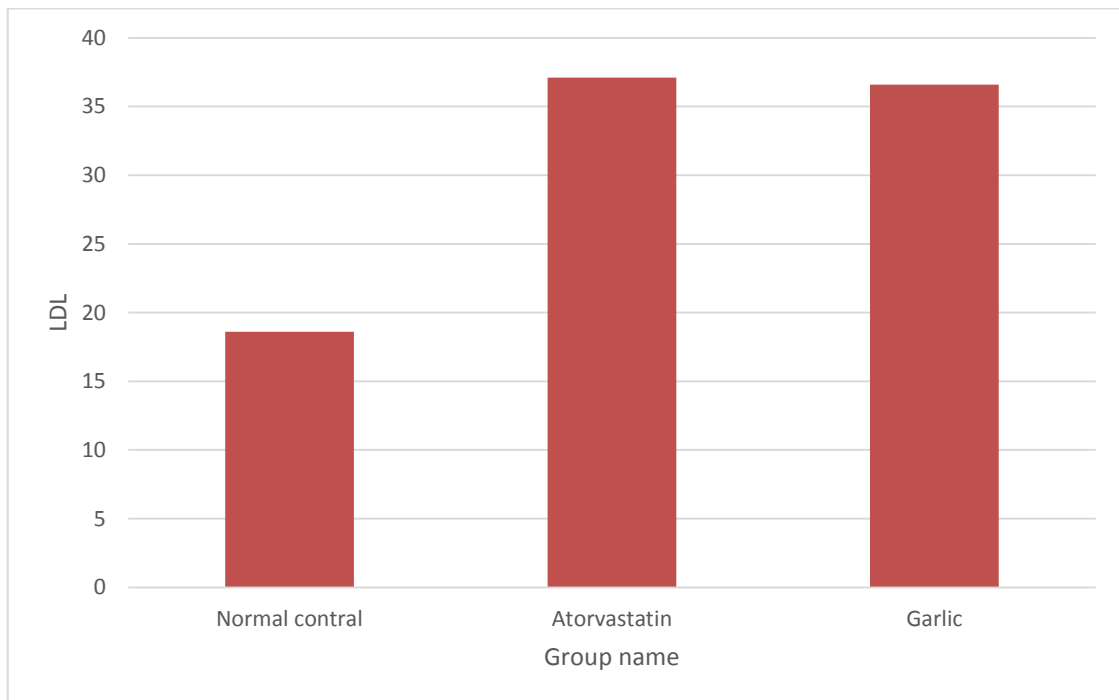
**Table 3-4: Result of Lipid profile among the 3 study groups**

<b>Group name</b>	<b>Total cholesterol</b>	<b>LDL</b>	<b>HDL</b>	<b>TG</b>
<b>Normal control</b>	<b>24 +</b> (2.5298221)	<b>18.6 +</b> (2.3380904)	<b>16.1 +</b> (5.419102)	<b>105.8 +</b> (5.419102)
<b>Atorvastatin</b>	<b>45.3 +</b> (13.559744)	<b>37.1 +</b> (13.166878)	<b>17.1 +</b> (12.566667)	<b>117.5 +</b> (29.392176)
<b>Garlic</b>	<b>41.1 +</b> (3.7103459)	<b>36.6 +</b> (3.7771241)	<b>10.8 +</b> (2.228602)	<b>50.5 +</b> (19.09712)

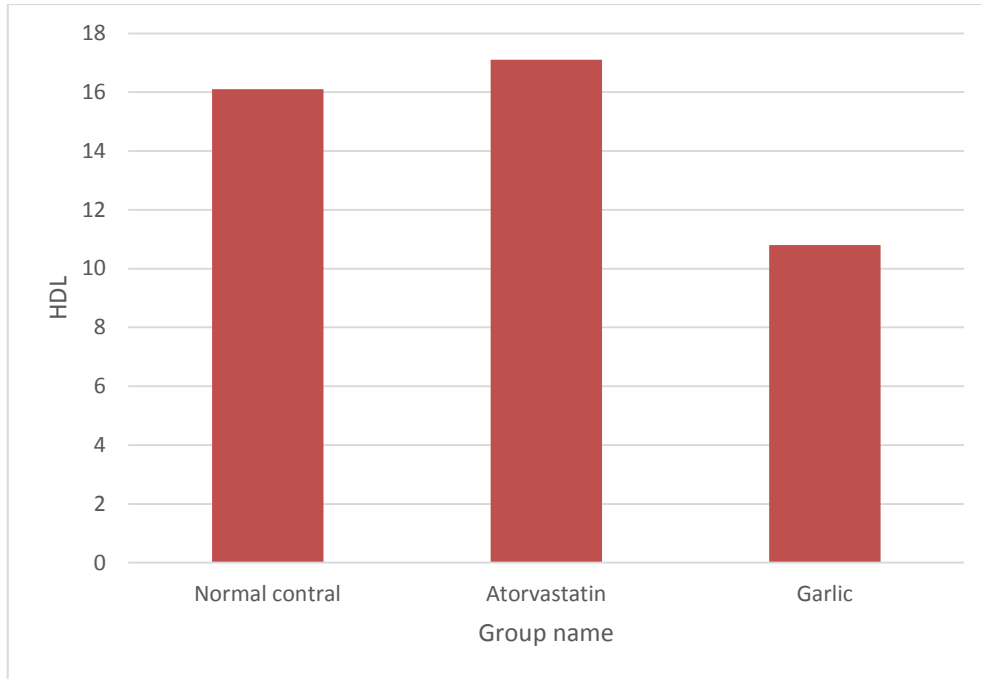
- Mean + (Standard Deviation)



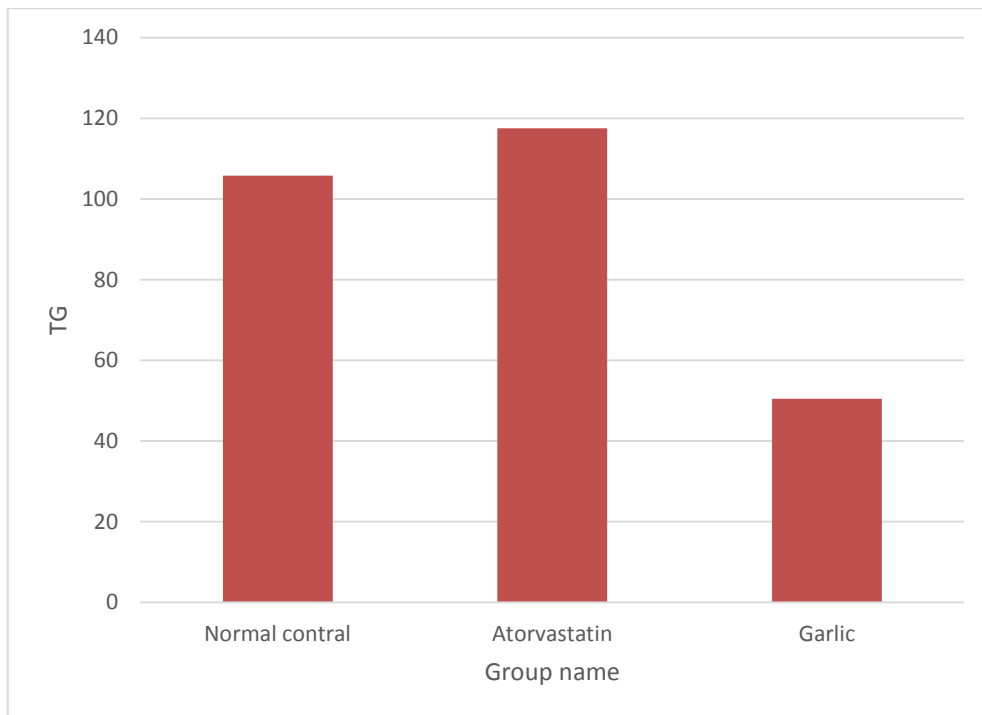
**Figure 3-5:** Free cholesterol levels among the 3 study groups



**Figure 3-6:** LDL levels among the 3 study groups



**Figure 3-7:** Result of LDH levels among the 3 study groups



**Figure 3-8:** Total Triglycerides levels among the 3 study groups.

**Table 3-5: Comparison of Total cholesterol level between Garlic and Normal control group:**

<b>Difference</b>	17.100
<b>Standard error</b>	1.833
<b>95% Confidence Interval [CI]</b>	13.0151 to 21.1849
<b>t-statistic</b>	9.327
<b>Significance level</b>	P < 0.0001

The P-Value is < 0.0001.

The result is significant at  $p < 0.05$ .

**Table 3-6: Comparison of LDL level between Garlic and Normal control group:**

<b>Difference</b>	18.000
<b>Standard error</b>	1.814
<b>95% CI</b>	13.9592 to 22.0408
<b>t-statistic</b>	9.925
<b>Significance level</b>	P < 0.0001

The P-Value is < 0.0001.

The result is significant at  $p < 0.05$ .

**Table 3-7: Comparison of HDL level between Garlic and Normal control group:**

<b>Difference</b>	-5.300
<b>Standard error</b>	2.392
<b>95% CI</b>	-10.6300 to 0.0300
<b>t-statistic</b>	-2.216
<b>Significance level</b>	P = 0.0511

The P-Value is 0.0511.

The result is not significant at  $p < 0.05$ .

**Table 3-8: Comparison of TG level between Garlic and Normal control group:**

<b>Difference</b>	-55.300
<b>Standard error</b>	8.104
<b>95% CI</b>	-73.3572 to -37.2428
<b>t-statistic</b>	-6.824
<b>Significance level</b>	P < 0.0001

The P-Value is < 0.0001.

The result is significant at  $p < 0.05$ .

**Table 3-9: Comparison of Total cholesterol level between Garlic and Atorvastatin group:**

<b>Difference</b>	-4.200
<b>Standard error</b>	5.739
<b>95% CI</b>	-16.9878 to 8.5878
<b>t-statistic</b>	-0.732
<b>Significance level</b>	P = 0.4811

The P-Value is 0.4811.

The result is not significant at  $p < 0.05$ .

**Table 3-10: Comparison of LDL level between Garlic and Atorvastatin group:**

<b>Difference</b>	-0.500
<b>Standard error</b>	5.592
<b>95% CI</b>	-12.9601 to 11.9601
<b>t-statistic</b>	-0.089
<b>Significance level</b>	P = 0.9305

The P-Value is 0.9305.

The result is not significant at  $p < 0.05$ .

**Table 3-11: Comparison of LDH level between Garlic and Atorvastatin group:**

<b>Difference</b>	-6.300
<b>Standard error</b>	5.210
<b>95% CI</b>	-17.9094 to 5.3094
<b>t-statistic</b>	-1.209
<b>Significance level</b>	P = 0.2544

The P-Value is 0.2544.

The result is not significant at  $p < 0.05$ .

**Table 3-12: Comparison of TG level between Garlic and Atorvastatin group:**

<b>Difference</b>	-67.000
<b>Standard error</b>	14.310
<b>95% CI</b>	-98.8839 to -35.1161
<b>t-statistic</b>	-4.682
<b>Significance level</b>	P = 0.0009

The P-Value is 0.0009.

The result is not significant at  $p < 0.05$ .

### **3.2 Discussion:**

The main objective of this research work is to study the effect of garlic juice on the cholesterol level in white albino rats. TG ,HDL,LDL and total cholesterol level were investigated in the blood of white albino rats when subjecting to administration of normal diet , high cholesterol diet mixed with statin as a drug and high cholesterol diet mixed with a garlic juice.

Comparing HDL value (mg/dl) in normal control group and garlic group ,this value decreased from 16.1 to 10.8 ( table 4 ) and this is reverse to our expectations and may be due to the dose and to type of garlic used.

Concerning LDL the same unexpected results were observed to increase from 18.6 to 36.6 mg/dl when comparing control group and garlic group and may be explained in term of same reasons.

Triglyceride (TG) value was lowered obviously though out this experiment Table (4), and this is expected and desired.

Finally we conclude that garlic juice is effective in patient with cholesterol with hypertriglyceridemia.

Other research works may be extended to study effect of garlic on HDL and LDL.

# **Chapter Four**

## **Recommendations and conclusion**

## **Chapter Four**

### **Recommendation and conclusion**

#### **4.1 Conclusion:**

We have demonstrated the cholesterol-lowering effects of Garlic in rats. Although the mechanism(s) is not completely understood, the data from our animal study indicate that the hypocholesterolemic action of garlic stems in part from lowering the Triglyceride level.

#### **4.2 Recommendations:**

We need further study on garlic

We need another method of garlic extraction

We need toxicological study on garlic

We need to fractionation

We need to increase number of experimental rats

in all groups to avoid the variation

We need to separate each rat in cage

We need to increase the dose and duration of experiment

We need to use rats that have the same weight

## References:

1. Bose, S.; Laha, B.; Banerjee, S. Quantification of allicin by high performance liquid chromatography-ultraviolet analysis with effect of post-ultrasonic sound and microwave radiation on fresh garlic cloves. *Pharmacogn. Mag.* 2014, 10, 288–293.
2. Diretto, G.; Rubio-Moraga, A.; Argandona, J.; Castillo, P.; Gomez-Gomez, L.; Ahrazem, O. Tissue-specific accumulation of sulfur compounds and saponins in different parts of garlic cloves from purple and white ecotypes. *Molecules* 2017, 22, 1359.
3. Szychowski, K.A.; Rybczynska-Tkaczyk, K.; Gawel-Beben, K.; Swieca, M.; Karas, M.; Jakubczyk, A.; Matysiak, M.; Binduga, U.E.; Gminski, J. Characterization of active compounds of different garlic (*Allium sativum* L.) cultivars. *Pol. J. Food Nutr. Sci.* 2018, 68, 73–81.
4. Jacob, B.; Narendhirakannan, R.T. Role of medicinal plants in the management of diabetes mellitus: A review. *3 Biotechnol.* 2019, 9, 4.
5. Boonpeng, S.; Siripongvutikorn, S.; Sae-Wong, C.; Sutthirak, P. The antioxidant and anti-cadmium toxicity properties of garlic extracts. *Food Sci. Nutr.* 2014, 2, 792–801.
6. Lee, D.Y.; Li, H.; Lim, H.J.; Lee, H.J.; Jeon, R.; Ryu, J.-H. Anti-inflammatory activity of sulfur-containing compounds from garlic. *J. Med. Food.* 2012, 15, 992–999
7. Hayat, S.; Cheng, Z.; Ahmad, H.; Ali, M.; Chen, X.; Wang, M. Garlic, from remedy to stimulant: Evaluation of antifungal potential reveals diversity in phytoalexin allicin content among garlic cultivars; allicin containing aqueous garlic extracts trigger antioxidants. *Front. Plant Sci.* 2016, 7, 1235
8. Percival, S.S. Aged garlic extract modifies human immunity. *J. Nutr.* 2016, 146, 433S–436S
9. Lee, H.S.; Lim, W.C.; Lee, S.J.; Lee, S.H.; Lee, J.H.; Cho, H.Y. Antiobesity effect of garlic extract fermented by *Lactobacillus plantarum* bl2 in diet-induced obese mice. *J. Med. Food* 2016, 19, 823–829.
10. Seckiner, I.; Bayrak, O.; Can, M.; Mungan, A.G.; Mungan, N.A. Garlic supplemented diet attenuates gentamicin nephrotoxicity in rats. *Int. Braz. J. Urol.* 2014, 40, 562–567
11. Yun, H.M.; Ban, J.O.; Park, K.R.; Lee, C.K.; Jeong, H.S.; Han, S.B.; Hong, J.T.

- Potential therapeutic effects of functionally active compounds isolated from garlic. *Pharmacol Ther.* 2014, 142, 183–195
12. Kimura, S.; Tung, Y.C.; Pan, M.H.; Su, N.W.; Lai, Y.J.; Cheng, K.C. Black garlic: A critical review of its production, bioactivity, and application. *J. Food Drug Anal.* 2017, 25, 62–70.
  13. (Bordia et al., 1998)
  14. (Okada et al., 2005; Gorinstein et al., 2006; Leelarungrayub et al., 2006; Corzo-Martinez et al., 2007)
  15. (Phelps and Harris, 1993; Pierre et al., 2005; Gorinstein et al., 2006; Lau, 2006)
  16. (Brosche et al., 1990)
  17. (Effendy et al., 1997; Corzo-Martinez et al., 2007)
  18. (Preety Lachhramka, *International Journal of Medical Science and Public Health*, Cholesterol lowering property of garlic (*Allium sativum*) on patients with hypercholesterolemia, Vol 5| Issue 11| 2016.)
  19. (Trejo-Gutierrez, Jorge F., and Gerald Fletcher, 2007, "Impact of Exercise on Blood Lipids and Lipoproteins", *Journal of Clinical Lipidology*, Vol. 1, pp. 175-181.)
  20. Donald Vort, Judith G. Voet. (2011)
  21. Peter A., Kathleen M. (2009).
  22. Jayasooriya A., et al. (2000). Effect of *Momordica charantia* powder on serum glucose levels and various lipid parameters in rats fed with cholesterol enriched rats. *J Ethnopharmacol.* 72, 331-336.
  23. Ann Prietrangeio, (2014). <http://www.healthline.com/health/cholesterol/effects-on-body>., The Effects of High Cholesterol on The Body.
  24. Diretto, G.; Rubio-Moraga, A.; Argandona, J.; Castillo, P.; Gomez-Gomez, L.; Ahrazem, O. Tissue-specific accumulation of sulfur compounds and saponins in different parts of garlic cloves from purple and white ecotypes. *Molecules* 2017, 22, 1359
  25. Szychowski, K.A.; Rybczynska-Tkaczyk, K.; Gawel-Beben, K.; Swieca, M.; Karas, M.; Jakubczyk, A.; Matysiak, M.; Binduga, U.E.; Gminski, J. Characterization of active compounds of different garlic (*Allium sativum* L.) cultivars. *Pol. J. Food Nutr. Sci.* 2018, 68, 73–81
  26. Bradley, J.M.; Organ, C.L.; Lefer, D.J. Garlic-derived organic polysulfides and

- myocardial protection. *J. Nutr.* 2016, 146, 403S–409S.
27. Wang, Y.C.; Guan, M.; Zhao, X.; Li, X.L. Effects of garlic polysaccharide on alcoholic liver fibrosis and intestinal microflora in mice. *Pharm. Biol.* 2018, 56, 325–332 .
  28. Yoo, D.Y.; Kim, W.; Nam, S.M.; Yoo, M.; Lee, S.; Yoon, Y.S.; Won, M.H.; Hwang, I.K.; Choi, J.H. Neuroprotective effects of Z-ajoene, an organosulfur compound derived from oil-macerated garlic, in the gerbil hippocampal CA1 region after transient forebrain ischemia. *Food Chem. Toxicol.* 2014, 72, 1–7.
  29. Mansingh, D.P.; Dalpati, N.; Sali, V.K.; Vasanthi, A.H.R. Alliin the precursor of allicin in garlic extract mitigates proliferation of gastric adenocarcinoma cells by modulating apoptosis. *Pharmacogn. Mag.* 2018, 14, S84–S91.
  30. Torres-Palazzolo, C.; Ramirez, D.; Locatelli, D.; Manucha, W.; Castro, C.; Camargo, A. Bioaccessibility and permeability of bioactive compounds in raw and cooked garlic. *J. Food Compos. Anal.* 2018, 70, 49–53.
  31. Lanzotti, V.; Bonanomi, G.; Scala, F. What makes allium species effective against pathogenic microbes? *Phytochem. Rev.* 2013, 12, 751–772.
  32. Liu, J.; Ji, F.; Chen, F.M.; Guo, W.; Yang, M.L.; Huang, S.X.; Zhang, F.; Liu, Y.S. Determination of garlic phenolic compounds using supercritical fluid extraction coupled to supercritical fluid chromatography/tandem mass spectrometry. *J. Pharm. Biomed. Anal.* 2018, 159, 513–523.
  33. Nagella, P.; Thiruvengadam, M.; Ahmad, A.; Yoon, J.Y.; Chung, I.M. Composition of polyphenols and antioxidant activity of garlic bulbs collected from different locations of Korea. *Asian J. Chem.* 2014, 26, 897–902.
  34. Hang, X. Isolation and identification of garlic polysaccharide. *Food Sci.* 2005, 26, 48–51.
  35. Sohn, C.W.; Kim, H.; You, B.R.; Kim, M.J.; Kim, H.J.; Lee, J.Y.; Sok, D.E.; Kim, J.H.; Lee, K.J.; Kim, M.R. High temperature- and high pressure-processed garlic improves lipid profiles in rats fed high cholesterol diets. *J. Med. Food.* 2012, 15, 435–440.
  36. Ha, A.W.; Ying, T.; Kim, W.K. The effects of black garlic (*Allium sativum*) extracts on lipid metabolism in rats fed a high fat diet. *Nutr. Res. Pract.* 2015, 9, 30–36.
  37. Siddiqui, N.A.; Haider, S.; Misbah-ur-Rehman, M.; Perveen, T. Role of herbal formulation of garlic on lipid profile in patients with type 2 diabetes related

- dyslipidemia. Pak. Heart J. 2016, 49, 146–150.
38. Ho, X.L.; Tsen, S.Y.; Ng, M.Y.; Lee, W.N.; Low, A.; Loke, W.M. Aged garlic supplement protects against lipid peroxidation in hypercholesterolemic individuals. *J. Med. Food* 2016, 19, 931–937.
39. Determination of allicin in allium sativum using high performance liquid chromatography and study of genotoxic effect on human leukocytes September 2015 *Asian Journal of Pharmaceutical and Clinical Research* 8(6) Authors: Nishu Sekar , et.al ...
40. Achuthan C.R. and Padikkala J., Hypolipidemic effect of *Alpinia galangal* (Rasna) and *Kaempferia galangal* (Kachoori), *Ind J Clin Biochem*, 1997, 12(1), 55-58. (With minor change).
41. Bhalla K, Hwang BJ, Dewi RE, et al. Metformin prevents liver tumorigenesis by inhibiting pathways driving hepatic lipogenesis. *Cancer Prev Res (Phila)* 2012;5:544–52.
42. Augusti KT. Therapeutic values of onion (*Allium cepa* L.) and garlic (*Allium sativum* L). *Indian J Exp Biol* 1996;34:634–40.
43. Budoff MJ, Ahmadi N, Gul KM, et al. Aged garlic extract supplemented with B vitamins, folic acid and L-arginine retards the progression of subclinical atherosclerosis: a randomized clinical trial. *Prev Med* 2009; 49:101–7.
44. Rahman K. Garlic and aging: new insights into an old remedy. *Ageing Res Rev* 2003;2:39–56.

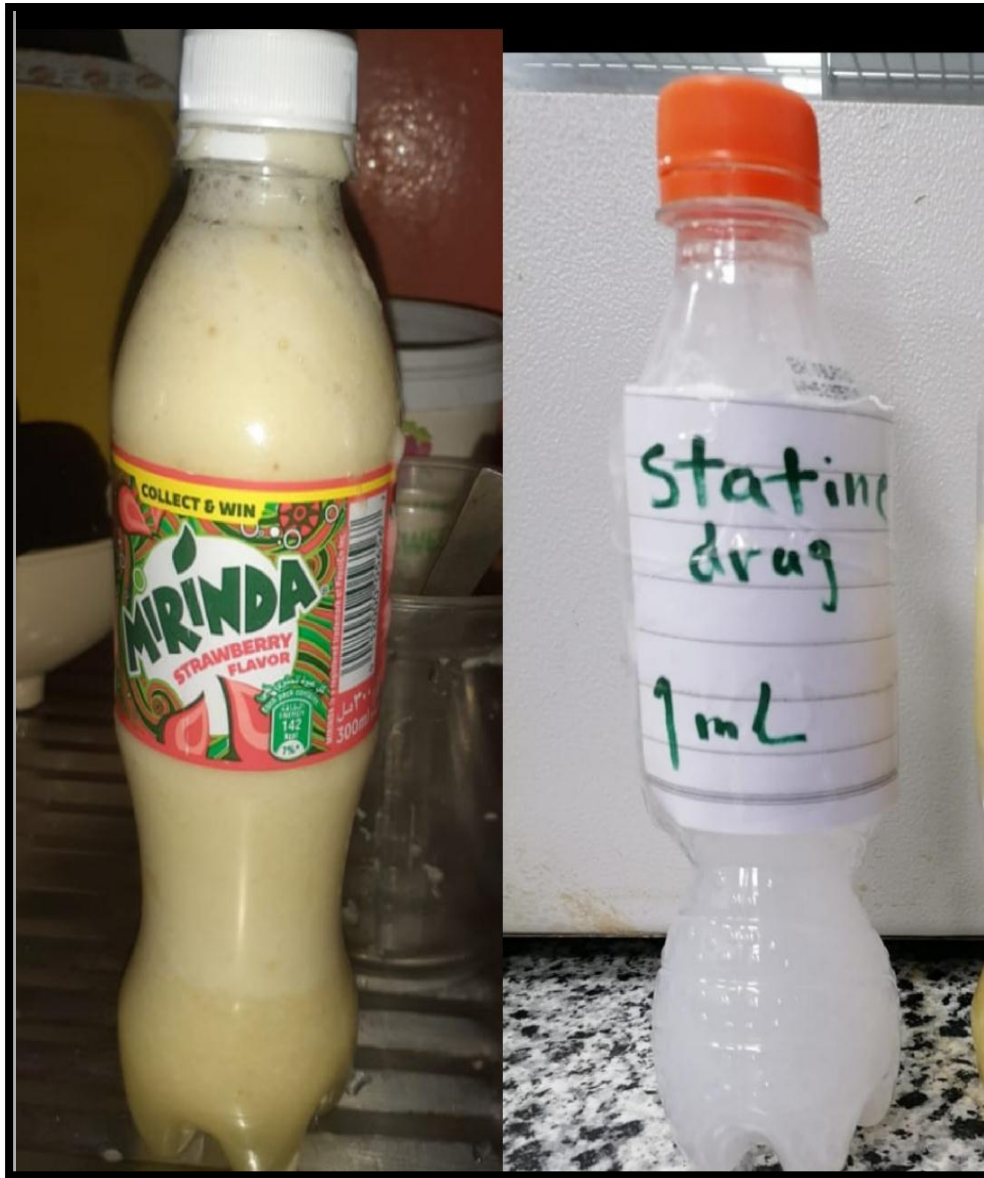
# **Appendixes**



**Appendix 1 : Rat feeding with gastric gavage**



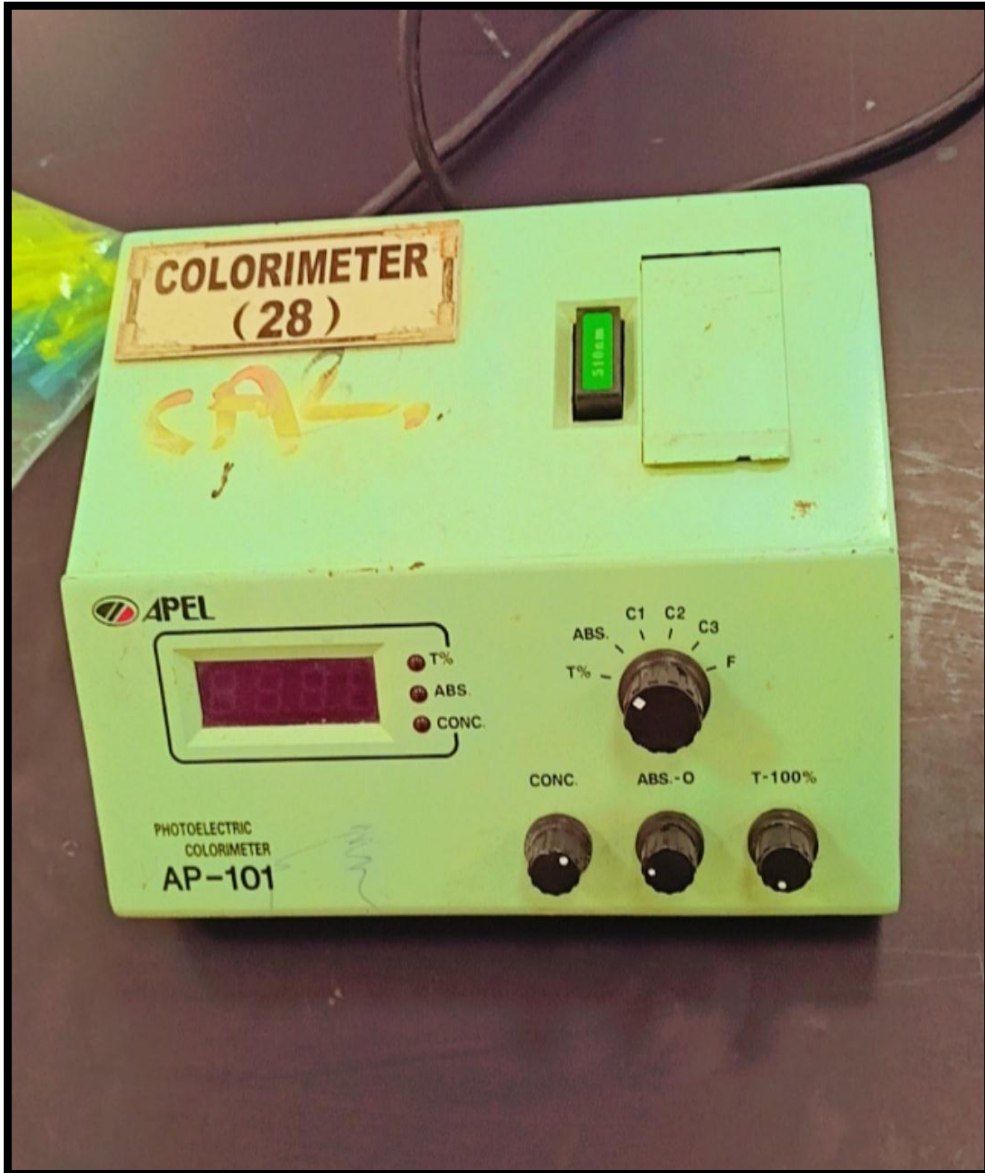
**Appendix 2 : Food of rats**



**Appendix 3 : Prepared garlic and atorvastatin**



**Appendix 4 : Centrifuge**



**Appendix 5 : colorimeter**