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EFFECT OF SINGLE-CLOVE GARLIC (ALLIUM SATIVUM VAR. SOLO GARLIC) EXTRACT ON LIPID PROFILE IN MALE WISTAR RATS WITH DYSLIPIDEMIA

Miranda Winda Sari Sitorus[1,2]*, Suandy[1,2], Linda Chiuman[2]
[1]PUI Phyto Degenerative & Lifestyle Medicine, Universitas Prima Indonesia, Jl. Sampul No.3, Sei Putih Barat, Medan Petisah, Medan, Sumatera Utara 20118, Indonesia
[2]Faculty of Medicine, Dentistry, and Public Health Sciences, Universitas Prima Indonesia, Jl. Sampul No.3, Sei Putih Barat, Medan Petisah, Medan, Sumatera Utara 20118, Indonesia
*sitorusmiranda2003@gmail.com

ABSTRACT

Dyslipidemia, a major risk factor for cardiovascular diseases, is characterized by abnormal lipid profiles. While conventional treatments exist, they often have side effects, leading to a growing interest in natural alternatives. Single-clove garlic (Allium sativum var. solo) contains bioactive compounds known for their antioxidant and lipid-lowering properties. This study aimed to evaluate the effectiveness of single-clove garlic extract in improving the lipid profile, including total cholesterol, triglycerides, HDL, and LDL, in dyslipidemic male Wistar rats. A quasi-experimental pre-test and post-test control group design was used with 24 male Wistar rats using purposive sampling. Dyslipidemia was induced with a high-fat diet for 40 days. The rats were divided into four groups: a positive control (simvastatin), a negative control, and two treatment groups receiving different doses of single-clove garlic extract. Lipid profiles were measured on days 7, 14, 21, and 28. Data were analyzed using one-way ANOVA and Tukey's HSD post-hoc test. The administration of single-clove garlic extract significantly improved the lipid profile of the rats. Over 28 days, treatment groups showed a significant reduction in total cholesterol, triglycerides, and LDL levels, while HDL levels increased. These changes were comparable to those observed in the positive control group. The findings suggest that single-clove garlic extract is effective in improving the lipid profile in dyslipidemic male Wistar rats.

Keywords: dyslipidemia; garlic; lipids; plant extracts; wistar rats

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INTRODUCTION

The most prevalent form of dyslipidemia is characterized by an abnormal lipid profile, which typically includes hypertriglyceridemia, hypercholesterolemia, and elevated low-density lipoprotein (LDL) levels, accompanied by a reduction in high-density lipoprotein (HDL). These alterations contribute significantly to the development of atherosclerosis and increase the risk of cardiovascular diseases (Thongtang et al., 2022). Dyslipidemia is a disorder of lipid metabolism characterized by abnormalities in plasma lipid fractions. The main disturbances include elevated levels of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG), along with decreased levels of high-density lipoprotein cholesterol (HDL-C) (Berberich & Hegele, 2022). These lipid fraction abnormalities are recognized as risk factors for non-communicable diseases, such as heart disease, arterial obstruction (arteriosclerosis), cerebrovascular obstruction (stroke), hypertension, and overweight (Powell-Wiley et al., 2021).

Dyslipidemia accounts for nearly four million cardiovascular disease–related deaths worldwide. In recent years, Asian nations, including Indonesia, Thailand, Malaysia, and China, have experienced the most significant rises in cholesterol levels, surpassing those reported in Western regions such as Europe and the United States (Zhao et al., 2019). Epidemiological data indicate that an increase in LDL levels of 5–30 mg/dL is associated with a 30% higher risk of developing coronary heart disease. The intake of saturated fatty acids has been shown to elevate LDL cholesterol levels. The recommended daily requirement of saturated fatty acids should not exceed 10% of total energy intake, with cholesterol consumption limited to no more than 300 mg per day. Elevated LDL cholesterol together with reduced HDL cholesterol promotes cholesterol accumulation in peripheral tissues and blood vessels, thereby contributing to atherosclerotic processes (Agung, 2021). The rising incidence of atherosclerosis, fatty liver disease, cardiovascular disorders, and degenerative diseases associated with dyslipidemia has led to increased mortality rates, highlighting the need for early therapeutic interventions (Finney et al., 2023).

Treatment of dyslipidemia with conventional drugs, such as simvastatin, often requires prolonged administration and may be associated with adverse effects, including nausea, vomiting, and hepatotoxicity. Consequently, there is growing interest in the use of biological resources as alternative therapies, such as single-clove garlic, which exhibit minimal side effects (Kong et al., 2020). Single-clove garlic (allium sativum var. solo) is a cultivar characterized by a single, large clove. It contains phenolic and flavonoid compounds that contribute to its antioxidant activity. For instance, extracts from Tawangmangu and Magetan regions have demonstrated IC50 values of 13.777 ppm and 20.216 ppm, respectively, indicating their potential to scavenge free radicals. These antioxidant effects are primarily due to the presence of phenolic and flavonoid compounds capable of donating hydrogen atoms to neutralize free radicals (Juniar; et al., 2019). A previos study demonstrated that in a dyslipidemic group with elevated cholesterol and folic acid levels, administration of garlic extract at a dose of 400 mg per 200 g body weight per day for 14 consecutive days resulted in reductions in total cholesterol, triglycerides, and the LDL/HDL ratio, along with an increase in HDL levels (Ahmad et al., 2024).

Despite evidence supporting the lipid-lowering and antioxidant properties of single-clove garlic, most studies to date have focused on general garlic varieties or short-term interventions in human subjects. Limited research has specifically examined the effects of allium sativum var. solo on lipid profiles in controlled animal models of dyslipidemia, particularly in male Wistar rats. Furthermore, variations in bioactive compound content based on cultivation regions, dosage, and duration of treatment highlight the need for standardized investigations. Therefore, evaluating the effectiveness of single-clove garlic extract in improving lipid profiles in dyslipidemic male Wistar rats could provide critical preclinical data to support its potential as a natural therapeutic alternative for dyslipidemia.

METHOD

This study employed a quasi-experimental design with a pre-test and post-test control group, investigating the effects of single-clove garlic extract (Allium sativum var. solo garlic) on the lipid profile of male Wistar rats with dyslipidemia. The study population consisted of 24 male Wistar rats. The sample size was calculated using Federer's formula(Clayton & Federer, 1999), resulting in six rats per group. Accordingly, a total of 24 male Wistar rats were used in this study using purposive sampling, which were divided into four groups with six rats in each group. The rats were acclimatized for one week prior to the experiment. Dyslipidemia was induced by administering a high-fat diet consisting of butter, quail eggs, goat fat, used cooking oil, and beef fat for 40 days. Blood samples were collected twice: before the initiation of the high-fat diet and after the feeding period. The rats were divided into four groups (n = 6 per group). The positive control group received butter and quail eggs 2–3 times per day, along with oral simvastatin at a dose of 2.1 mg/kg body weight per day. The negative control group was administered aquabidest and fed the high-fat diet. Treatment group 1 received single-clove garlic extract three times daily in addition to the high-fat diet, while treatment group 2 received the same extract orally via gavage three times daily during feeding, along with the high-fat diet. Lipid profile analysis was conducted using a spectrophotometer. A 5 µL blood sample was collected from the tail vein of each Wistar rat and placed on a test strip. The device then measured and displayed the lipid profile results on the spectrophotometer screen. Blood samples were collected twice: before and after the administration of single-clove garlic extract.

The data were processed analytically, yielding results for total cholesterol, LDL, HDL, and triglyceride levels. Normality of the data was assessed using the Shapiro-Wilk test. For normally distributed data, one-way ANOVA followed by Tukey's HSD post-hoc test was performed. For non-normally distributed data, the Kruskal-Wallis test was applied. All statistical analyses were conducted using IBM SPSS Statistics 27 for Windows, and a p-value of <0.05 was considered statistically significant. The study was approved by the Health Research Ethics Committee, Universitas Prima Indonesia No. 021/KEPK/UNPRI/II/2025.

RESULT

This study investigated the lipid profile (total cholesterol, triglycerides, HDL, and LDL) following the administration of single-clove garlic extract (*Allium sativum* var. solo garlic) in male Wistar rats with dyslipidemia, conducted from March to May 2025. The lipid profile measurements were recorded on days 7, 14, 21, and 28. This study investigated the lipid profile (total cholesterol, triglycerides, HDL, and LDL) following the administration of single-clove garlic extract (*Allium sativum* var. solo garlic) in male Wistar rats with dyslipidemia, conducted from March to May 2025. The lipid profile measurements were recorded on days 7, 14, 21, and 28.

Table 1.
Lipid Profile Results (Total Cholesterol, Triglycerides, HDL, and LDL)

Gorup	Day	Lipid Profile			
		TC Mean±SD	TG Mean±SD	HDL Mean±SD	LDL Mean±SD
Positive	7	141,33 ±7,31	221,7 ±29,96	31,33 ±1,96	83,17±5,49
	14	113,5±8,83	189,3±21,93	33,17±2,93	53±10,92
	21	86,83±5,56	144,8±17,74	34,83±5,31	25±5,40
	28	66,33±6,65	95,5±21,28	38,33±6,31	7,5±4,14
Negative	7	158,83±12,43	250,5±20,11	31,17±1,83	92,17±6,91
	14	142±14,25	239,33±18,48	30,83±2,40	63,17±10,87
	21	127,33±10,63	213,67±10,37	32,17±3,54	52,33±7,63
	28	118±9,01	167,17±12,34	35,17±4,62	49,5±12,91
Treatment 1	7	158,17±6,74	280,83±34,53	34,67±5,79	78,83±6,46
	14	136,83±8,61	243,5±32,52	39,83±7,60	48±6,60
	21	117±9,61	198,17±18,51	42±6,26	34,33±4,97
	28	83,67±8,64	126,5±7,15	41±4,60	19,5±10,09
Treatment 2	7	154,17±8,06	229±24,71	31,67±5,05	84,33±,28
	14	131,67±10,46	174,33±73,66	35,17±4,22	54±6,10
	21	96±7,40	167,33±15,87	35±4,05	27,17±1,60
	28	71,83±5,85	107,33±7,69	39,33±3,93	12±6,63

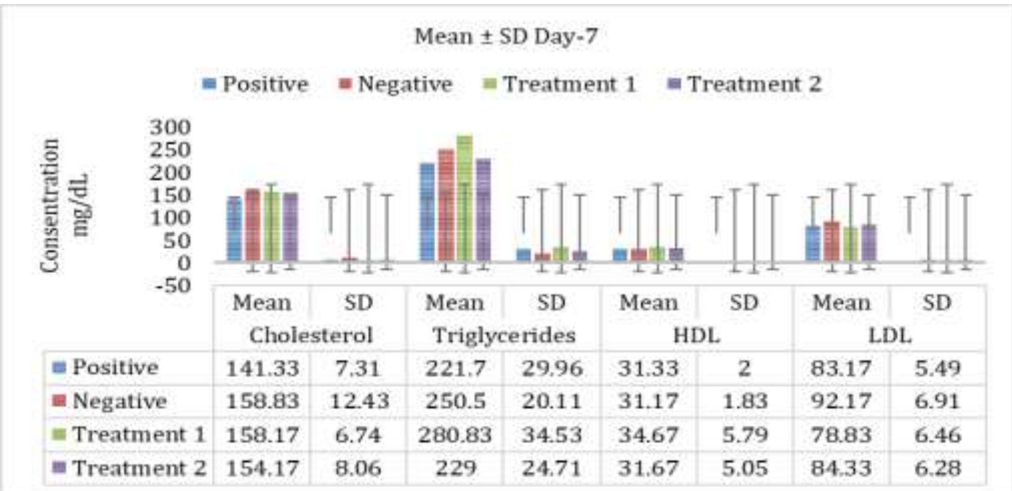
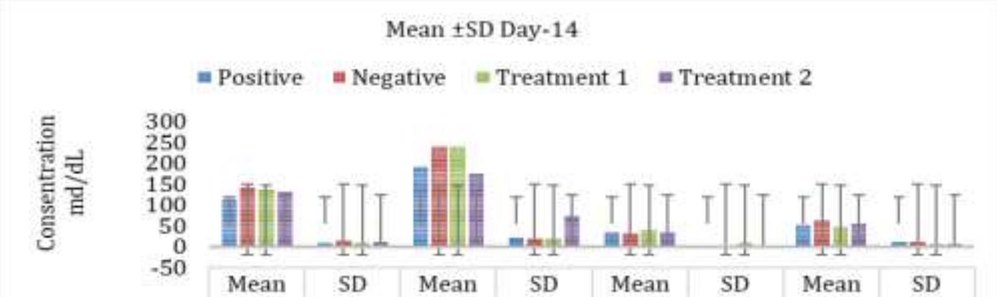


Figure 1. Mean ±SD Day-7

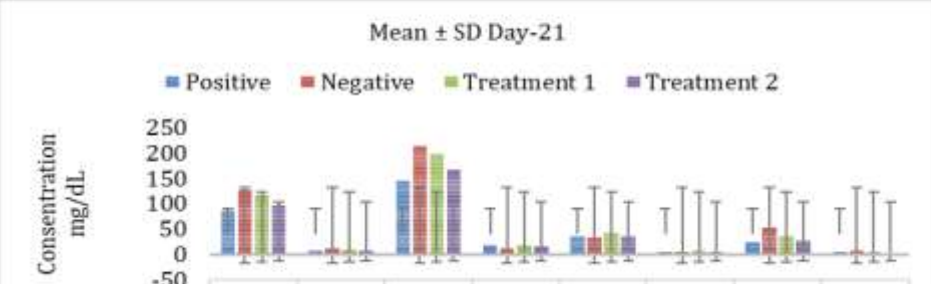
On day 7, the lipid profile showed clear differences among the four groups. The positive control group had the best lipid values, with the lowest cholesterol, triglycerides, and LDL levels. ANOVA showed significant differences for cholesterol, triglycerides, and LDL, while HDL did not differ among groups. Tukey's test confirmed that the negative control and both treatment groups had higher cholesterol and triglycerides than the positive control, with Treatment 1 having the highest triglycerides. Treatment 1 also showed the lowest LDL level. HDL levels were similar across all groups. Overall, the treatments affected cholesterol, triglycerides, and LDL, but did not influence HDL levels.



	Cholesterol Mean	Cholesterol SD	Triglycerides Mean	Triglycerides SD	HDL Mean	HDL SD	LDL Mean	LDL SD
Positive	113.5	8.83	189.3	21.93	33.17	2.93	53	11
Negative	142	14.25	239	18.48	30.83	2	63.17	11
Treatment 1	136.83	8.61	239	18.48	39.83	7.6	48	6.6
Treatment 2	131.67	10.46	174	73.66	35.17	4.22	54	6.1

Figure 2. Mean ± SD Day-14

On day 14, the lipid profile showed that the positive control group had the lowest cholesterol, triglyceride, and LDL levels compared with the other groups. ANOVA confirmed significant differences in cholesterol, triglycerides, and HDL, but not in LDL. Tukey's test showed that cholesterol and triglycerides in the negative control, treatment 1, and treatment 2 were higher than in the positive control. Treatment 1 had the highest HDL level, while LDL levels remained similar across all groups, with no significant differences. Overall, the results indicate that the treatments affected cholesterol, triglycerides, and HDL, but had little impact on LDL levels.



	Cholesterol Mean	Cholesterol SD	Triglycerides Mean	Triglycerides SD	HDL Mean	HDL SD	LDL Mean	LDL SD
Positive	86.83	5.56	144.8	17.74	35	5	25	5.4
Negative	127.33	10.63	214	10.37	32.17	3.54	52.33	7.63
Treatment 1	117	9.61	198	18.51	42	6.26	34.33	4.97
Treatment 2	96	7.4	167	15.87	35	4.05	27.17	1.6

Figure 3. Mean ± SD Day-21

On day 21, the lipid profile showed strong differences among the four groups. The positive control group had the lowest cholesterol, triglyceride, and LDL levels, while the negative control group consistently showed the highest values. ANOVA confirmed significant differences for all lipid parameters—cholesterol, triglycerides, HDL, and LDL. Tukey's test showed that cholesterol and triglyceride levels in the negative control and both treatment groups were significantly higher than in the positive control, although treatment 2 was closer to the positive control. Treatment 1 had the highest HDL level, while LDL remained lowest in the positive control group. Overall, these findings indicate that all lipid parameters were significantly affected on day 21, with the positive control showing the best overall lipid profile.

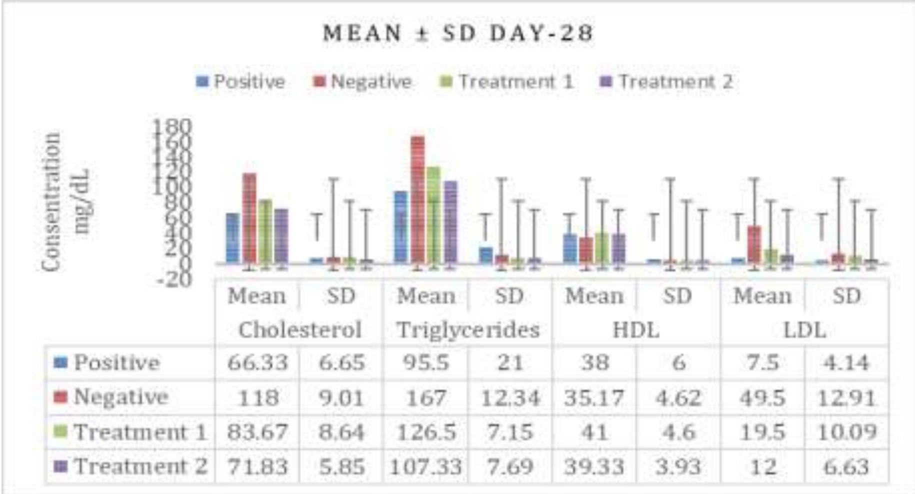


Figure 4. Mean ± SD Day-28

On day 28, the lipid profile showed large differences among the groups. The positive control group had the best results, with the lowest cholesterol, triglyceride, and LDL levels, while the negative control group showed the highest values for these parameters. ANOVA confirmed significant differences for cholesterol, triglycerides, and LDL, but HDL did not differ significantly among groups. Tukey’s test showed that all other groups had higher cholesterol and triglycerides than the positive control, although treatment 2 was the closest to it. LDL levels also remained much higher in the negative control and treatment groups compared with the positive control. Overall, day-28 data indicate strong treatment effects on cholesterol, triglycerides, and LDL, while HDL levels stayed relatively similar across groups.

Table 2.
Histopathological Observations of the Heart

Group	Histopathological observations	
	Day-0	Day-28
Positive	1,83 ± 0,41	0,5 ± 0,55
Negative	0,5 ± 0,55	0,5 ± 0,55
Treatment 1	1,33 ± 0,52	0,5 ± 0,55
Treatment 2	0,67 ± 0,82	0,67 ± 0,52

Histopathological examination of the heart showed that on day 0, the positive control group had the highest score, while the negative control and treatment 2 groups had the lowest. By day 28, the scores were similar across all groups, indicating an overall improvement or stabilization in heart tissue condition.

Table 3.
Histopathological Damage Score of the Heart

Group	Histopathological damage	
	Day-0	Day-28
Positive	2	0
Negative	1	1
Treatment 1	1	1
Treatment 2	2	0

Based on the histopathological analysis of the heart in experimental animals on day 0, the results showed that slide 1 exhibited cardiac damage of >25–50%, slides 2 and 3 showed cardiac damage of >0–25%, and slide 4 demonstrated cardiac damage of >25–50%.

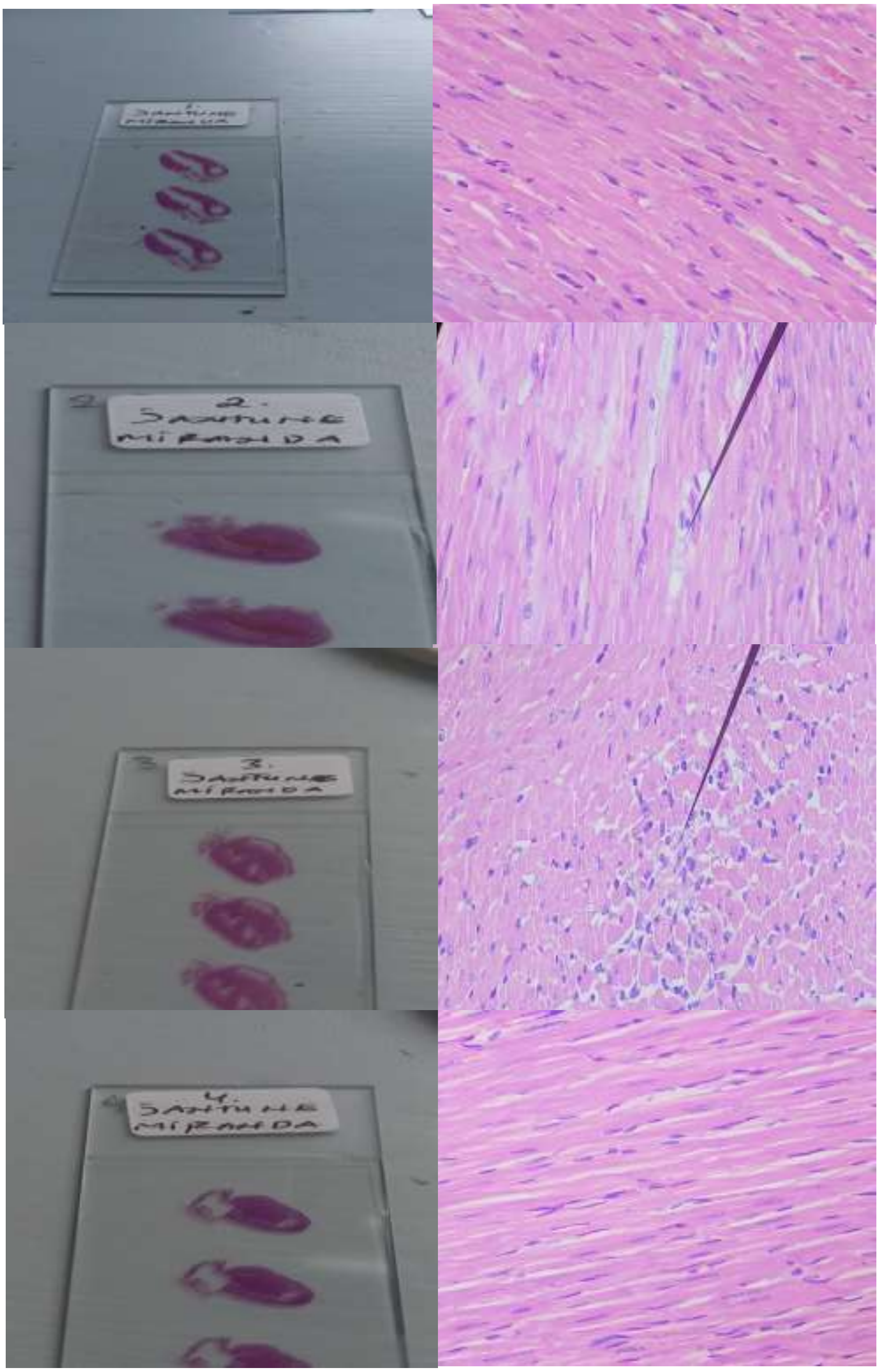


Figure 5. Histopathological findings of the heart observed using a Zeiss Primo Star microscope (Zeiss, Germany) with a 10× ocular lens and a 40× objective lens.

Based on the histopathological analysis of the heart in experimental animals on day 28, slides 1–4 showed cardiac damage in the range of 0–25%.

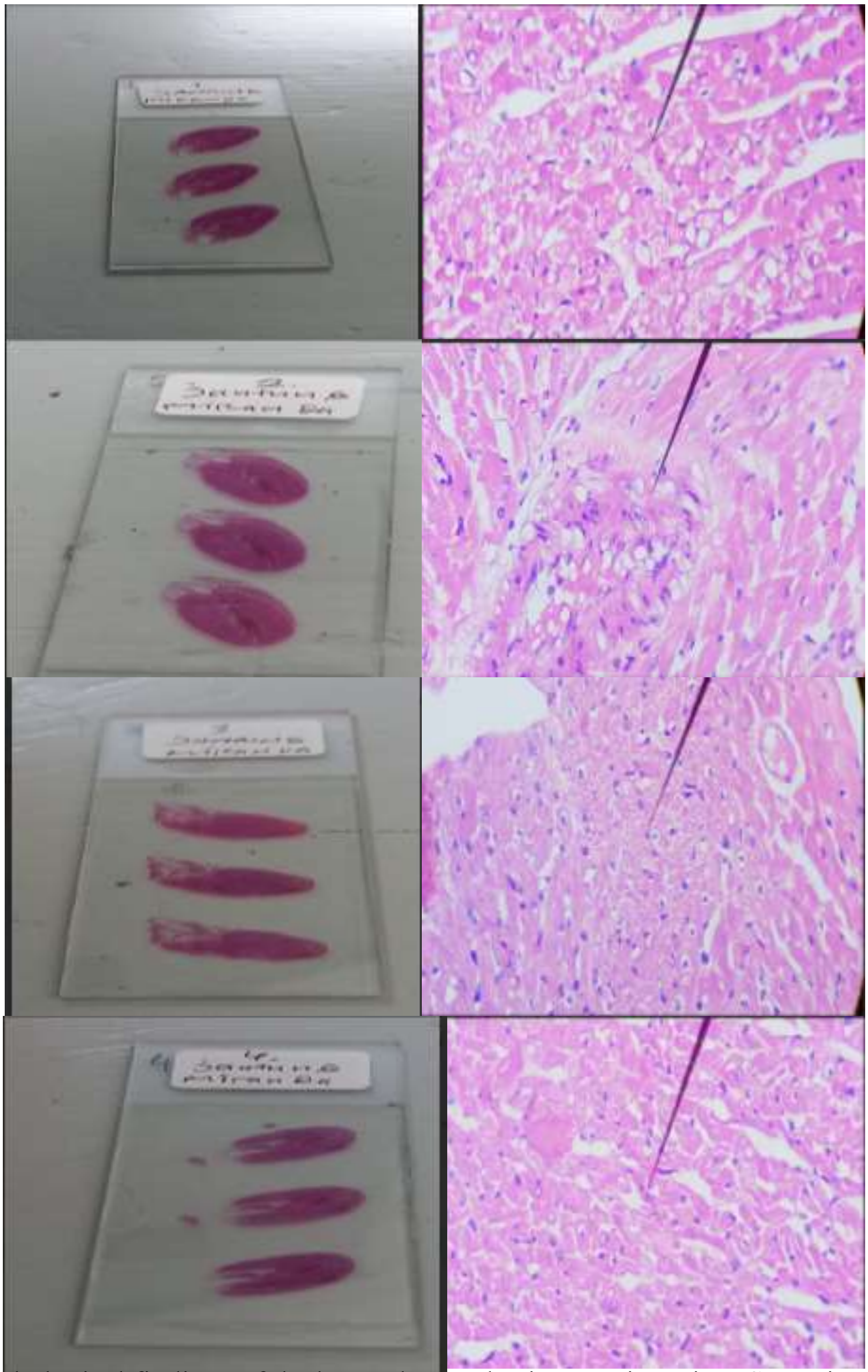


Figure 6. Histopathological findings of the heart observed using a Zeiss Primo Star microscope (Zeiss, Germany) with a 10× ocular lens and a 40× objective lens

DISCUSSION

Based on the results of this study, single-clove garlic extract was found to affect the blood lipid profile of male Wistar rats after 28 days of treatment. The study included four experimental groups, with measurements taken on days 7, 14, 21, and 28. The observed effects are attributed to the bioactive compounds present in single-clove garlic, including alkaloids, saponins, flavonoids, tannins, glycosides, and triterpenoids/steroids. Single-clove garlic can reduce cholesterol levels due to its content of allicin and various antioxidants, including vitamin C, germanium, sulfur-containing compounds, tannins, phenolics, and flavonoids (Qoyimmah & Herdyastuti, 2025). Single-clove garlic contains allicin at concentrations ranging from 1,500 to 27,800 mg/dL. Allicin reduces cholesterol levels by inhibiting the activity of HMG-CoA reductase, an enzyme involved in cholesterol biosynthesis. HMG-CoA reductase catalyzes the conversion of 3-hydroxy-3-methylglutaryl-CoA (HMG-CoA) to mevalonate, and allicin acts as a competitive inhibitor of this enzyme (Gebhardt, 1993). Additionally, allicin inhibits the activity of thiolase, an enzyme responsible for converting two molecules of acetyl-CoA into acetoacetyl-CoA. By inhibiting thiolase, the formation of acetyl-CoA, which serves as the carbon source for cholesterol synthesis, is reduced, thereby decreasing overall cholesterol production (Vögeli et al., 2018).

Najman et al, (2021) reported that the health-promoting effects of garlic are associated with its content of vitamins (C and B), minerals (selenium, calcium, potassium, and copper), polyphenols, and other bioactive compounds, which, together with organosulfur compounds, contribute to overall health improvement. The antioxidant effect of garlic is one of its most important properties for promoting health. Garlic protects blood vessels from the harmful effects of free radicals by exhibiting antioxidant activity. These antioxidants safeguard LDL cholesterol from oxidation, thereby delaying the progression of atherogenic changes and reducing cholesterol and lipid levels in the blood (Młynarska et al., 2024). By scavenging free radicals, antioxidants prevent lipid peroxidation and oxidative modification of LDL cholesterol in vitro. This may represent one of the mechanisms underlying garlic's protective effects against atherosclerosis. Garlic and its primary active constituent, diallyl disulfide, have been shown to be effective in preventing dyslipidemia and neutralizing reactive free radicals induced by a high-fat diet in hyperlipidemic rats (Mohammed Basheeruddin Asdaq et al., 2022).

CONCLUSION

This study successfully demonstrated that the administration of single-clove garlic extract is effective in improving the lipid profile in dyslipidemic male Wistar rats. The significant reduction in total cholesterol, triglycerides, and LDL levels, along with the increase in HDL, suggests that the extract possesses strong lipid-modulating properties. These findings provide compelling preclinical evidence that single-clove garlic could be a promising natural therapeutic alternative for the management of dyslipidemia, offering a potential solution to mitigate the side effects often associated with conventional treatments. The histopathological analysis of the heart in the test animals on day 0 revealed myocardial damage of >25%–50% in slide 1, >0%–25% in slides 2 and 3, and >25%–50% in slide 4. In contrast, histopathological analysis on day 28 showed myocardial damage of 0%–25% across slides 1–4.

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