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The Effect of Telang Flower Extract (*Clitoria Ternatea*) on Reducing Total Cholesterol Levels in Male Wistar Rats (*Rattus Norvegicus*) with Obesity

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ABSTRACT

Several health problems can arise from obesity, including an increased risk of diabetes mellitus, heart disease, high blood pressure, and high cholesterol. High cholesterol levels are associated with obesity, which is a health risk in and of itself. Achieving excellent health requires careful monitoring of cholesterol levels, and one way to do this is to eat foods rich in antioxidants. Specifically, this study used a laboratory experimental design, a true of experimental quantitative research. The research used twenty-four male Wistar rats (*Rattus norvegicus*). This study set out to compare the pre-and post-administration of Telang flower extract (*Clitoria ternatea*) to total cholesterol levels in the blood of rats (Rattus norvegicus). The tests were administered for homogeneity, one-way ANOVA, and normality. After that, SPSS was used to examine the study data. Researchers observed that compared to other methods, a 600mg/KgBW dose of butterfly pea flower extract (*Clitoria ternatea*) significantly reduced total cholesterol levels in obese male Wistar rats (*Rattus norvegicus*) from 65.06mg/dl to 37.46mg/dl. The study found that the phytochemical content of Telang flowers helped obese people lower their cholesterol levels.

Keywords:

Telang Flower, Cholesterol Levels, Obesity

1. INTRODUCTION

Human lifestyles are transformed by technological progress. Less physical activity is required to complete tasks because they do not require much movement. Because many food options are high in calories, such as fast food, and people do not exercise, they overeat [1], [2]. The metabolic disease known as obesity will develop if this disparity between caloric and energy expenditure persists [3].

The health risks associated with being overweight include type 2 diabetes, heart disease, high blood pressure, and abnormal lipid profiles [4]. Obesity is an abnormal or excessive body buildup of fat or adipose tissue. Obesity is defined as a body mass index (BMI) of 30 or more, whereas overweight is defined as a BMI of 25–29.9. A person is considered obese if their body fat percentage is abnormally high. This results from a chronic imbalance between caloric intake and expenditure [5].

Lifestyle factors like food and exercise, genetic factors like obesity in the family, preexisting diseases, and substance abuse, and demographic factors like age, gender, location, education, and income are all contributors to the epidemic of overweight and obesity [6]. Environmental variables, including the intake of high-calorie foods and drinks, excessive sugar consumption, insufficient physical activity, excessive television use, etc., are significant contributors to the worldwide epidemic of obesity, making lifestyle issues a major public health problem today. Because of social globalization, people are constantly bombarded with ads and displays for inexpensive, tasty, and high-calorie foods. Furthermore, there is a discrepancy between our caloric intake and expenditure since our physical requirements have evolved. The obesogenic environment that modern lifestyles foster promotes overeating and insufficient physical activity. One example is the correlation between adults' screen usage and their risk of obesity, according to some research [7].

High cholesterol levels are associated with obesity, which is a health risk in and of itself. Our bodies contain two kinds of cholesterol: Low-Density Lipoprotein (LDL), which can cling to blood vessel walls, and High-Density Lipoprotein (HDL), a lipid that can dissolve LDL. At the same time, total cholesterol is the sum of all cholesterol in the body [8].

One of the most frequent polycyclic compounds, cholesterol, is also known as a "sterol" due to its formation from the combination of alcohol and steroids. Cholesterol is fundamental to mammalian survival because of its role in cellular function and abundance in cell membranes. Oguro et al. also noted that it is a precursor to producing vital hormones and metabolites, including vitamin D and bile acids [9]. The functions of transportation, nerve conduction, and cellular signaling are all significantly impacted by cholesterol [8].

One of the most essential lipids in many membranes is cholesterol. Because of their solubility in water, lipids such as cholesterol and triglycerides must be carried into the bloodstream by proteins called lipoproteins. Several critical processes rely on lipoproteins. One of these is the transport of dietary lipids from the small intestine to various tissues, such as the liver, muscle, and adipose tissue. Another necessary process is the transport of hepatic lipids to peripheral tissues. Lastly, there is reverse cholesterol transport, which involves the transport of cholesterol from peripheral tissues to the liver and intestines [10].

Since cholesterol is lipophilic, it does not dissolve well in blood. Therefore, it is bundled as phospholipid-apolipoprotein lipoproteins [11]. The hydrophilic outer membrane of lipoproteins contains phospholipids, apolipoproteins, and free cholesterol. The lipid core might contain cholesterol esters and triglycerides. This lets lipid molecules travel through the blood to the needed cells. Distinct lipoproteins in the blood serve distinct purposes. HDL, IDL, LDL, and VLDL are lipoproteins.

LDL particles are believed to transmit at least two-thirds of circulating cholesterol in peripheral tissues. In contrast, HDL molecules may do the opposite. They return excess cholesterol to the liver for elimination. Due to their association with atherosclerotic vascular disease, high LDL and low HDL are clinically relevant [12]. Consuming antioxidant-rich meals helps manage cholesterol levels for optimal health. Telang flowers (*Clitoria ternatea*) are antioxidant-rich [13].

The Telang flower (*Clitoria ternatea*) grows in tropical and subtropical regions like the Caribbean, Central America, Africa, Southeast Asia, and India [14]. Traditional medicine and food use roots, stems, leaves, blossoms, and seeds [15]. Fixed oil, tannic acid, glucose, and bitter acid resin in the seeds have laxative properties when mixed with ginger powder [16]. Food coloring can be made from seeds [17]. Cooling, laxative, diuretic, anthelmintic, and anti-inflammatory effects make the root helpful in treating severe bronchitis, asthma, and high fever [18]. India recommends the stem for snake and scorpion bites [19]. Glycoside esters and resins in the leaves alleviate bodily pains, infections, and urogenital illnesses. The leaves are also an anthelmintic and insect sting remedy. Anthocyanins, which are antibacterial and anti-inflammatory, are found in flowers and employed as blue colorants in meals [20].

Multiple research projects have documented the antioxidant properties of *Clitoria ternatea*, the blossoms of the butterfly pea, or Telang. Reducing hemolysis and oxidative damage produced by 2,2'-azobis-2-methyl-propanimidide dihydrochloride were the phenolic compounds, flavonoids, and anthocyanins that were extracted from the aqueous extract of Telang flowers. AAPH, a plant analog, stands for 2,2'-Azobis (2-methylpropionamidine) dihydrochloride. In light of the preceding, the study sought to investigate whether or not obese male Wistar rats (*Rattus norvegicus*) would benefit from taking an extract from the Telang flower (*Clitoria ternatea*) to lower their total cholesterol levels.

2. METHOD

True Experimental study controls all external variables that affect the experiment. Most importantly, experimental and control groups use random samples from a population [21]. A variable is a changeable quantity that can affect outcomes or study findings [22]—using a floral extract from the Telang (*Clitoria ternatea*) as an independent variable. Reduced total cholesterol levels are the dependent variable. A high-cholesterol diet is a precondition for obesity. The research sample used 24 Wistar rats. 6 animals per group, and grouping was carried out randomly into 4 test groups.

Methods used in the study included acclimating the animals to the laboratory environment at the University of North Sumatra's Department of Pharmacology and Therapeutics, as well as extracting phytochemicals from Telang flowers and screening them for flavonoids, saponins, tannins, alkaloids, and steroids/terpenoids. Other procedures included creating preparations to raise cholesterol and rat blood fat levels. Methodology of Treatment Afterwards, four groups were formed from the acclimatization period animals that were fed a high-fat, cholesterol-rich diet: Treatments for Group 1, the Control Group, were administered 200, 400, and 600 mg/Kg/BW/day of Telang flower extract for 14 days. After that, we check your cholesterol and weight by drawing blood samples.

Then, we used the Levene test to ensure that the variances were homogeneous and the distribution was normal. The data did not follow a normal distribution, so a One-Way ANOVA test was used to compare the groups [23]. The data processing was carried out using SPSS 25.0 for Windows.

3. RESULTS AND DISCUSSION

This study used 20 200-300-gram Wistar white rats. This study examined whether Telang flower extract (*Clitoria ternatea*) lowers cholesterol in obese male Wistar white rats (*Rattus norvegicus*). The mice are preconditioned exogenously with a high-cholesterol duck egg yolk diet for 14 days to produce obesity.

Table 1. Characteristics Test Animals

Component	Group			
	Control	**P1**	**P2**	**P3**
Types of Rats	*Rattus norvegicus* White Wistar Strains			
Gender	Male			
General circumstances	The coat color is white, healthy, and active.			
AVG Initial BW (After high-fat diet)	312 gr	321 gr	318 gr	320 gr
AVG Final BW (After administering Telang flower extract)	308 gr	285 gr	263 gr	251 gr

Table 2. Mouse Body Weight

Parameter	Group	Average a high-fat diet	
		Before	After
Weight (gr)	Control	312	308
	P1	321	285
	P2	318	263
	P3	320	251
Nasoanal-length (mm)	Control	203	206
	P1	203	224
	P2	201	221
	P3	201	226
Lee Index	Control	0.33	0.32
	P1	0.33	0.29
	P2	0.33	0.28
	P3	0.33	0.27

All groups of mice on a high-fat diet had a Lee index value of 0.33, indicating obesity. Mice lost weight after receiving Telang flower extract at various doses, as shown by Lee index values. With a Lee index of <0.3 [24], mice treated with Telang flower extract were no longer considered obese. Table 2 shows the difference between obese mice fed distilled water and those given Telang flower extract at different concentrations. In the control group, the Lee index was 0.32, indicating obesity. Treatment group 1 (200 mg/KgBW Telang flower extract decreased to 0.29. This dropped to 0.28 in treatment group 2, given Telang flower extract at 400mg/KgBW. The last group received 600 mg/kg BW Telang flower extract, which fell to 0.27. Researchers found that Telang flower extract *(Clitoria ternatea*) influenced obese mice's weight.

These measurements confirmed the elevated total cholesterol levels in the rats used in the experiment. After 14 days of being fed a diet rich in fat and cholesterol, serum samples were taken from each mouse for the measurements. The normal range for blood cholesterol in white Wistar rats (*Rattus norvegicus*) is 10-54 mg/dl [25]. It is considered high when cholesterol levels reach more than 54 mg/dl. The data in the table show that the control and treatment groups of mice given a high-fat diet had more than 54 mg/dl of cholesterol.

Each animal's cholesterol levels were re-evaluated after 14 days of treatment with Telang flower extract (*Clitoria ternatea*). The cholesterol levels in each group are decreasing in the table above. The average cholesterol level in the control group was 63.96 mg/dl following a high-fat diet; however, following 14 days of therapy with distilled water, it decreased to 59.06 mg/dl. At >54 mg/dl, this amount is still considered high cholesterol. There was a reduction from 64.23mg/dl to 50.81mg/dl in treatment group 1, which involved administering Telang flower extract at 200mg/KgBW. In group 2, the Telang flower extract was administered at 400mg/KgBW. Initial levels in this group decreased from 64.86mg/dl to 43.98mg/dl. Group 3, which received a dose of 600mg/dl, saw the most significant decrease, going from 65.06mg/dl to 37.46mg/dl. It is evident from the data that the group who received the extract of Telang flowers no longer had elevated cholesterol levels, as their cholesterol levels dropped below 54 mg/dl.

The secondary metabolite components of butterfly pea flower extract (*Clitoria ternatea*) were tested phytochemically. Phytochemical assays include flavonoids, saponins, tannins, alkaloids, and steroids/triterpenoids. Flavonoid testing began. In a test tube, 1 gram of butterfly pea flower extract (*Clitoria ternatea*) was added to concentrated HCl and cooked for 15 minutes in a water bath. Red or yellow indicates flavonoids (flavone, chalcone, aurone). A crimson extract indicates the presence of flavonoids.

The second for the saponin test, 1 gram of butterfly pea flower extract (*Clitoria ternatea*) is added to a test

tube, and 10 ml of hot water is added, cooled, and shaken violently for 10 seconds. Saponin is present if the foam is 1-10 cm high in 10 minutes and does not dissolve after adding one drop of 2NHCl. This study detected froth in butterfly pea flower extract (*Clitoria ternatea*), indicating saponin. The third tannin test involves adding 1 gram of butterfly pea flower extract (*Clitoria ternatea*) to a test tube, 10 mL of hot water, and boiling for 5 minutes. The filtrate is then added 3-4 drops of FeCl3. A blue-green (green-black) sample is tannin-positive. A yellow liquid in tannin test results means no tannin.

Table 3. Cholesterol levels

No	Group	Repetition	Total Cholesterol Levels after high-fat diet (mg/dl)	Overall cholesterol after Telang flower extract (mg/dl)
1	Control	1st	62.2	56.6
2		2nd	61.4	57.3
3		3rd	65.2	60.8
4		4th	65.8	60.2
5		5th	66.1	61.1
6		6th	63.1	58.4
		Average	63.97	59.06
7	Treatment I (200mg/Kg BW)	1st	65.9	50.1
8		2nd	67.1	53.2
9		3rd	61.2	49.1
10		4th	63.3	50.8
11		5th	66.7	51.3
12		6th	61.2	50.4
		Average	64.23	50.81
13	Treatment II (400mg/Kg BW)	1st	67.2	45.6
14		2nd	63.9	44.2
15		3rd	61.2	48.4
16		4th	65.3	42.3
17		5th	65.5	41.8
18		6th	66.1	41.6
		Average	64.86	43.98
19	Treatment III (600mg/Kg BW)	1st	61.2	37.2
20		2nd	65.3	33.5
21		3rd	62.9	36.7
22		4th	67.3	38.1
23		5th	66.3	39.2
24		6th	67.4	40.1
		Average	65.06	37.46

Two grams of butterfly pea flower extract (*Clitoria ternatea*) was placed in a test tube, dripped with 5 mL of 2 N HCl, heated, cooled, and divided into three 1 mL test tubes for the fourth alkaloid test. Reagents are added to each tube. If Mayer's reagent precipitates white or yellow, alkaloids are present. In this study, the alkaloid test was red, indicating no alkaloids. The sixth steroid/triterpenoid test involved shaking 2 grams of butterfly pea flower extract (*Clitoria ternatea*) in a test tube with 2 mL of ethyl acetate. The ethyl acetate layer was dropped onto a drop plate to dry. After drying, two drops of acetic acid and one drop of concentrated sulfuric acid were added. Terpenoids are present if they become red or yellow. Steroids are present if they turn green. Red indicates triterpenoids in the steroid/triterpenoid test.

A normality test determines if data is regularly distributed. This study used Shapiro-Wilk to test normality. Data normality testing is crucial because regularly distributed data represents the population. Data is normally distributed if the p-value is > 0.05 and not normally distributed if $p < 0.05$ [26].

Table 4. Phytochemical Tests

Secondary Metabolites	Testing	Color	Result
Flavonoids	Wilstater	Red	+
Saponins	Forth	Blue and bubbly	+
Tannin	FeCl3	Blackish green	+
Alkoloid	Wagner	Red	-
Triterpenoids	Lieberman – Burchard	Red	+

Table 5. Normality Test

Group Extract Dose	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control (C)	.224	6	.200*	.901	6	.378
Treatment P1	.197	6	.200*	.948	6	.723
Treatment P2	.236	6	.200*	.887	6	.302
Treatment P3	.203	6	.200*	.944	6	.695

Table 5 displays the outcomes of the Kolmogorov-Smirnov test, which was used to validate the data for normalcy and achieved a significance level of 0.200 across all categories. A regularly distributed data set is one in which the p-value is more significant than 0.05. The data is thus assumed to follow a normal distribution.

We checked for group homogeneity using the Levene test at a 5% significance level. As a rule of thumb, while making decisions, a significance value less than 0.05 indicates that the data is not homogeneous. In contrast, a significance value of more than 0.05 indicates that the data is homogeneous [27].

Table 6. Homogeneity Test Results

	Levene Statistical	df1	df2	Sig.
Base on Mean	1.021	3	20	.404
Base on Median	.889	3	20	.464
Based on the Median, the adjusted df	.889	3	15.205	.469
Based on trimmed mean	1.024	3	20	.403

As shown in Table 6, the Levene test was used to determine homogeneity. In the significance column, the probability value is 0.404. We can conclude that the control group, treatment group-1, treatment group-2, and treatment group-3 come from populations with the same variance or that the four groups are homogeneous because the computed significance probability value is more significant than 0.05.

A One-way ANOVA test was conducted to test for significant efficacy between the trial groups after the study data passed normality and homogeneity tests. The results also had homogeneous variance and were normally distributed. The significant value produced by the One-Way ANOVA test is 0.000, which is less than 0.05, as seen in the previously provided table. It is clear from these numbers that the treatment group differs significantly from the control group.

Table 7. One-Way ANOVA Test Results

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1544.270	3	514.757	114.641	.000
Within Groups	89.803	20	4.490		
Total	1634.073	23			

In order to examine the variations in average LDL levels among the groups, the post hoc LSD follow-up test was used. Table 8 displays the outcomes of the LSD post-hoc follow-up test.

Finding out if groups are significantly different from each other is the job of the LSD Post Hoc Test. Table 8 displays the results of the Post Hoc LSD test analysis, which indicates that the group differs significantly from other groups with a significance value of 0.000, which is less than 0.05.

Table 8. Post-Hoc LSD Test Results for Serum Lipase Levels

Experimental Group (I)	Experimental Group (J)	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control (Aquades)	Treatment P1	8.25000*	1.22341	.000	5.6980	10.8020
	Treatment P2	15.08333*	1.22341	.000	12.5314	17.6353
	Treatment P3	21.60000*	1.22341	.000	19.0480	24.1520
Treatment 1 (200mg/Kg BW)	Control (C)	-8.25000*	1.22341	.000	-10.8020	-5.6980
	Treatment P2	6.83333*	1.22341	.000	4.2814	9.3853
	Treatment P3	13.35000*	1.22341	.000	10.7980	15.9020
Treatment 2 (400mg/Kg BW)	Control (C)	-15.08333*	1.22341	.000	-17.6353	-12.5314
	Treatment P1	-6.83333*	1.22341	.000	-9.3853	-4.2814
	Treatment P3	6.51667*	1.22341	.000	3.9647	9.0686
Treatment 3 (600mg/Kg BW)	Control (C)	-21.60000*	1.22341	.000	-24.1520	-19.0480
	Treatment P1	-13.35000*	1.22341	.000	-15.9020	-10.7980
	Treatment P2	-6.51667*	1.22341	.000	-9.0686	-3.9647

*. The mean difference is significant at the 0.05 level.

Discussion

In order to prepare the animals for testing, they were fed a high-fat diet consisting of duck egg yolks for 14 days. After that, they were divided into four groups, each receiving a different treatment. A control group received only distilled water, while groups 1, 2, and 3 received extracts as their treatment. Various doses of Telang pea flower (*Clitoria ternatea*), namely 200mg/KgBW, 400mg/KgBW, and 600mg/KgBW. Following this, the researchers examined whether or not the extract from Telang flowers (*Clitoria ternatea*) might lower the overall cholesterol levels in overweight male Wistar white rats (*Rattus norvegicus*). The researchers were particularly interested in finding out which dosage reduced total cholesterol more effectively in obese male Wistar white rats (*Rattus norvegicus*).

The metabolic disease known as obesity will develop if the current pattern of insufficient physical exercise and excessive caloric consumption is not corrected [2]. High cholesterol levels are associated with obesity, which is a health risk in and of itself. Our bodies contain two kinds of cholesterol: low-density lipoprotein (LDL), which can cling to blood vessel walls, and high-density lipoprotein (HDL), a lipid that can dissolve LDL. At the same time, total cholesterol refers to the whole quantity of cholesterol present in the body [28].

Cholesterol regulates membrane fluidity and structure. Vitamin D, steroid hormones (cortisol, aldosterone, adrenal androgens), and sex hormones (testosterone, estrogen, and progesterone) are synthesized from cholesterol. Bile salts contain cholesterol to help digest fat-soluble vitamins A, D, E, and K [29]. If cholesterol levels are too high, it might harm the body. Unbalanced cholesterol levels might cause health issues that increase the risk of cardiovascular disease [30]. Achieving excellent health requires careful monitoring of cholesterol levels, and one way to do this is to eat foods rich in antioxidants. The butterfly pea flower, Telang, or *Crucitaria ternatea*, is an antioxidant-rich plant. This study was carried out to demonstrate that extract from butterfly pea flowers can be utilized as an all-natural remedy to lower total cholesterol levels in individuals suffering from obesity.

This 14-day observation approach yielded data that needed processing and testing, requiring various data analyses. Processing and normalcy testing follow data collection. The Kolmogorov-Smirnov test in SPSS determined normality. All test groups have typically distributed data with a significance value of 0.200. Thus, the data is regularly distributed or represents the population. The Levene test determines if normally distributed data originates from a population with the same variance. Results demonstrate significance at 0.404. With a significance probability greater than 0.05, the control and treatment groups 1, 2, and 3 are homogeneous or from the same population. One-way ANOVA assessed this normally distributed and homogeneous data for efficacy and significance.

One-way ANOVA test results demonstrate 0.000 or greater than 0.05 significance. Based on this data, a follow-up post-hoc LSD test is needed because the control group, treatment group 1, treatment group 2, and treatment group 3 differ significantly. A post-hoc LSD test was used to compare the group's average total cholesterol levels. The Post Hoc LSD test analysis in this study yielded a significance value of 0.000 or less than 0.05, indicating that all groups differed.

As supplementary evidence, researchers in this study included a weight assessment. White rats (Rattus norvegicus) of the Wistar strain were weighed using the Lee index before and after treatment with distilled water and Telang flower extract (*Clitoria ternatea*) at varying doses. The rats were fed a high-fat diet. The Lee index value in the control group was 0.32 or higher than 0.3. According to this number, the control group is still considered obese. The first treatment group, which received 200 mg/kg body weight of Telang flower extract (*Clitoria ternatea*), declined to 0.29. At 400 mg/kg body weight in treatment group 2, it dropped to 0.28; at 600 mg/kg in group 3, it dropped to 0.27. The researchers determined the effects of aloe vera extract on the weight of obese mice.

The data demonstrates total cholesterol levels in obese male Wistar white rats (Rattus norvegicus) drop across all experimental groups. Various average post-test readings show that total cholesterol levels were reduced differently. The average total cholesterol level in the control group, which received only distilled water, was 59.06 mg/dl, indicating their levels were still high. Group 2's total cholesterol level was 50.81 mg/dl, which was achieved by administering 200 mg/KgBW of Telang flower extract (*Clitoria ternatea*). Finally, in treatment group 3, the levels were 37.46 mg/dl, while in group 2, they were 43.98 mg/dl. With total cholesterol levels below 54 mg/dl, it is evident from the findings that the group administered Telang flower extract (*Clitoria ternatea*) no longer had elevated cholesterol. Treatment group 3, which received 600 mg/kg body weight of Telang flower extract (*Clitoria ternatea*), saw the most significant drop in total cholesterol levels.

According to the results, trial participants treated with Telang flower extract (*Clitoria ternatea*) had lower total cholesterol levels than those in the control group who received merely distilled water. The Telang flower extract (*Clitoria ternatea*) contains triterpenoids, tannins, saponins, and flavonoids, among other substances. As a result of its physiological effects, tannin is effective for weight loss in obese mice. These benefits include lowering blood pressure and serum lipid levels and exhibiting high antioxidant potential. This study's findings suggest that, in obese white rats (*Rattus norvegicus*) Wistar strain, the Telang flowers (*Clitoria ternatea*) extract can lower cholesterol levels and overall body weight. This study supports Arifah and colleagues' (2022) finding that butterfly pea flower extract (*Clitoria ternatea*) improved Wistar white rats' lipid profiles [31]. Another study by Purnomo (2023) found that butterfly pea flower tea lowers cholesterol and body mass index [32].

4. CONCLUSION

Results show that mice given Telang flower extract (*Clitoria ternatea*) had different total cholesterol levels than control mice. Total cholesterol levels were less than 54 mg/dl in the therapy group. At 59.06 mg/dl, the control group remained above the 54 mg/dl threshold. The results showed that the mice's weight changed between the pre- and post-administration of Telang flower extract (*Clitoria ternatea*). The characteristics of the Lee index show changes in body weight. A Lee index value of 0.32, more than 0.3, was recorded for the control group that received only distilled water. The first treatment group, which received 200 mg/kg body weight of Telang flower extract (*Clitoria ternatea*), declined to 0.29. It was 0.28 in the second treatment group and 0.27 in the third. After testing it on obese mice, researchers found that an extract from Telang flowers (*Clitoria ternatea*) helped decrease their weight.

Results showed that total cholesterol levels in obese male Wistar rats (*Rattus norvegicus*) decreased from 65.06 mg/dl to 37.46 mg/dl when administered 600 mg/kg body weight of Telang flower extract (*Clitoria ternatea*). The phytochemical experiments conducted on the Telang (*Clitoria ternatea*) flower extract have shown the presence of secondary metabolite chemicals, such as flavonoids, saponins, tannins, and triterpenoids. Obese white Wistar rats (*Rattus norvegicus*) benefit from these chemicals by decreasing their total cholesterol levels.

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REFERENCES

[1] B. Caballero, "Humans against Obesity: Who Will Win?," *Adv. Nutr.*, vol. 10, pp. S4–S9, 2019, doi: 10.1093/advances/nmy055.

[2] R. Yudin *et al.*, "Risk of Dyslipidemia in Obese Young Adult Subjects as Measured by Various Obesity Indices," *J. Endocrinol. Metab.*, vol. 12, no. 3, pp. 102–106, 2022, doi: 10.14740/jem819.

[3] G. Muscogiuri *et al.*, "The management of very-low-calorie ketogenic diet in obesity outpatient clinic: A practical guide," *J. Transl. Med.*, vol. 17, no. 1, pp. 1–9, 2019, doi: 10.1186/s12967-019-2104-z.

[4] J. M. Oppert *et al.*, "Exercise training in the management of overweight and obesity in adults: Synthesis of the evidence and recommendations from the European Association for the Study of Obesity Physical Activity Working Group," *Obes. Rev.*, vol. 22, no. S4, pp. 1–12, 2021, doi: 10.1111/obr.13273.

[5] IDF Committee, *International Diabetes Federation Atlas*, 9th ed. Online Edition: Pfizer - MSD - Alliance - Lilly - Novo Nordisk, 2019. doi: 10.1016/S0140-6736(55)92135-8.

[6] A. Kerkadi *et al.*, "The relationship between lifestyle factors and obesity indices among adolescents in Qatar," *Int. J. Environ. Res. Public Health*, vol. 16, no. 22, pp. 1–15, 2019, doi: 10.3390/ijerph16224428.

[7] D. Albuquerque, C. Nóbrega, L. Manco, and C. Padez, "The contribution of genetics and environment to obesity," *Br. Med. Bull.*, vol. 123, no. 1, pp. 159–173, 2017, doi: 10.1093/bmb/ldx022.

[8] M. Sonal Sekhar, B. S. Reddy, S. J. Kurian, M. Rao, and S. Marupuru, "Physiological role of cholesterol in human body," in *Dietary Sugar, Salt and Fat in Human Health*, H. G. Preuss and D. Bagchi, Eds., Academic Press, 2020, pp. 453–481. doi: 10.1016/B978-0-12-816918-6.00021-4.

[9] H. Oguro, "The roles of cholesterol and its metabolites in normal and malignant hematopoiesis," *Front. Endocrinol. (Lausanne).*, vol. 10, no. APR, pp. 1–15, 2019, doi: 10.3389/fendo.2019.00204.

[10] K. R. Feingold, "Lipid and Lipoprotein Metabolism," *Endocrinol. Metab. Clin. North Am.*, vol. 51, no. 3, pp. 437–458, 2022, doi:

10.1016/j.ecl.2022.02.008.
[11] H. H. Wang, G. Garruti, M. Liu, P. Portincasa, and D. Q. H. Wang, “Cholesterol and lipoprotein metabolism and atherosclerosis: Recent advances in reverse cholesterol transport,” *Ann. Hepatol.*, vol. 16, pp. s27–s42, 2017, doi: 10.5604/01.3001.0010.5495.
[12] F. M. Sacks *et al.*, “Dietary fats and cardiovascular disease: A presidential advisory from the American Heart Association,” *Circulation*, vol. 136, no. 3, pp. e1–e23, 2017, doi: 10.1161/CIR.0000000000000510.
[13] R. R. Multisona, S. Shirodkar, M. Arnold, and A. Gramza-Michalowska, “Clitoria ternatea Flower and Its Bioactive Compounds: Potential Use as Microencapsulated Ingredient for Functional Foods,” *Appl. Sci.*, vol. 13, no. 4, 2023, doi: 10.3390/app13042134.
[14] S. Dhanasekaran, A. Rajesh, T. Mathimani, S. Melvin Samuel, R. Shanmuganathan, and K. Brindhadevi, “Efficacy of crude extracts of Clitoria ternatea for antibacterial activity against gram negative bacterium (Proteus mirabilis),” *Biocatal. Agric. Biotechnol.*, vol. 21, no. August, p. 101328, 2019, doi: 10.1016/j.bcab.2019.101328.
[15] P. K. Mukherjee, V. Kumar, N. S. Kumar, and M. Heinrich, “The Ayurvedic medicine Clitoria ternatea-From traditional use to scientific assessment,” *J. Ethnopharmacol.*, vol. 120, no. 3, pp. 291–301, 2008, doi: 10.1016/j.jep.2008.09.009.
[16] M. B. Lijon, N. S. Meghla, E. Jahedi, M. A. Rahman, and I. Hossain, “Phytochemistry and Pharmacological Activities of Clitoria ternatea,” *Int. J. Nat. Soc. Sci.*, vol. 4, no. 1, pp. 01–10, 2017, [Online]. Available: www.ijnss.org
[17] S. Ab Rashid *et al.*, “Anthocyanin Microcapsule from Clitoria ternatea: Potential Bio-preservative and Blue Colorant for Baked Food Products,” *Arab. J. Sci. Eng.*, vol. 46, no. 1, pp. 65–72, 2021, doi: 10.1007/s13369-020-04716-y.
[18] N. Upwar, R. Patel, N. Waseem, and N. K. Mahobia, “Evaluation of antidiarrhoeal activity of the root of Clitoria ternatea Linn,” *Int. J. Pharm. Sci. Rev. Res.*, vol. 5, no. 1, pp. 131–134, 2010.
[19] D. S. K. Sarma, D. Kumar, C. Yamini, C. Santhalahari, C. Lahari, and G. C. Kumar, “Review on Clitoria Ternata,” *Int. J. Pharm. Sci. Med.*, vol. 8, no. 9, pp. 43–58, 2023, doi: 10.47760/ijpsm.2023.v08i09.004.
[20] C. Li *et al.*, “Phytochemical Properties and In Vitro Biological Activities of Phenolic Compounds from Flower of Clitoria ternatea L.,” *Molecules*, vol. 27, no. 19, 2022, doi: 10.3390/molecules27196336.
[21] S. Notoatmodjo, *Metodologi Penelitian Kesehatan*, 3rd ed. Jakarta: Rineka Cipta, 2022.
[22] B. Suwarno and A. Nugroho, *Kumpulan Variabel-Variabel Penelitian Manajemen Pemasaran (Definisi & Artikel Publikasi)*, 1st ed. Bogor: Halaman Moeka Publishing, 2023.
[23] I. Ghozali, *Aplikasi Analisis Multivariate dengan Program IBM SPSS 25*. Semarang, 2018.
[24] S.-I. Lee *et al.*, “Anti-obesity Effect of Monascus pilosus Mycelial Extract in High Fat Diet-induced Obese Rats,” *J. Appl. Biol. Chem.*, vol. 54, no. 3, pp. 197–205, 2011, doi: 10.3839/jabc.2011.033.
[25] J. B. Smith and S. Mangkoewidjojo, *Pemeliharaan, Pembiakan dan Penggunaan Hewan Percobaan Di Daerah Tropis*. Jakarta: UI-Press, 1988.
[26] Sugiyono, *Statistika untuk Penelitian*, 3rd ed. Bandung: Alfabeta, 2019.
[27] Sugiyono, *Metode penelitian kuantitatif, kualitatif dan kombinasi (mixed methods)*, 2nd ed. Bandung: Alfabeta, 2018.
[28] R. Setyawati and M. Lasroha, “Overview of HDL, LDL, Triglycerides, and Total Cholesterol in Obese Patients,” *Adv. Heal. Sci. Res.*, vol. 39, no. SeSICNiMPH, pp. 12–14, 2021.
[29] A. Di Ciaula *et al.*, “Bile acid physiology,” *Ann. Hepatol.*, vol. 16, pp. s4–s14, 2017, doi: 10.5604/01.3001.0010.5493.
[30] T. Huff, B. Boyd, and I. Jialal, *Physiology, Cholesterol*. Creighton University School of Medicine: StatPearls Publishing, Treasure Island (FL), 2023. [Online]. Available: http://europepmc.org/abstract/MED/29262185
[31] Y. Arifah, S. Sunarti, and R. Prabandari, “Efek Bunga Telang (Clitoria ternatea L.) Terhadap Kolesterol Total, LDL, HDL Pada Tikus (Rattus Norvegicus),” *J. Syifa Sci. Clin. Res.*, vol. 4, no. 1, pp. 18–31, 2022, doi: 10.37311/jsscr.v4i1.13493.
[32] E. Purnomo, “The Effect of Drinking Telang Flower Tea on Weight Reduction And Cholesterol,” *Medikora*, vol. 22, no. 2, pp. 22–32, 2023, doi: 10.21831/medikora.v22i2.66493.