Identification of Bioactive Compounds and Testing The Activity of Takokak Fruit Ethanol Extract (*Solanum Torvum* L.) for Reducing Blood Cholesterol Levels for Hypercholesterolemia Patients

Nuning Nurcahyani[1], Endang L Widiastuti[1], Menti Manda Utama[1]

[1] Department of Biology, Faculty of Mathematics and Science, University of Lampung
Jl. Prof. Soemantri Brojonegoro No. 1. Gedong Meneng, Rajabasa, Bandar Lampung. 35141
nuning.nurcahyani@fmipa.unila.ac.id

Abstract. Indonesia is a megabiodiversity country that has a lot of natural resources, especially plants, one of which is the takokak (*Solanum torvum* L.). Takokak contains bioactive compounds which are thought to have the potential to act as anti-hypercholesterolemia. Hypercholesterolemia is a condition where the concentration of cholesterol in the blood increases beyond normal and is a major risk factor for Coronary Heart Disease (CHD). This study aims to identify bioactive compounds from the ethanol extract of takokak fruit (*Solanum torvum* L.) and test its activity in reducing total cholesterol, LDL, HDL and triglyceride levels in mice (*Mus musculus* L). This research began with maceration and extraction of takokak fruit with ethanol solvent, then identified the structure and content of bioactive compounds in takokak fruit extract using phytochemical tests. Next, the takokak fruit extract activity test was carried out using a Completely Randomized Design (CRD) using 25 mice. The mice were divided into 5 groups and 5 repetitions, namely: negative control (without treatment), positive control (induced by cow's brain), treatment group was induced by cow's brain and then given takokak fruit extract 5.6 mg/25 gbb, 10.5 mg/25 gbb, and 17.5 mg/25 gbb. Observations were made on days 1, 15, and 29. Data were analyzed using ANOVA, with LSD (Least Significant Difference) further testing at a 5% significance level. The research results showed that from the phytochemical test, the ethanol extract of takokak fruit contained bioactive compounds of flavonoids, triterpenoids, tannins, saponins, and phenolics. Ethanol extract of fruit takokak (*Solanum torvum* L.) can reduce levels of total cholesterol, LDL, tiglycerides, and increase HDL in hypercholesterolemia mice (*Mus musculus* L.) with the most effective dose of 10.5 mg/25gbw.

Keywords: takokak fruit, *Solanum torvum* L, hypercholesterolemia, ethanol extract.

© The Author(s) 2025
S. Hadi et al. (eds.), *Proceedings of the 5th International Conference on Applied Sciences, Mathematics, and Informatics (ICASMI 2024)*, Advances in Physics Research 13,
https://doi.org/10.2991/978-94-6463-730-4_21

1 Introduction

One of the diseases that is currently of great concern is hypercholesterolemia, namely high levels of cholesterol in the blood [14]. The presence of cholesterol in the body is very important for the needs of cell life and as a raw material for the synthesis of phospholipids which are components of cell membranes. But if you have excess cholesterol it will have a bad impact on your health. Hypercholesterolemia is a major risk factor for Coronary Heart Disease (CHD). People are beginning to avoid treating hypercholesterolemia using synthetic drugs because they are thought to cause side effects such as gastrointestinal disorders, muscle pain, stomach irritation, liver damage, gallstones and kidney damage, especially with long-term use [3]. The takokak plant (*Solanum torvum* L.), which is abundant in Indonesia and consumed by the public, has the potential to be used as an ingredient for lowering cholesterol levels in the blood. Currently, takokak fruit (*Solanum torvum*) is used as a medicine to prevent and lower cholesterol levels because it contains secondary metabolite compounds in the form of alkaloids, flav noids, saponins, quinones, tannins and triterpenoids [18].

Based on this, it is necessary to carry out research to identify bioactive compounds and determine the potential of takokak fruit (*Solanum torvum* L.) ethanol extract to reduce total cholesterol, LDL, HDL and triglyceride levels in the blood of hypercholesterolemia sufferers. This is done to develop cholesterol-lowering drugs that are save and more effective for sufferers of hypercholesterolemia.

2 Methods

2.1 Preparation of Takokak Extract

About 500 grams of dried takokak fruit powder was macerated using 1850 ml of 96% ethanol for 3 x 24 hours. The filtrate was filtered and concentrated using a rotary evaporator at 50 ^{o}C until a thick extract was obtained. After that made it in paste form by putting into the oven at 50 ^{o}C for several hours and after that, put it in the oven at 50 ^{o}C until the extract is obtained in paste form and dissolve it with 1% Na-CMC. Then the extract is placed in a bottle and stored [6].

To indicate bioactive compound, phytochemical procedures was applied as follows [21].

Table 1. Phytochemical procedures.

Bioactive Compounds	Treatment	Indicator (+)
Saponin	0,5 mL sample + 5 ml distilled water, shaken for 30 seconds	Foam is formed
Steroid	0.5 ml sample + 0.5 ml glacial acetic acid + 0.5 ml H_2SO_4	Blue or turquoise
Terpenoid	0.5 ml sample + 0.5 ml glacial acetic acid + 0.5 ml H_2SO_4	Orange, red or yellow
Tanin	1 ml sample + drops of $FeCl_3$ solution	Bluish black color
Alkaloid	0.5 ml sample + 5 drops of chloroform + 5 drops of Meyer reagent (1 g KI dissolved in 20 ml distilled water and added 0.271 g $HgCl_2$	Brownish white color
Flavonoid	0.5 ml sample + 0.5 g Mg powder + 5 ml concentrated HCl	Red or yellow color and foams formed

2.2 Test the Activity of Takokak Fruit Extract in Reducing Cholesterol Levels

Before treatment, male mice (*Mus musculus* L.) were acclimatized for a week. Special high cholesterol feed to increase cholesterol levels is given every day for 14 days. Cow brain is processed by steaming it first, then blending it and adding water 1:1. 100 grams of cow brain contains around 2 grams of cholesterol and 2.9 g of saturated fatty acids [15].

2.3 Experimental Design

The treatment of mice divided into 5 groups was carried out after the mice's blood cholesterol levels reached above 100 mg/dl. For the treatment group, on days 1 to 14, mice were given high-cholesterol feed in the form of cow brain [15] and on days 15 to 29, mice were given treatment using takokak fruit extract according to the predetermined dose. They put in 5 different group randomly: Negative control group (K1) were given only food and drink, Positive control group (K2) were induced by 1 ml/kgbw cow brain, treatment 1 group (P1) were induced by 1 ml/kgbw cow brain and takokak fruit ethanol extract at a dose of 4.48 mg/20 gbw orally for 14 days, treatment 2 group (P2) were induced by 1 ml/kgbw cow brain and takokak fruit ethanol extract at a dose of 8.4 mg/20 gbw orally for 14 days, and treatment 3 group (P3) were induced by 1 ml/kgbw cow brain and takokak fruit ethanol extract at a dose of 14 mg/20 gbw orally for 14 days.

2.4 Measurement of Total Cholesterol, LDL, HDL, and Triglyceride Levels

Total blood cholesterol, Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), and triglyceride levels were examined in all experimental groups using the Lipid Pro device for 3 times. The first examination was on day 1 when the mice had not been induced by the cow brain to determine the initial cholesterol levels of the mice, the second was after the mice induced by the cow brain (day 15), and the third was after treated with takokak fruit extract (day 29). The blood was taken from the tip of the mice's tail was placed on a test strip that has been inserted into the device, the results will be visible on the device screen after 150 seconds, the numbers that appear indicate the cholesterol levels expressed in mg/dl [8].

2.5 Data Analysis

The data obtained during the measurements were analyzed using the One Way-Analysis of Variance (Anova) statistical method with a significance level of 5%. If there are real differences between groups, they will be analyzed further using the LSD (Least Significant Difference) test at 5% significance level.

3 Result And Discussion

3.1 Phytochemical Test Results of Ethanol Extract of Takokak Fruit (*S. torvum* L)

The bioactive compounds of the ethanol extract of takokak fruit can be seen in Table 2.

Table 2. Phytochemical test results of ethanol extract of takokak fruit (*S. torvum L.*)

Compound	100% Ethanol	Description
Flavonoid	+	Positive
Terpeneoid	+	Positive
Fenolik	+	Positive
Tanin	+	Positive
Saponin	+ ++	Positive
Alkaloid	-	Negative
Steroid	-	Negative

Based on the phytochemical test, the ethanol extract of takokak fruit positively contains bioactive compounds of flavonoids, terpenoids, phenolics, tannins, saponins, but is negative for alkaloids and steroids, so it does not contain these two compounds

3.2 Average Total Cholesterol of Mice (*Mus musculus L.*)

Table 3. Average Total Cholesterol of Mice (Mean ± SEM, mg/dL).

Group	Day-0 (mg/dL)	Day-8 (mg/dL)	Day-15 (mg/dL)
K-	116,80 ± 10,82	127,60 ± 7,29[a]	118,20 ± 6,25[a]
K+	117,00 ± 8,05	174,80 ± 6,74[b]	159,20 ± 6,03[b]
P1	128,80 ± 5,24	182,00 ± 9,57[b]	136,40 ± 6,08[a]
P2	134,20 ± 2,28	188,20 ± 13,45[b]	118,20 ± 6,68[a]
P3	124,80 ± 12,96	163,80 ± 6,82[b]	138,20 ± 7,21[ab]

Note: different superscript values showed a significant difference $p \leq 0.05$).

On the 8th day, with oral administration of cow brain, there was an increase in total cholesterol levels in mice. The normal cholesterol level in mice is 26.0-82.4 mg/dL, indicating that mice have high cholesterol levels after being given cow brain orally for 7 days. The average total cholesterol in mice can be seen in Table 3. On the 15th day, with treatment of takokak fruit extract, the total cholesterol levels of mice decreased. Cow brain induction increased total cholesterol levels from each treatment in the range of 40-60 mg/dL, significantly compared with the negative control (K-). On the 15th day, after administering takokak ethanol extract, all treatment groups experienced a decrease in total cholesterol levels, but at different percentage levels. At K- it was 7.36%, K+ was 8.92%, P1 was 25.05%, P2 was 37.19%, and P3 was 15.62%. The P2 group has a better ability to reduce total cholesterol levels in mice compared to other treatment groups.

Research by Yuliantini et al. [25] showed a significant relationship between fat intake and cholesterol levels, the higher the fat intake, the higher the cholesterol levels will be. Cow brain is often used to increase cholesterol levels in experimental animals [1], because cow brain has a relatively high cholesterol content of around 2000 mg/100 grams. Around 52.2% of a cow brain consists of fat, which if consumed continuously will accumulate fat in the body and increase cholesterol levels in the body.

The mechanism of hypercholesterolemia starts from the intake of saturated fat and cholesterol from the cow brain which will be digested in the small intestine, producing free fatty acids, triglycerides, phospholipids and cholesterol. These compounds are then converted into chylomicrons after being absorbed by the intestines. There is residual breakdown of chylomicrons in the form of free cholesterol together with apoprotein to form VLDL. Next, the lipoprotein lipase enzyme in endothelial cells converts VLDL into IDL (Intermediate Density Lipoprotein) which lasts for 2-6 hours before turning into LDL.

Control of blood cholesterol levels depends on the formation of LDL, if LDL levels in the body are high, cholesterol will stick to the walls of blood vessels and cause plaque. In addition, intake of cholesterol, saturated fat and trans fat will increase total cholesterol and triglyceride levels by increasing fat accumulation in the liver so that the

amount of acetyl Co A in liver cells increases and is directly proportional to the increase in the activity of the HMG Co A reductase enzyme. Increasing this enzyme will increase cholesterol production capacity [16].

On the 15th day, after giving takokak fruit extract for 7 days, there was a decrease in total cholesterol levels in mice. The treatment group that produced the most optimum reduction in total cholesterol was in the dose 10.5 mg/25gbw) with a percentage reduction of 37.19%. The reduction is assumed because of the alkaloids, flavonoids, glycosides, phenols, saponins and sterols in takokak fruits. Flavonoids are antioxidants that work by suppressing LDL oxidation and progressive inflammation in the artery walls. Also, they can capture free radicals, stimulate the production of nitrous oxide which can dilate (relax) blood vessels, and inhibit the clumping of blood cell pieces [12].

3.3 Average LDL of Mice (*Mus musculus L.*)

Table 4. Average LDL of Mice (*Mus musculus* L.)

Group	Day-0 (mg/dL)	Day-8 (mg/dL)	Day-15 (mg/dL)
K-	22,40 ± 0,63	24,63 ± 0,56[a]	22,29 ± 0,47[a]
K+	23,23 ± 0,82	28,12 ± 0,71[b]	25,70 ± 0,55[b]
P1	24,21 ± 0,73	32,67 ± 0,55[c]	26,17 ± 0,55[b]
P2	22,92 ± 0,48	37,45 ± 0,58[d]	22,93 ± 0,52[a]
P3	25,25 ± 0,61	36,74 ± 0,73[d]	28,17 ± 0,28[c]

On the 8th day, with oral administration of cow brain, there was an increase in LDL levels in mice. On the 15th day, with treatment with takokak fruit extract, the LDL levels of mice decreased. Giving cow brain showed an increase in the range of 10-20 mg/dL. Cow brain induction increased LDL levels from each treatment. On the 15th day, after administering takokak ethanol extract, there was a decrease in LDL. The average LDL of mice can be seen in Table 4.

Based on the research results, it showed that all treatment groups experienced a decrease in LDL levels, but at different percentage levels. At K- it was 9.62%, K+ was 8.6%, P1 was 19.89%, P2 was 38.77%, and P3 was 27.32%. This shows that the P2 group has a better ability to reduce LDL levels in mice compared to other treatment groups.

Based on the measurement results, the average LDL levels of mice on day 8 were K- (24.63 ± 0.56 mg/dL), K+ (28.12 ± 0.71 mg/dL), P1 (32.67 ± 0 .55 mg/dL), P2 (37.45 ± 0.58 mg/dL), and P3 (36.74 ± 0.73 mg/dL). With normal LDL levels in mice, 2-27 mg/dL, indicate that mice have high LDL levels after being given cow brain orally for 7 days.

The increase in LDL was caused by cholesterol and saturated fatty acids in cow brain suspension. Cholesterol originating from the cow brain is absorbed by the small intes-

tine and then combines with cholesterol biosynthesis in the liver in the form of cholesterol esters. Cholesterol esters together with triglycerides which are also synthesized in the liver from free fatty acids will form Very Low Density Lipoprotein (VLDL) which then becomes Intermediate Density Lipoprotein (IDL) and LDL in the body. Saturated fatty acid content can also increase LDL levels by increasing LDL formation in serum, reducing LDL receptor activity, and inhibiting the clearance of triacyl glycerol-rich lipoproteins. Beef brain contains 3% cholesterol and 2.3% saturated fatty acids. The main saturated fatty acids in beef brain are 1.26% stearic acid, 0.92% palmitic acid, 0.03% behenic acid, 0.03% margaric acid, 0.03% myristic acid, and 0.02% arachidic acid [19].

There is an increase in LDL and a decrease in HDL in hypercholesterolemia, due to the accumulation of cholesterol in the blood due to induced hypercholesterolemia. Increased LDL levels and decreased HDL levels are due to excess cholesterol, which causes a buildup of cholesterol in the body. Furthermore, the build up of cholesterol followed by free radical activity causes oxidative damage to several tissues. High cholesterol levels in the blood cause VLDL. forms LDL, as a result LDL in the blood increases. Continuously increasing LDL levels make HDL depressed and unable to get rid of excess cholesterol in the blood, so HDL decreases. Hypercholesterolemia results in lipoprotein metabolism disorders, which include increased LDL levels and decreased HDL levels [22].

On the 15th day, after giving takokak fruit extract for 7 days, there was a decrease in LDL levels in mice. The treatment group that resulted in the most optimum reduction in LDL levels was group P2 (10.5 mg/25gbw) with a percentage reduction of 38.77% compared to groups P1 and P3. Reducing serum cholesterol levels by administering takokak fruit extract is thought to contain flavonoids which function as antioxidant compounds [20]. The flavonoid compounds contained is quercetin. Quercetin can inhibit the HMG-CoA reductase enzyme so that cholesterol synthesis decreases. Quersetin also works in inhibiting the secretion of Apolipoprotein B-100 into the intestine, resulting in a decrease in Apolipoprotein B-100. Apolipoprotein B-100 is an apoprotein found in lipoprotein molecules known as the formation of VLDL and LDL [10].

3.4 Average HDL of Mice (Mus musculus L.)

Table 5. Average HDL of Mice (*Mus musculus* L.)

Group	Day-0 (mg/dL)	Day-8 (mg/dL)	Day-15 (mg/dL)
K-	46,20 ± 1,06	43,80 ± 1,15[b]	45,40 ± 0,92[a]
K+	48,20 ± 0,86	37,00 ± 0,70[a]	44,80 ± 1,42[a]
P1	49,40 ± 1,63	39,40 ± 1,73[a]	58,20 ± 2,88[b]
P2	51,00 ± 2,73	37,60 ± 1,02[a]	70,80 ± 4,11[c]
P3	48,60 ± 1,80	38,00 ± 1,41[a]	61,20 ± 3,83[b]

On the 8th day, with oral administration of cow brain, there was a decrease in HDL levels in mice. On the 15th day, with takokak fruit extract treatment, there was an increase in the HDL levels of mice. The average HDL in mice can be seen in Table 5.

Giving cow brain showed a decrease in the range of 10-20 mg/dL. Cow brain induction reduced HDL levels from each treatment. Significantly when compared with the negative control (K-). On the 15th day, after administering takokak ethanol extract, there was an increase in HDL. The percentage increase in HDL levels in mice, shows that all treatment groups experienced an increase in HDL levels but at different percentage levels. At K- it was 3.52%, K+ was 17.41%, P1 was 32.3%, P2 was 46.89%, and P3 was 37.89%. This shows that the P2 group has a better ability to increase HDL levels in mice compared to other treatment groups.

Based on the measurement results, the average HDL levels of mice on day 8 were K- (43.80 ± 1.15 mg/dL), K+ (37.00 ± 0.70 mg/dL), P1 (39.40 ± 1 .73 mg/dL), P2 (37.60 ± 1.02 mg/dL), and P3 (38.00 ± 1.41 mg/dL). With normal levels of HDL in mice, namely 35-85 mg/dL, it shows that HDL levels decreased after being given cow's brain orally for 7 days compared to the initial check levels before giving cow's brain.

When total cholesterol levels rise, LDL cholesterol levels rise, and HDL cholesterol levels fall, this condition is known as hypercholesterolemia [4]. It has been proven that HDL levels in mice given beef brain fat decreased over time. Male mice given cow brain can reduce HDL cholesterol levels.

Cow brain as a high-fat feed was given for 7 days, after which the HDL levels were checked in each group. 100 grams of beef brain contains 2 grams of saturated fatty acids. Saturated fatty acids have the potential to reduce HDL levels. This is in line with the hypothesis of Naufalina and Nuryanto [11], which states that a decrease in HDL cholesterol levels can be caused by a decrease in HDL cholesterol levels and can be caused by cow brain which contains saturated fatty acids which can inhibit HDL cholesterol synthesis

The HDL cholesterol of mice given cow brain was lower than those not given cow brain. Mice that have been adapted are given high-fat food in the form of beef brain. Olivia and Agustini [13] stated that high-fat feed can have an impact on hyperlipidemia,

namely reducing HDL cholesterol levels, increasing triglyceride levels, total cholesterol levels and LDL cholesterol. According to research conducted by Wulandari et al. [23] HDL cholesterol levels can decrease due to high-fat feed through the pathway of increasing lipid absorption and increasing intake. A high-fat diet will result in an increase in lipids, including cholesterol and triglycerides, in small-density lipoproteins and peripheral cells. This is supported by research conducted by Heriansyah [5] which states that giving high-fat feed can increase hepatic lipase activity which will result in reducing HDL cholesterol levels and reducing the size of HDL

The results were checked on the 15th day, after giving takokak fruit extract for 7 days, there was an increase in HDL levels in mice. The treatment group that produced the most optimum increase in HDL levels was group P2 (10.5 mg/25gbw) with a percentage increase of 46.89% compared to groups P1 and P3.

The increase in HDL levels is influenced by one of the compounds contained in takokak fruit, namely flavonoids. Flavonoids are able to increase HDL levels and reduce LDL and VLDL levels in mice with hypercholesterolemia. The total flavonoid extract of Actinida columicta was able to improve hyperlipidemia in mice induced by high-fat diet, it is possible that this mechanism is related to a decrease in HMG CoA reductase activity. The chemical content contained in takokak as an antioxidant can increase HDL levels by increasing liver Apo A1 mRNA which plays a role in initiating the synthesis of Apo A1 which is the main component of HDL. Apo A1 can also suppress the increase in LDL. Flavonoids act as antioxidants directly by donating hydrogen ions to capture hydroxyl radicals (OH) so that they do not become reactive and thus inhibit free radicals. Flavanoids work by capturing and eliminating O- in nitric peroxide (ONOO-) which is formed from nitric oxide (NO) with superoxide (O2-) which is a free radical [2].

3.5 Average Triglycerides of Mice (*Mus musculus L.*)

Table 6. Average Triglycerides of Mice (*Mus musculus L.*)

Group	Day-0 (mg/dL)	Day-8 (mg/dL)	Day-15 (mg/dL)
K-	71,20 ± 2,13	75,40 ± 1,96[a]	69,60 ± 2,29[a]
K+	70,40 ± 3,07	92,40 ± 6,16[a]	84,00 ± 4,12[ab]
P1	70,60 ± 1,21	100,20 ± 5,99[ab]	82,20 ± 6,52[ab]
P2	78,20 ± 6,29	113,80 ± 11,46[ab]	56,60 ± 4,90[a]
P3	71,40 ± 5,51	104,60 ± 12,80[ab]	89,60 ± 10,24[ab]

On the 8th day, with oral administration of cow brain, there was an increase in mice triglyceride levels. On the 15th day, with treatment with takokak fruit extract, the triglyceride levels of mice decreased. Giving cow brain showed an increase in the range of 20-40 mg/dL. Cow brain induction increased triglyceride levels from each treatment.

Significantly when compared with the negative control (K-). The average triglycerides in mice can be seen in Table 6.

On the 15th day, after administering takokak ethanol extract, there was a decrease in triglycerides. Percentage reduction in triglyceride levels of mice showed that all treatment groups experienced a decrease in triglyceride levels but at different percentage levels. At K- it was 7.69%, K+ was 9.09%, P1 was 17.96%, P2 was 50.26%, and P3 was 14.34%. This shows that the P2 group has a better ability to reduce triglyceride levels in mice compared to other treatment groups.

Based on the measurement results, the average triglyceride levels of mice on day 8 were K- (75.40 ± 1.96 mg/dL), K+ (92.40 ± 6.16 mg/dL), P1 (100.20 ± 5 .99 mg/dL), P2 (113.80 ± 11.46 mg/dL), and P3 (104.60 ± 12.80104.60 ± 12.80 mg/dL). The normal triglyceride level in mice is 26-145 mg/dL, indicating that mice have high triglyceride levels after being given cow brain orally for 7 days.

Excessive fat consumption can result in an increase in triglyceride levels in the blood. 100 g of cow brain contains around 2.9 g of saturated fatty acids. Saturated fatty acids consumed from food will go through the digestive process and be absorbed. During the absorption process in the small intestinal mucosa, saturated fatty acids are activated to become acyl-co A by the thiokinase enzyme, then the acyl-coA undergoes an esterification process where glycerol 3 phosphate is added to form triglycerides. Triglycerides are transported in the form of chylomicrons to the lymph circulation which then enters the blood circulation [24].

If triglyceride levels are high it will affect the increase in VLDL and LDL levels and low HDL levels. This is because triglycerides that are transported from the intestine to the liver are in the form of chylomicrons which will then be metabolized, some of this metabolism is when VLDL is transported from the liver to the tissues [7]. Triglycerides or triacyl glycerol are the main lipid compounds in food and body fat deposits. The lipid oxidation process results in the inhibition of the process of acetyl Co-A formation which plays a role in triglyceride biosynthesis so that the triglyceride transferred to it decreases.

On the 15th day, after giving takokak fruit extract for 7 days, triglyceride levels in mice decrease with the most optimum reduction in the treatment dose 10.5 mg/25gbw (50.26%). Antioxidant compounds such as flavonoids in takokak fruit are thought to be able to reduce triglyceride levels in mice with hypercholesterolemia. According to Rusdaina and Syauqy [17], flavonoid can reduce triglyceride levels by increasing the activity of the LPL (lipoprotein lipase) enzyme. The activity of the LPL enzyme functions to convert VLDL into LDL so that VLDL accumulation can be reduced. The mechanism by which flavonoid compounds can reduce triglyceride levels is by increasing the activity of the LPL enzyme. By increasing this enzyme, VLDL which transports triglycerides will undergo hydrolysis into fatty acids and glycerol. The fatty acids released will be absorbed by muscles and other tissues, then oxidized to produce energy and adipose tissue will store them as energy reserves. Maryani et al. [9] state that saponin will bind with bile acids and cholesterol (from food), then form micelles which cannot be absorbed by the intestine and also inhibit the work of the LPL enzyme. Saponins can also inhibit the absorption of cholesterol and triglycerides in the intestine by

forming complex bonds that are insoluble in cholesterol, binding with bile acids to form micelles and increasing the binding of cholesterol and triglycerides by fiber.

Based on the research results, takokak fruit extract has potential to reduce total cholesterol, LDL, triglyceride levels, and increase HDL. The most effective dose was 10.5 mg/25gbw.

4 Conclusion

Ethanol extract of fruit takokak (*Solanum torvum* L.) can reduce levels of total cholesterol, LDL, tiglycerides, and increase HDL in hypercholesterolemia mice (*Mus musculus* L.) with the most effective dose of 10.5 mg/25gbw.

Reference

1. Agustina, R.Y., Sulchan, M.: Pengaruh pemberian jus apel Fuji (Malus domestica) dan susu tinggi kalsium rendah lemak terhadap kadar trigliserida pada tikus Sprague Dawley hiperkolesterolemia. Journal of Nutrition College **2**(4), 615-621 (2013)
2. Darni, J., Tjahjono, K., Sofro, M.A.U.: Pengaruh pemberian ekstrak daun Alfalfa (Medicago sativa) terhadap profil lipid dan kadar malondialdehid tikus hiperkolesterolemia. Jurnal Nutrisi Klinik Indonesia **13**(2), 51–58 (2016)
3. Dewi, Y.R., Santoso, L.M., Tibrani, M.M.: Manfaat buah nanas (Ananas comosus) terhadap penurunan kadar kolesterol darah pada tikus putih (Rattus norvegicus) yang diinduksi aloksan. Jurnal Kedokteran dan Kesehatan Indonesia (2012)
4. Handayani, M., Simatupang, A.: Penggunaan Statin Pada Pasien Hiperkolesterolemia. Majalah Kedokteran UKI **35**(3) (2019)
5. Heriansyah, T.: Pengaruh berbagai durasi pemberian diet tinggi lemak terhadap profil lipid tikus putih (Rattus norvegicus strain Wistar) jantan. Jurnal Kedokteran Syiah Kuala **13**(3), 144–150 (2013)
6. Ismail, R., Naki, M.I.: Uji efektivitas antihiperglikemi ekstrak etanol buah takokak (Solanum torvum Swartz) terhadap hewan uji tikus putih yang diinduksi glukosa. FAJR: Jurnal Riset Kefarmasian **1**(1), 11–20 (2023)
7. Mamuaja, C.F.: Karakteristik pasta tomat dengan penambahan asam sitrat selama penyimpanan. Jurnal Ilmu dan Teknologi Pangan **5**(1), 17–23 (2017)
8. Mariana, M., Rahmadi, A., Syahrumsyah, H.: Pengaruh pemberian cuka mandai terhadap kadar kolesterol total, lipoprotein, dan trigliserida pada mencit (Mus musculus) dengan induksi kuning telur. Journal of Tropical AgriFood **2**(1), 45–52 (2020)
9. Maryani, P.E., Ulfa, E.U., Rachmawati, E.: Pengaruh ekstrak metanol daun kayu kuning (Arcangelisia flava (L.) Merr.) terhadap kadar kolesterol total dan trigliserida tikus hiperlipidemia. Pustaka Kesehatan **4**(1), 20–26 (2016)
10. Mayes, P.A.: Biokimia Harper, 25th edn. Penerbit Buku Kedokteran (2003)
11. Naufalina, M.D., Nuryanto, N.: Pengaruh pemberian susu kacang koro pedang (Canavalia ensiformis) terhadap kadar kolesterol LDL dan HDL pada tikus dislipidemia. Journal of Nutrition College **3**(4), 456-464 (2014)
12. Nova, N.: Pengaruh ekstrak etanol buah rimbang (Solanum torvum Swartz) terhadap kadar LDL (Low Density Lipoprotein) tikus jantan yang diinduksi pakan tinggi lemak (2018)

13. Olivia, Z., Agustini, R.: Pengaruh pemberian Psyllium husk (Psyllium husk) terhadap kadar LDL dan kadar HDL tikus Wistar hiperkolesterolemia (Rattus norvegicus). Jurnal Kesehatan **7**(2), 75–81 (2019)
14. Pitaloka, E.V.D.: Pengaruh ekstrak daun bungur (Lagerstroemia speciosa [L.] Pers) terhadap penurunan kadar kolesterol total mencit jantan (Mus musculus L.) hiperkolesterolemia. Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Lampung (2017)
15. Prihantika, S.: Pemberian Sargassum sp. dan taurin terhadap penurunan kadar kolesterol total mencit (Mus musculus L.) jantan hiperkolesterolemia. Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Lampung (2016)
16. Primawestri, M.A., Rustanti, N.: Pengaruh pemberian susu koro pedang (Canavalia ensiformis) terhadap kadar kolesterol total dan trigliserida serum tikus Sprague Dawley hiperkolesterolemia. Journal of Nutrition College **3**(4), 447–455 (2014)
17. Rusdaina, R. Syauqy, A.: Pengaruh Pemberian Pisang Kepok (*Musa paradisiaca*) Terhadap Kadar Trigliserida Tikus Sprague Dawley PRA Sindrom Metabolik. Journal of Nutrition College. (2015)
18. Sangkal, A., Lewa, S., Ismail, R.: Uji aktivitas antidiabetes fraksi etil asetat buah takokak (Solanum torvum Swartz) dengan metode tes toleransi glukosa per oral. Jurnal Riset Kefarmasian **1**(2), 1–5 (2023)
19. Sayekti, N.A., Rustanti, N.: Pengaruh pemberian yoghurt koro pedang (Canavalia ensiformis) terhadap kadar kolesterol LDL dan HDL serum tikus Sprague Dawley dislipidemia. Journal of Nutrition College **3**(1), 125–133 (2014)
20. Subandi, A.: Efektivitas ekstrak buah rimbang (Solanum torvum Swartz) terhadap penurunan kadar kolesterol total dalam darah pada tikus putih jantan dewasa galur Wistar. Jurnal Penelitian Universitas Jambi: Seri Sains **15**(2) (2013)
21. Tasmin, N., Erwin, Kusuma, I. W.: Isolasi, Identifikasi dan Uji Toksisitas Senyawa Flavonoid Fraksi Kloroform dari Daun Terap (*Artocarpus odoratissimus* Blanco). Jurnal Kimia Mulawarman **12**(1) (2014)
22. Wannasiri, S., Chansakaow, S., Sireeratawong, S.: Effects of Solanum torvum fruit water extract on hyperlipidemia and sex hormones in high-fat fed male rats. Asian Pacific Journal of Tropical Biomedicine **7**(5), 401–405 (2017)
23. Wulandari, R.L., Susilowati, S., Asih, M.: Pengaruh kombinasi ekstrak etanol daun sirsak (Annona muricata L.) dan simvastatin terhadap kadar kolesterol total dan low density lipoprotein (LDL) tikus yang diinduksi pakan tinggi lemak. Jurnal Ilmu Farmasi dan Farmasi Klinik **12**(2), 24–32 (2015)
24. Wulandari, W.A., Pramono, A.: Pengaruh pemberian yoghurt koro pedang (Canavalia ensiformis) terhadap kadar serum trigliserida tikus Sprague Dawley hipertrigliseridemia. Journal of Nutrition College **3**(1), 172–178 (2014)
25. Yuliantini, E., Sari, A.P., Nur, E.: Hubungan Asupan Energi, Lemak, Dan Serat Dengan Rasio Kadar Kolesterol Total-HDL. Jurnal Penelitian Gizi dan Makanan **38**(2), 139-147 2015

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.