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The Effect of Black Rice Extract on Lipid Profile Changes in Hypercholesterolemic *Mus musculus*

Awalia[1], Armanto Makmun[2], Aryanti R. Bamahry[3], Rasfayanah[4], Yusriani Mangareng [5]

[1]*Medical Profession Education Program, Faculty of Medicine, Universitas Muslim Indonesia*
[2]*Department of Public Health, Faculty of Medicine, Universitas Muslim Indonesia*
[3]*Department of Clinical Nutrition, Faculty of Medicine, Universitas Muslim Indonesia*
[4]*Department of Biochemistry, Faculty of Medicine, Universitas Muslim Indonesia*
[5]*Department of Microbiology, Faculty of Medicine, Universitas Muslim Indonesia*

**Corresponding Author: Armanto Makmun*
E-mail: armanto.makmun@umi.ac.id

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Abstract

Increased levels of lipid profiles in the blood affect the occurrence of coronary heart disease. Several large studies have shown that several natural food ingredients rich in antioxidants are associated with a lower incidence of cardiovascular disease. prevent the occurrence of several degenerative diseases. The research design used was a research design with a control group (pretest-posttest control group design). The research design used was a pretest-posttest control group design with 27 mice (mus musculus). They were divided into 3 groups: the negative control group (placebo), the positive control group (simvastatin), and the treatment control group (black rice). The intervention was carried out for 21 days. Data analysis was carried out using the paired T test and one way ANOVA test. Giving black rice extract can significantly improve lipid profile levels in mice, especially increasing HDL cholesterol levels by (10.44%) and decreasing triglyceride levels by (12.89%) as well as Simvastatin administration can also improve lipid profile levels significantly, especially decreased total cholesterol levels by (24.67%) and decreased LDL cholesterol by (32.08%). Based on the one way ANOVA test, P values were obtained successively in the administration of black rice extract, namely total cholesterol (p=<0.001), HDL cholesterol (p=<0.001), LDL cholesterol (p=<0.001), and triglycerides (p=<0.001). Likewise, in the administration of simvastatin, the lipid profile levels were obtained (p = <0.001). The conclusion of this study was that there was a significant effect of giving black rice extract on the lipid profile of hypercholesterolemia mice which was as effective as simvastatin.

Introduction

Lipids or fats are a collection of substances that are insoluble in water but can dissolve in solvents such as alcohol or chloroform. Lipid profile is the elements of fat in plasma consisting of cholesterol, triglycerides, phospholipids and free fatty acids. The first three elements are associated with certain proteins (apoproteins) to form lipoproteins, namely chylomicrons, VLD, LDL (low density lipoproteins) and HDL (high density lipoproteins), each of which has a fat element with a different content (Darafika, 2017; Felmlee et al., 2013; Meades, 2014).

Increased levels of lipid profiles in the blood affect the occurrence of coronary heart disease, which is a cardiovascular disease that is currently one of the leading causes of death in the world (Sahara & Adelina, 2021). Cardiovascular disease and its complications are largely

triggered by the formation of atherosclerotic plaques in blood vessels. One of the causes of atherosclerotic plaque formation is due to high serum cholesterol levels called hypercholestrolemia (Corwin, 2009; van Rooy & Pretorius, 2014).

Hypercholestrolemia is a condition where blood cholesterol levels exceed >240 mg/dl (Ardian et al., 2020). This disease is caused by unhealthy food intake, such as consuming high fat, low fruit and vegetable consumption, obesity, low physical activity, hypertension, stress, smoking, and alcohol use (Lestari & Utari, 2017; Whatnall et al., 2016).

Data from the World Health Organization (WHO) in 2012 showed that 17.5 million people in the world died from cardiovascular disease or 31% of the 56.5 million deaths worldwide. More than 3/4 of deaths from cardiovascular disease occur in developing countries with low to moderate income (Rokom, 2017). Data from the 2018 Riskesdas showed that the highest prevalence of heart disease in Indonesia was 1.5%. Of this prevalence, the highest rate was in the province of North Kalimantan at 2.2% and the lowest in the province of East Nusa Tenggara at 0.7%. According to the age group, CHD is most prevalent in the age group >75 years, and the incidence rate of women is higher than men (Pemerintah RI, 2018).

To reduce the risk of cardiovascular disease, several methods are recommended, including lifestyle modification, increased physical activity, and weight maintenance. Large population studies have shown that some natural foods rich in antioxidants are associated with a lower incidence of cardiovascular disease (Pinontoan, 2015). One of the natural food ingredients that is high in antioxidants is rice. Where the difference in each color of rice determines the benefits produced. Data shows that the highest antioxidant content is found in black rice and the lowest in white rice (Pinontoan, 2015; Zhu et al., 2022). This black rice has anthocyanin compounds that function as antioxidants and free radical catchers so that it plays a role in preventing the occurrence of several degenerative diseases (Tan et al., 2016).

Based on previous studies that have been conducted using roasted black rice tea extract and found changes in serum lipid profiles in Wistar rats (Rattus novergicus), while this study will use black rice extract macerated using ethanol. Based on this background, this study wants to test whether or not the effect of giving black rice extract on the lipid profile of mice (Mus Musculus) with hypercholesterolemia.

Methods

The research design used was a pretest-posttest control group design. The research design is a design in which there are two groups, namely the experimental group that receives treatment and the control group that does not receive treatment. So that it allows researchers to determine the extent or how much change occurs because the test is carried out at the beginning and at the end of the treatment.

Result and Discussion

Body weight of mice (Mus musculus) before and after treatment

The graph of changes in mice body weight before and after treatment can be seen in Figure 1.

The graph in Figure 2.1, shows changes in mice body weight before and after treatment. In group P0, the body weight of mice increased from before to after treatment. In group P1 the body weight of mice decreased from before to after treatment. And also in group P2 the body weight of mice decreased from before to after treatment.

The summary of body weight data analysis is presented in Table 2.1. the average body weight before treatment in group P0 was 27.70 ± 5.69 and after 28.16 ± 7.29. after that the paired T test between the mean values obtained sig = 0.481 ($p>0.05$) which means there is no comparison between body weight before and after treatment.

In the P1 group, 31.27 ± 3.79 and after 30.82 ± 3.19. after that a paired T test between the mean values was obtained sig = 0.323 (p>0.05) which means there is no comparison between body weight before and after treatment.

In the P2 group, 28.11 ± 2.20 and after 26.22 ± 1.98. after that a paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between body weight before and after treatment.

Figure 1. Weight Change Chart

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Table 1. Average Weight Measurement Results of Mice (Mus Musculus) Before and After Treatment

Treatment	Before treatment	After treatment	P-value	Percentage decrease (%)
P0	27.70 ± 5.69	28.16 ± 7.29	0,481	0,46
P1	31.27 ± 3.79	30.82 ± 3.19	0,323	0,45
P2	28.11 ± 2.20	26.22 ± 1.98	<0,001	1,89

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Comparison of Total Cholesterol Levels Before and After Treatment in All Groups

The graph of changes in total cholesterol levels of mice before and after treatment can be seen in Figure 2.

The graph in Figure 4, shows changes in total cholesterol levels of mice before and after treatment. In the P0 group, the total cholesterol level of mice decreased from before to after treatment. In group P1 the total cholesterol levels of mice decreased from before to after treatment. And also in group P2 the total cholesterol levels of mice decreased from before to after treatment.

The summary of the analysis of total cholesterol data is presented in Table 2.2. obtained the mean results of total cholesterol levels before treatment in the P0 group were 113.89 ± 9.26 and after 109.00 ± 7.95. after that the paired T test between the mean values obtained sig =

0.34 (p>0.05) which means there is no comparison between the total cholesterol values before and after treatment.

In the P1 group, 136.00 ± 16.31 and after 111.33 ± 9.52. after that the paired T test between the mean values was obtained sig = 0.002 (p <0.05) which means there is a comparison between the total cholesterol values before and after treatment.

In the P2 group, 122.67 ± 16.46 and after 113.67 ± 14.30. After that, a paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between the total cholesterol values before and after treatment.

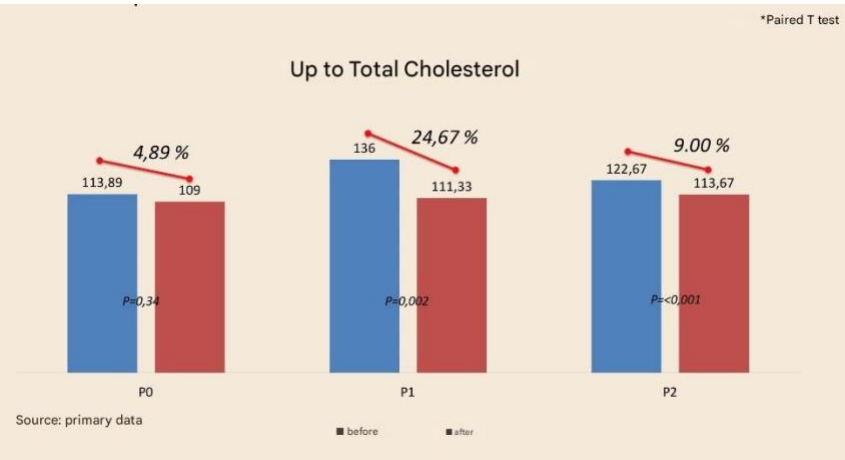

Figure 2. Graph of Changes in Total Cholesterol Levels

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Table 2. Measurement Results of Total Cholesterol Levels of Mice (Mus Musculus) Before and After Treatment in All Groups

Treatment	Before treatment	After treatment	P-value	Percentage decrease (%)
P0	113.89 ± 9.26	109.00 ± 7.95	0,34	4.89
P1	136.00 ± 16.31	111.33 ± 9.52	0,002	24.67
P2	122.67 ± 16.46	113.67 ± 14.30	<0,001	9.00

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Comparison of HDL Levels Before and After Treatment in All Groups

The graph of changes in HDL cholesterol levels of mice before and after treatment can be seen in Figure 2.

The graph in Figure 2.3, shows changes in HDL cholesterol levels in mice before and after treatment. In the P0 group, HDL cholesterol levels decreased from before to after treatment. In group P1 HDL cholesterol levels of mice decreased from before to after treatment. And also in group P2 HDL cholesterol levels of mice decreased from before to after treatment.

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Summary of HDL cholesterol data analysis is presented in Table 2.3. obtained the mean HDL levels before treatment in the P0 group were 28.89 ± 6.23 and after 34.11 ± 7.52. after that the paired T test between the mean values obtained sig = 0.005 (p <0.05) which means there is a comparison between HDL cholesterol values before and after treatment.

After that, a paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between HDL cholesterol values before and after treatment. After that, a paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between HDL cholesterol values before and after treatment.

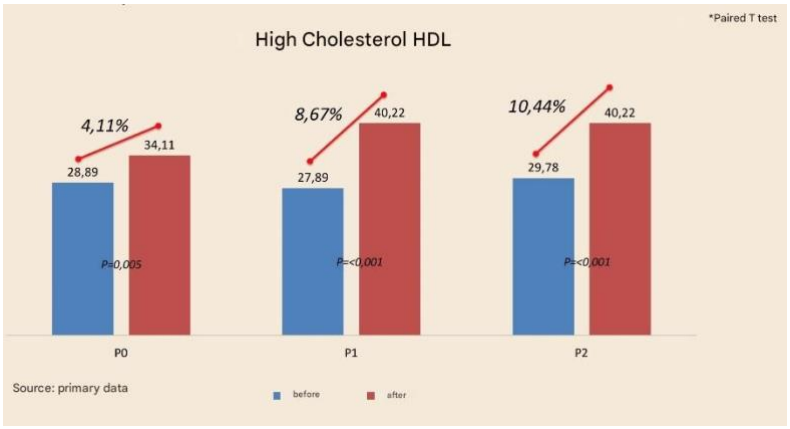

Figure 3. Graph of Changes in HDL Cholesterol Levels

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Table 3. HDL Cholesterol Level Measurement Results of Mice (Mus Musculus) Before and After Treatment in All Groups

Treatment	Before treatment	After treatment	P-value	Percentage increase (%)
P0	28.89 ± 6.23	34.11 ± 7.52	0.005	-4.11
P1	27.89 ± 4.10	40.22 ± 4.49	< 0.001	-8.67
P2	29.78 ± 4.63	40.22 ± 4.49	< 0.001	-10.44

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Comparison of LDL Levels Before and After Treatment in All Groups

The graph of changes in LDL cholesterol levels of mice before and after treatment can be seen in Figure 2.4.

The graph in Figure 2.4, shows changes in LDL cholesterol levels of mice before and after treatment. In the P0 group, the LDL cholesterol levels of mice decreased from before to after treatment. In the P1 group, the LDL cholesterol levels of mice decreased from before to after treatment. And also in the P2 group, the LDL cholesterol levels of mice decreased from before to after treatment.

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The summary of LDL cholesterol data analysis is presented in Table 2.4. obtained the mean results of LDL levels before treatment in the P0 group were 70.15 ± 14.26 and after 62.11 ± 15.41. after that the paired T test between the mean values obtained sig = 0.005 (p <0.05) which means there is a comparison between LDL cholesterol values before and after treatment.

After that, the paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between the LDL cholesterol values before and after treatment.After that, the paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between the LDL cholesterol values before and after treatment.

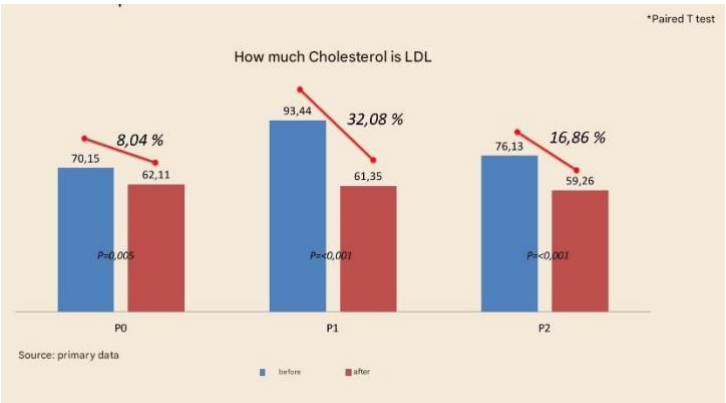

Figure 4. Graph of Changes in LDL Cholesterol Levels

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Table 4. HDL Cholesterol Level Measurement Results of Mice (Mus Musculus) Before and After Treatment in All Groups

Treatment	Before treatment	After treatment	P-value	Percentage increase (%)
P0	70.15 ± 14.26	62.11 ± 15.41	0.005	8.04
P1	93.44 ± 19.11	61.35 ± 12.48	< 0,001	32.08
P2	76.13 ± 16.87	59.26 ± 13.77	< 0.001	16.86

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Comparison of Triglyceride Levels Before and After Treatment in All Groups

The graph of changes in Triglyceride levels of mice before and after treatment can be seen in Figure 5.

The graph in Figure 2.5, shows changes in Triglyceride levels of mice before and after treatment. In the P0 group, the Triglyceride levels of mice decreased from before to after treatment. In the P1 group, the Triglyceride levels of mice decreased from before to after treatment. And also in group P2 Triglyceride levels of mice decreased from before to after treatment.

The summary of TG data analysis is presented in Table 2.5. The mean results of TG levels before treatment in the P0 group were 70.15 ± 14.26 and after 62.11 ± 15.41. after that the paired T test between the mean values was obtained sig = <0.001 (p <0.05) which means there is a comparison between TG values before and after treatment.

After that, the paired T test between the mean values was obtained sig = <0.001 (p<0.05) which means there is a comparison between the TG values before and after treatment. After that, a paired T test between the mean values was obtained sig = <0.001 (p<0.05) which means there is a comparison between the TG values before and after treatment.

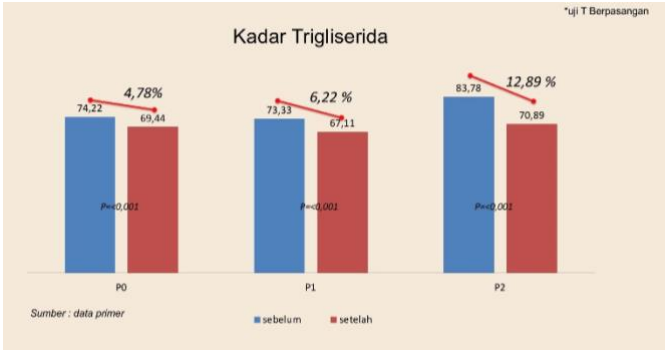

Figure 6. Graph of Changes in Triglyceride Levels

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Table 5. HDL Cholesterol Level Measurement Results of Mice (Mus Musculus) Before and After Treatment in All Groups

Treatment	Before treatment	After treatment	P-value	Percentage increase (%)
P0	74.22 ± 11.13	69.44 ± 11.62	< 0.001	4.78
P1	73.33 ± 7.26	67.11 ± 7.40	< 0.001	6.22
P2	83.78 ± 4.99	70.89 ± 5.25	< 0.001	12.89

Description:

P0: Hypercholestrolemia mice + placebo

P1: Hypercholestrolemia mice + simvastatin 0.026 mg/day

P2: Hypercholestrolemia mice + black rice extract 0.52 ml/KgBB

Comparison of Lipid Profile Levels Before and After Treatment in All Groups

A summary of lipid profile data analysis before and after treatment in all groups is presented in Table 8. Total cholesterol levels before treatment and after treatment in groups P0, P1, and P2 obtained sig = <0.001 (p<0.05) which means there is a comparison of total cholesterol levels in all groups.

HDL cholesterol levels before treatment and after treatment in groups P0, P1, and P2 obtained sig = <0.001 (p<0.05) which means there is a comparison of HDL cholesterol levels in all groups. LDL cholesterol levels before treatment and after treatment in groups P0, P1, and P2 obtained sig = <0.001 (p<0.05) which means there is a comparison of HDL cholesterol levels in all groups.

Triglyceride levels before treatment and after treatment in groups P0, P1, and P2 obtained sig = 0.002 (p <0.05) which means there is a comparison of Triglyceride levels in all groups.

Table 6. Measurement Results of Lipid Profile Levels of Mice (Mus Musculus) Before and After Treatment in All Groups

Lipid profile	Group	Mean ± SD	P-value
	P0	4.88 ± 5.75	
Total Cholesterol	P1	24.66 ± 16.40	< 0.001
	P2	9.00 ± 4.00	
	P0	-4.11 ± 3.25	
HDL Cholesterol	P1	-8.66 ± 1.65	< 0.001
	P2	-10.44 ± 0.52	
	P0	8.04 ± 6.21	
LDL cholesterol	P1	32.08 ± 16.02	< 0.001
	P2	16.86 ± 5.28	
	P0	4.77 ± 1.48	
Triglycerides	P1	6.22 ± 0.44	0.002
	P2	12.88 ± 6.66	

Mean Body Weight of Mice (Mus Musculus) Before and After Treatment in All Groups

Based on table 3. In the positive control group (P1), the average body weight of mice decreased, this is because the drug simvastatin is able to inhibit HMG-CoA reductase in converting acetyl-CoA into mevalonate acid. simvastatin clearly induces an increase in LDL receptors with high affinity. This effect increases the rate of LDL extraction by the liver, thereby reducing plasma LDL stores. Its ability to inhibit HMG-CoA reductase and reduce plasma LDL stores results in a decrease in total cholesterol levels. This is in line with research conducted by Iwagami et al. (2021) that there is a relationship between body weight and total blood cholesterol levels (Katzung, 2013).

In the treatment group (P2) the average body weight of mice decreased, due to black rice containing fiber and anthocyanins. high fiber content so that it will be digested longer in the stomach which will experience a longer feeling of satiety. In addition, food fiber shows its ability to regulate energy intake thereby increasing body weight loss (Nastiti et al., 2020).

Thus it can be concluded that there is an effect of giving black rice extract in losing weight as well as giving simvastatin, but not better than giving black rice extract.

Comparison of Total Cholesterol Levels Before and After Treatment in All Groups

In the positive control group (P1) with the administration of simvastatin for 21 days, a decrease of 24.67% was obtained as in the table where there was a decrease between before and after simvastatin treatment. This occurs because the drug simvastatin is able to inhibit HMG-CoA reductase in converting acetyl-CoA into mevalonate acid. simvastatin clearly induces an increase in LDL receptors with high affinity. This effect increases the rate of LDL extraction by the liver, thereby reducing plasma LDL stores. Its ability to inhibit HMG-CoA reductase and reduce plasma LDL stores results in a decrease in total cholesterol levels (Tan et al., 2016).

W hile in the treatment group (P2) with the administration of black rice extract for 21 days, a decrease of 9.00% was obtained as in table 4, where there was a significant decrease between before and after the treatment of black rice extract. This shows that the treatment of black rice extract has the potential to reduce total cholesterol levels. This is due to the content in black rice which has high antioxidant levels. Research conducted by fajrin states that black glutinous

rice ethanol extract containing high anti-oxidants can reduce serum total cholesterol levels in white rats (Fajrin, 2010). And also one of the components contained in black rice, namely oryzanol, can affect lipid metabolism in the body. The content of oryzanol is known to reduce total cholesterol, LDL cholesterol and VLDL levels in hypercholestrolemia rats (Herlambang et al., 2015; Mantiri et al., 2024).

Thus it can be concluded that there is an effect of giving black rice extract in reducing total cholesterol levels but not as great as the effect of giving simvastatin which is one of the drugs used in hypercholestrolemia therapy.

Comparison of Hdl Cholesterol Levels Before and After Treatment in All Groups

In the positive control group (P1) with the administration of simvastatin for 21 days, there was an increase in HDL cholesterol levels before and after treatment, namely -8.67% as in table 5, where there was an increase between before and after simvastatin treatment. This can be due to the way this drug works is by inhibiting HMG-CoA reductase which has a function as a catalyst in cholesterol formation. Inhibition of HMG-CoA reductase will reduce cholesterol synthesis and increase LDL receptors. So it can be concluded that simvastatin can reduce cholesterol primarily by working in reducing plasma LDL, but is less effective in increasing plasma HDL (Campolongo et al., 2016).

In the treatment group (P2) with the administration of black rice extract for 21 days, there was an increase in HDL cholesterol levels before and after treatment, namely -10.44% as in table 5, where there was an increase between before and after treatment with black rice extract. This is similar to research conducted by Nelwan (2012) where there was a significant increase in HDL levels between before and after giving red apple fruit juice containing anthocyanins. This is due to anthocyanins contained in black rice. Suliartini in her research said that the blacker the color of the rice skin, the higher the anthocyanin content. Research conducted by Mohammadi et al. (2024) said brown rice and black rice contain anthocyanin-type antioxidants that can be used in hypolipidemic therapy, stabilizing the formation of atherosclerotic plaques and increasing antioxidant levels in rabbits fed a high cholesterol diet.

Thus it can be concluded that there is an effect of giving black rice extract in raising HDL cholesterol levels significantly compared to the administration of simvastatin.

Comparison of Ldl Cholesterol Levels Before and After Treatment in All Groups

In the positive control group (P1) with the administration of simvastatin for 21 days, a decrease of 32.08% was obtained as in table 6, where there was a decrease between before and after simvastatin treatment. This occurs because simvastatin can reduce LDL cholesterol levels by inducing an increase in LDL cholesterol receptors with high affinity. This effect increases the speed of LDL cholesterol extraction by the liver, thereby reducing plasma LDL cholesterol stores (Tan et al., 2016).

In the treatment group (P2) with the administration of black rice extract for 21 days, a decrease of 16.86% was obtained as in table 6, where there was a decrease between before and after treatment with black rice extract. In black rice extract there are compounds that are believed to reduce LDL cholesterol levels, namely anthocyanins. Anthocyanins are natural dyes found in plants, these compounds belong to the flavonoid group. Research in Bali by Sumardika and Jawi (2012) showed the ability of purple sweet potato leaf extract to maintain lipid profiles within normal limits, besides that in research conducted by Park (2008) showed that black rice containing anthocyanin active compounds had high antioxidant activity (Pinontoan, 2015).

So it can be concluded that the administration of black rice extract has an effect on reducing LDL cholesterol levels, but not as good as the reduction in LDL cholesterol levels in the simvastatin administration group

Comparison of Triglyceride Levels Before and After Treatment in All Groups

In the positive control group (P1) with the administration of simvastatin for 21 days, a decrease of 6.22% was obtained as in table 7, where there was a decrease between before and after simvastatin treatment. This happens because simvastatin can inhibit apo-B secretion from the liver, by increasing apolipoprotein B receptors. apo B is the largest component contained in triglycerides. So it can be formulated that the decrease in triglyceride levels by simvastatin is more on its ability to inhibit the secretion of Apo-B as the largest component of triglycerides (Ginsberg et al., 1987).

In the treatment group (P2) with the administration of black rice extract for 21 days, a decrease of 12.89% was obtained as in table 7, where there was a decrease between before and after treatment with black rice extract. Triglyceride levels can be influenced by black and brown rice extracts. Soluble fiber contained in black rice and brown rice has similar characteristics with other dietary fibers in binding bile acids which will further reduce fat digestibility and fat absorption. This is in line with research conducted by Ausman showing that rice skin oil can reduce triglyceride levels in hamsters that experience hypercholesterolemia (Herlambang et al., 2015). So it can be concluded that there is an effect of giving black rice extract in reducing triglyceride levels as well as giving simvastatin but not better than giving black rice extract.

Comparison of Lipid Profile Levels Before and After Treatment in All Groups

In the positive control group (P1) with the administration of simvastatin for 21 days, the lipid profile that experienced a significant decrease was total cholesterol and LDL cholesterol, this is because statins work by inhibiting the HMG-CoA reductase enzyme and reducing LDL deposits, which can reduce total cholesterol levels. And also simvastatin can reduce LDL cholesterol levels by inducing an increase in LDL cholesterol receptors with high affinity.

In the treatment group (P2) with the administration of black rice extract for 21 days, the lipid profile that experienced a significant decrease was HDL cholesterol and triglycerides. This is because black rice is the seed of the black rice plant which has a high anthocyanin content, anthocyanins are secondary metabolite compounds of the flavonoid group that have the ability as antioxidants. The anthocyanin content in black rice has been shown to have an effect in preventing cardiovascular disease by lowering blood pressure, total cholesterol, LDL cholesterol, VLDL, triglycerides and increasing plasma HDL levels (Istanti et al., 2018). So it can be concluded that there is an effect of giving black rice extract in reducing lipid profile levels, especially HDL cholesterol and triglyceride levels, as well as giving simvastatin can reduce lipid profile levels, especially total cholesterol and LDL cholesterol levels.

Conclusion

Comparison of changes in body weight before and after treatment was significantly different in the black rice extract group, while in the placebo and simvastatin groups there was no significant difference. Comparison of changes in total cholesterol levels before and after treatment in all groups was significantly different and the largest percentage decrease was in the simvastatin group. Comparison of changes in HDL cholesterol levels before and after treatment in all groups was significantly different and the largest percentage decrease was in the black rice extract group. Comparison of changes in LDL cholesterol levels before and after treatment in all groups was significantly different and the largest percentage decrease was in the simvastatin group. Comparison of changes in Triglyceride levels before and after treatment in all groups was significantly different and the largest percentage decrease was in the black rice extract group. Comparison of changes in lipid profile levels before and after treatment in all groups is significantly different, the greatest percentage decrease in reducing total cholesterol and LDL cholesterol levels is the simvastatin group, and the greatest percentage decrease in reducing HDL cholesterol and triglyceride levels is the black rice extract group.

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Suggestion

For further research, it is recommended to test various doses of black rice extract to determine the best dose in reducing the lipid profile of mice.

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