

Effect of High Fiber Diet and Physical Activity on Total Cholesterol Levels

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Abstract

High-fiber diet is the provision of food according to high nutritional requirements of fiber so that it can stimulate intestinal peristalsis for normal defecation and can also bind bile acids that can lower blood cholesterol. Aerobic exercise can increase the muscle's ability to use fat as a source of energy and is an important addition in diet to lower cholesterol levels. The purpose of this study is to determine the effect of high-fiber diet and physical activity on the reduction of total cholesterol levels in male rats Wistar strain. This research is an experimental research with randomized post test only control group design. In this study, 30 male rats of wistar strain are divided into 5 groups randomly and treated for 21 days. Group C (-) is given a standard diet, Group C (+) is given a diet high in cholesterol, Group T1 was given a diet high in cholesterol and a high-fiber diet, Group T2 is given a diet high in cholesterol and physical activity, and T3 group is given a combination of high-fiber diet and activity physical. Total cholesterol is measured using the CHOD-PAP method. Data is analyzed using Oneway Anova and Tukey Test. The result of P Value Anova Oneway for total cholesterol is $p = 0.002$. Tukey test results for total cholesterol significantly differed, Group T1 with T2 ($p = 0.008$), T2 with T3 ($p = 0.003$). The conclusion of this study is both a high-fiber diet and physical activity can reduce total cholesterol levels in wistar strain rats.

Keywords: High Fiber Diet, Physical Activity, Total Cholesterol

I. INTRODUCTION

Cholesterol is an essential component of the structural membrane of all cells and is a major component of brain cells and nerves [1]. Hypercholesterolemia is a condition of increasing total cholesterol in the blood due to fatty metabolic disorders [2]. The increased total cholesterol levels in the blood become a strong predictor of atherosclerosis and coronary artery disease and can develop into cardiovascular disease [3].

In Indonesia, the survey shows that the consumption of fruits and vegetables in the population aged ≥ 10 years nationally is categorized "less" because the consumption of vegetables or fruits ≤ 5 servings per day for one week. In addition, risky food consumption behaviors such as salty, sweet, fatty, baked, preserved, caffeinated and seasoned foods in Indonesia are very high. It is about 40% of Indonesian people have a habit of eating fatty foods, cholesterol, and fried foods ≥ 1 times per day. This will have an impact on public health, because the behavior of eating fatty foods, cholesterol, and fried can cause the risk of degenerative diseases such as hypercholesterolemia and heart disease [4].

Sedentary behavior is a risky behavior against one of the occurrences of vascular blockage diseases, heart disease, and even affecting life expectancy. The results of the 2013 riskesdas show that almost half the proportion of the population of ≥ 10 years age group with sedentary behavior is 3-5.9 hours (42%) per day. This shows that people aged ≥ 10 years of less active activity is evidenced by a quarter of a day spent with sedentary behavior such as sitting, lying, reading, typing and driving.

Of the two things mentioned above, namely the low consumption of vegetables and the high sedentary activity, it is necessary to prevent the disease for hypercholesterolemia so that it will not increase. Prevention can be done with a high-fiber diet and carrying out physical activity regularly. High-fiber diet is a diet that fits with a high nutritional requirements of fiber so that it can stimulate intestinal peristalsis to run defecation normally and can also bind bile acids that can lower blood cholesterol [1]. Physical activity is a physical movement performed by skeletal muscle and requires energy¹. Physical activity performed over and over again for several days is called exercise [5]. Aerobic exercise can increase the muscle's ability to use fat as an energy source and is an important addition in diet to lower cholesterol and and diet to reduce body fat, the factor may reduce the risk of coronary heart disease [6].

The purpose of this study was to determine the effect of high-fiber diet and physical activity on total cholesterol levels in male rats wistar.

II. METHODS

This study was an experimental research with randomized post test only control group design. The experiment was conducted at the animal cage laboratory of the Faculty of Veterinary Medicine of Airlangga University for the maintenance of rats and at “Balai Besar” Health Laboratory of Surabaya to test the blood of mice.

The experimental animals used were male white rats wistar 12 weeks age, 150 - 200 gram weight for about 30 mice, which were obtained from the try animal cage Laboratory of the Faculty of Veterinary Medicine of Airlangga University. Mice were placed in plastic box measuring 30 x 40 x 40 cm. In this study, 30 male rats of wistar strain were divided into 5 groups randomly and treated for 21 days. 7 days for adaptation and 14 days for treatment. Group C (-) was given a standard diet, Group C (+) was given a diet high in cholesterol, Group T1 was given a diet high in cholesterol and a high-fiber diet, Group T2 was given a diet high in cholesterol and physical activity, and T3 group was given a diet high in cholesterol and combination of high-fiber diet and physical activity.

Food ingredients used for high cholesterol feed was duck egg yolk with dose 5% of total feed (1g), while diet for high fiber diet was bran which was mashed with dose 50% from total feed (10g).

Swimming exercise was performed by rats for 14 days using a tub that was 50 cm in diameter and 60 cm high with a water depth of 40 cm so that the rat's tail did not touch the bottom of the water bath [7]. Physical activity that can lower cholesterol is a physical activity with low intensity [8]. According to Bompa, 2009 moderate low physical activity exercise, using aerobic energy system in which the energy was generated during exercise is derived from fat.

Determination of the duration of swimming exercise was determined by determining the maximum time of swimming which was characterized by the inability of rats to swim or being tired was a nearly drowned mouse with a characteristic feature of rats can't appear on the surface of the water despite being given a stimulus on his back. It also appeared air bubbles from nasal [9]. The maximum time was then taken an average. Then it was converted to the intensity table of physical exercise. Low physical exercise was 50% of maximum ability[10]. The frequency of swimming exercises was 6 times in one week [11].

The ethical test of research ethics was issued by the health research commission of the public health faculty of Airlangga University with no 330 KEPK.

The white mouse was swallowed for 12 hours, then the sacrifice of an anesthesia was done by using ketamine HCl (20 - 40 mg / kg BB) intramuscularly. After the eyes faded, and the body did not move, then the abdominal skin incised with a scalpel and then it was taken \pm 3-4 ml blood from the heart vent, then it was immediately taken to the Regional Health Laboratory Surabaya to be analyzed. Blood was centrifuged for 15 - 20 minutes at 3000 rpm to take the serum, then we can measure total cholesterol levels by CHOD-PAP method. The data will be released by using Oneway Anova and Tukey HSD tests with SPS program.

III. RESULTS

Based on this research, the mean of swimming maximum time of group (T2) and (T3) was 80 seconds. So, the duration of swimming was 40 seconds per day. The Average of total cholesterol levels in all groups after 21 days of treatment could be seen in the table below

Table 1. Mean and Standard Deviation of Total Cholesterol Level

Group	Mean \pm SD
Negative Control	41.8 \pm 2.86 mg/dL
Positive Control	55.6 \pm 2.07 mg/dL
Treatment 1	36.0 \pm 2.73 mg/dL
Treatment 2	42.0 \pm 1.87 mg/dL
Treatment 3	35.0 \pm 2.91 mg/dL

Overall, the results showed that high-fiber diet and physical activity was able to lower total cholesterol levels compared to the C+ group that was given a diet high in cholesterol.

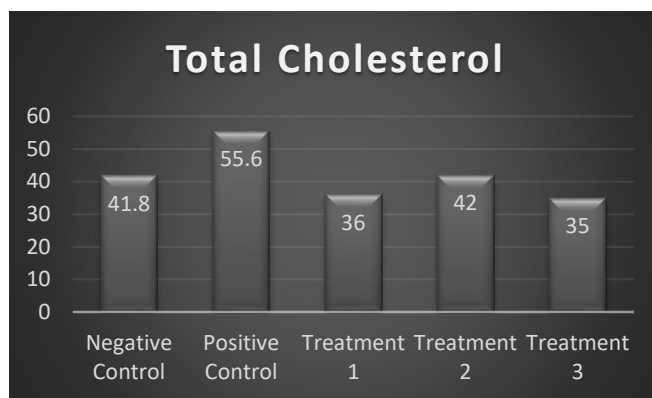


Figure1. Mean Distribution of Total Cholesterol Level

Based on Oneway ANOVA test, it was known that the average total cholesterol level of the five groups was significantly different with the value of $p = 0.002$. Therefore, it was followed by a Tukey Test to find out more about the differences between groups. Tukey Test results showed that there was a difference between the high-fiber diet (T1) and physical activity (T2) $p = 0.008$. And there was a difference between giving physical activity (T2) and combination of high fiber diet and physical activity (T3) $p = 0.003$.

IV. DISCUSSION

A. The Effect of High Cholesterol Diet to Total Cholesterol

In this study rats were given a diet high in cholesterol, namely duck egg yolks for about 1 gram (5% of feed requirement of mice) for 2 weeks. This dose had been adapted to the conversion of mice to humans in which cholesterol consumption in humans should not exceed for more than 300 mg / day.

A saturated fat diet increases blood cholesterol concentrations by 15 to 25%. This is predicted as a result of the increasing fat deposition in the liver, which then leads to an increase in the amount of acetyl CoA in liver cells where acetyl CoA is the main ingredient of cholesterol biosynthesis. At first, two molecules of acetyl-CoA unite to form acetoacetyl-CoA which is catalyzed by thiolase cytosol. Acetoacetyl-CoA is condensed with other acetyl-CoA molecules catalyzed by HMG-CoA synthase to form HMG-CoA which is reduced to mevalonate by NADPH and catalyzed by HMG-CoA reductase. This last stage is the main regulatory stage in the cholesterol synthesis pathway [12]. With the ongoing cholesterol biosynthesis, the more the amount of cholesterol that is formed.

This is in line with Vanessa's research which states that the increase in cholesterol levels of mice fed a high cholesterol diet in the form of a combination of egg yolks and pork oil within 2 weeks [13]. In addition other studies revealed that mice given a mixture of cow's fat and egg yolks for 2 weeks experienced increased levels of cholesterol and LDL [14].

Based on the above-mentioned theory it can be concluded that a diet high in cholesterol can increase total cholesterol levels

B. The Effect of High Fiber Diet to Total Cholesterol levels

The results showed that P1 group which is given a diet high in cholesterol and a diet high in fiber can lower total cholesterol levels. Decrease in cholesterol levels occurred due to the presence of water soluble fiber mechanism that can absorb bile acids. Water-soluble fiber has the ability to bind and excrete bile salts containing cholesterol [15]. Since bile acids have been binding to the fiber, the body needs bile acids to perform its function. Therefore the liver immediately take cholesterol from the blood plasma as a raw material for cholesterol. The more hearts take cholesterol from the plasma, the plasma cholesterol will decrease.

Besides the presence of high coarse fiber in bran (the main ingredient of high-fiber diet), will cause the volume of food in the intestinal lumen resulting in mechanical stimulation that can improve intestinal peristalsis [16]. High consumption of fiber will reduce the food transit time in the common bow called short longstay [17], this causes the consumed cholesterol can not be absorbed by the intestine. So that the incoming foods (cholesterol and fiber) will be quickly excreted with feces [18].

Another thing that makes rat blood cholesterol decrease when consuming high cholesterol diet and fiber diet is in the mechanism of cholesterol biosynthesis that exists in the liver. When fiber enters the intestine, the fibers undergo a fermentation process. Fermented fiber in the intestine produces short chain fatty acids (SCFA), namely acetate, propionate, and butyrate that rapidly enter the portal vein to the liver [15]. The presence of short chain fatty acids will decrease the activity of HMG CoA reductase enzyme through mevalonate pathway in cholesterol biosynthesis [12]. So cholesterol biosynthesis (cholesterol formation) will be disrupted because of the fiber.

Research showed that fiber can lower total cholesterol, LDL, and triglyceride levels by giving bran by 50% within 4 weeks. The decrease is due to the content of fiber water that can lower total cholesterol levels, as well as vitamin E, tocopherol, oryzanol and tokotrienol as an antioxidant that can inhibit cholesterol synthesis [19].

The use of bran as a feed additive for animals can lower total blood cholesterol levels. The research revealed that there is a tendency to decrease cholesterol and blood fats by increasing the use of fine bran in the feed [20]. Based on the theory above, it can be concluded that a diet high in fiber can reduce total cholesterol levels of rats

C. The Effect of Physical Activity on Total Cholesterol

With physical exercise, insulin sensitivity will increase, then insulin sensitivity affects the production of Lipoprotein Lipase [21]. When Lipoprotein lipase enzymes active, it can bound to the lining of small blood vessels and capillaries in adipose and muscle tissue lead to release of free fatty acids, cholesterol and α glycerol. Free fatty acids are rapidly absorbed and used for energy or reincorporated in the form of triglycerides. Inside the liver, the cholesterol ester gets the esterification process and along with the fatty acids entering the liver pool. Cholesterol is excreted into bile or esterified and synthesized into VLDL for further transport.

The lipoprotein lipase enzyme causes the VLDL to be hydrolyzed to IDL, and IDL will be hydrolyzed into LDL because of the help of HDL and LCAT (Lecithin-cholesterol Acyl Transferase) that esterify cholesterol with unsaturated fatty acids. LDL consisting of cholesterol, protein, and phospholipid ester cores will enter the cells that have cholesterol receptors. Then, HDL will bring LDL-released cholesterol in the cells to take to the liver

The release of cholesterol from LDL inhibits or suppresses cholesterol biosynthesis so as to lower blood cholesterol levels. On the contrary, HDL will increase as it is the main vehicle for the transfer of cholesterol from the surface tissue back into the liver. It is an important process in cholesterol removal [18]

The results showed that physical activity can reduce total cholesterol levels. The mean total cholesterol of Group (T2) is lower than in the (C+) group, but it does not differ significantly between the (T2) and (C-) groups. It might happen because the length of the study is only 2 weeks. If the exercise continues for a longer period of time, then cholesterol levels are likely to be lower than those for 2 weeks.

V. CONCLUSION

The conclusion of this study is both a high-fiber diet and physical activity can reduce total cholesterol levels in wistar strain rats.

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