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The study of rice bran cookies for diabetic diet and dyslipidemic diet

Badanie ciastek z otrębów ryżowych dla diety cukrzykowej i antydyslipidemicznej

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Abstract
This study is about the use of rice bran as a snack for people with degenerative diseases of diabetes mellitus and hypercholesterolemia. Non-Communicable Diseases (NCDs) are the highest cause of death and result in loss of productive days for sufferers and companions. To overcome this problem, the study aims to test rice bran cookies with 30% substitution on glucose levels, cholesterol levels, and triglyceride levels in experimental animals so that they can be recommended as healthy cookies low in sugar and low in fat for a snack for people with diabetes mellitus and dyslipidemia. This type of research is an experiment. Research location of the Inter-University Center Experimental Animal Laboratory (PAU) Gadjah Mada University (UGM). The initial stage is to prepare 15 male Sprague Dawley (SD) male white rats weighing 250-300 grams and in closed cages. Rats measured blood glucose levels, total cholesterol and triglycerides. Furthermore, the rats were grouped into 3 groups, and 2 groups were given an injection of streptozotocin (STZ) to make the rats diabetic. Group 1: 5 healthy rats fed a standard diet, group 2: 5 diabetic rats fed a standard diet, and group 3: 5 diabetic rats fed with rice bran cookies. Drinking water is given ad libitum and feeding is given every morning. Furthermore, weighing and analysis of blood glucose levels, total cholesterol, and triglycerides were carried out on the seventh, tenth, seventeenth, twenty-fourth, thirty-first, and thirty-eighth days. The results showed that 30% substitute bran cookies were able to reduce glucose levels, cholesterol levels, and serum triglyceride levels so that they could be recommended as a snack for people with diabetes mellitus and people with dyslipidemia.

Keywords
rice bran, cookies, diabetic, dyslipidemic, non-communicable diseases

Streszczenie
Niniejsze badanie koncentruje się na zastosowaniu otrębów ryżowych jako przekąski dla osób cierpiących na choroby metaboliczne takie jak cukrzyca oraz hipercholesterolemia. Choroby niezakaźne (NCDs) stanowią główną przyczynę zgonów i powodują utratę produktywnych dni zarówno dla chorych, jak i ich opiekunów. W celu przeciwdziałania tym problemom, badanie to ma na celu przetestowanie ciastek z otrębami ryżowymi, z 30-procentową substytucją, pod kątem wpływu na poziom glukozy, cholesterolu i triglicerydów u zwierząt doświadczalnych, aby móc je zalecić jako zdrowe ciastka o niskiej zawartości cukru i tłuszczu dla osób z cukrzycą i hipercholesterolemią. Typ badania to eksperyment przeprowadzony w Lokalizacji badawczej Laboratorium Zwierząt Doświadczalnych Inter-University Center na Uniwersytecie Gadjah Mada (UGM). Pierwszym etapem było przygotowanie 15 samców białych szczurów Sprague Dawley (SD) o wadze 250-300 gramów, umieszczonych w zamkniętych klatkach. U szczurów mierzono poziom glukozy we krwi, całkowity cholesterol oraz triglicerydy. Następnie szczury podzielono na 3 grupy, z czego dwóm grupom podano iniekcję streptozotocyny (STZ), aby wywołać u nich cukrzycę. Grupa 1: 5 zdrowych szczurów karmionych standardową dietą, grupa 2: 5 szczurów z cukrzycą karmionych standardową dietą, i grupa 3: 5 szczurów z cukrzycą karmionych ciastkami z otrębów ryżowych. Woda pitna była dostępna ad libitum, a karmienie odbywało się każdego ranka. Następnie przeprowadzono ważenie oraz analizę poziomu glukozy we krwi, całkowitego cholesterolu i triglicerydów w dniach siódmym, dziesiątym, siedemnastym, dwudziestym czwartym, trzydziestym pierwszym i trzydziestym ósmym. Wyniki wykazały, że ciastka z 30% dodatkiem otrębów ryżowych były w stanie obniżyć poziom glukozy, cholesterolu i triglicerydów w surowicy, dzięki czemu mogą być zalecane jako przekąska dla osób z cukrzycą oraz hipercholesterolemią.

Słowa kluczowe
otręby ryżowe, ciastka, cukrzyca, hipercholesterolemia, choroby niezakaźne

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Introduction

This study addresses the rising prevalence of diabetes mellitus and hypercholesterolemia and explores the abundant rice bran produced as a by-product of rice milling. Rice bran which is still high in nutritional content can be used as a food product to reduce glucose levels in people with diabetes mellitus and reduce cholesterol in people with hypercholesterolemia. Non-Communicable Diseases (NCDs) are catastrophic diseases with the highest cause of death resulting in loss of productive days for sufferers and companions. NCDs are a major cause of death and morbidity worldwide, with the greatest burden in low- and middle-income countries, where nearly 80% of deaths are related to non-communicable diseases [1].

A Global Burden of Disease (GBD) study reports chronic non-communicable diseases, such as diabetes, hypertension, cardiovascular disease (CVD) are the leading causes of global death [2]. NCDs is the main cause of death worldwide, the death rate reaches 41 million people each year, equivalent to 71% of all deaths globally and the top four causes of death which together account for more than 80% of all NCDs premature deaths per year are cardiovascular disease. The top four causes of death, accounting for more than 80% of all NCDs premature deaths per year, are cardiovascular disease (17.9 million), cancer (9.0 million), respiratory disease (3.9 million), and diabetes (1.6 million) [3]. Risk factors for non-communicable diseases (NCDs) are becoming increasingly common among adolescents due to lack of consumption of vegetables, fruit and physical activity which are three of the four most common risk factors in all regions [4].

88% of women and 89% of men from 186 countries have a higher probability of dying before the age of 70 due to NCDs [5]. In 2017, non-communicable diseases (NCDs) accounted for 73% of global deaths [6]. Behavioral risk factors such as diet, physical activity, alcohol consumption, smoking, and related metabolic risks such as high blood pressure, obesity, high cholesterol, and high blood sugar are the main causes of NCDs [7]. NCDs management can only be done by changing behavior such as changing lifestyle and diet. According to Hadian et. al the basis of prevention of non-communicable diseases is the identification of primary risk factors and the prevention and control of these factors with the aim of preventing the spread of the disease and controlling it as much as possible, so that if population growth continues at this rate then by 2030 there will be 52 million people dying from this disease every year [8].

Various research results show that rice bran has high nutritional value, contains antioxidant bioactive compounds, and contains rice bran saccharide fiber. Antioxidants are able to inhibit the incidence of diabetes, Alzheimer's disease, prevention of heart disease and cancer [9]. Bran as a by-product of rice milling contains a large number of nutrients (protein, fat, unsaturated fatty acids, dietary fiber, K, Ca, Mg, and Fe) and antioxidants (γ-oryzanol, tocopherols, tocotrienols, and ferulic acid) [10, 11, 12, 13, 14]. Bran contains 11-15% high protein, is a very good source of fiber (7-11%), and has far more nutrients and vitamins than other rice mill fractions [15]. The health effects obtained from rice bran are antidiabetic, lipid lowering, hypotensive, antioxidant, and anti-inflammatory effects, while its consumption also improves intestinal function and these health benefits provide potential for rice bran to be applied as food and as a nutraceutical product to reduce metabolic risk factors in humans [16]. Rice bran also contains about 20% lipid where bran oil has attracted attention due to its nutraceutical properties and unique fatty acid content [17]. Devarajan et. al. found a new mixture of 20% cold pressed crude sesame oil and 80% physically purified rice bran oil as cooking oil can reduce hyperglycemia and improve lipid profile in type 2 diabetes mellitus patients [18]. Rice bran oil can lower plasma cholesterol and is beneficial for the prevention of cardiovascular disease because it contains several effective ingredients. Rice bran oil is rich in linoleic and oleic acids, contains γ-oryzanol which is known to reduce plasma cholesterol levels, contains tocotrienols which are analogues of vitamin E and has a unique bioactivity that is different from tocopherols [19]. Kubota et. al. showed that the livers of rats that were fed rice bran had much lower accumulation of lipids so that it was concluded that a diet containing rice bran could improve diabetes, fatty liver, and diabetic nephropathy in rats [20]. Meanwhile, research by Ramezani-Jolfai et. al. found that consumption of bran oil can reduce LDL (low density lipoprotein) concentrations and also have the effect of increasing HDL (high density lipoprotein) in men so that changes associated with other lipid profile components are not significant [21]. Mixing 70% wheat, 20% soycake, 5% rice bran and 5% oat bran as a highly nutritious composite flour has the ability to lower blood glucose so that it can be recommended as a food ingredient in managing diabetes [22].

Based on some of the studies above, the findings that can be found are bran has nutrients and bioactive compounds that have beneficial effects on health. Therefore this research is considered important to be conducted to determine the effect of rice bran cookies with 30% substitution in reducing serum glucose, cholesterol and triglycerides. Research conducted by Sofianti et. al., the best results of bran cookies obtained were found at the level of substitution (30%) [23]. The remaining sections of this paper are organized as follows: Section 2 reviews all materials and methods, Section 3 presents the results, Section 4 presents the discussions about this study and finally Section 5 concludes the findings with some direction for future work.

Materials and methods

Study design

This study employs an experimental approach. The number of samples was 15 male Sprague Dawley (SD) rats aged 3 months with a weight of 250-300 grams. Samples were taken from the Inter-University Central Experimental Animal Laboratory Gadjah Mada University (UGM), Yogyakarta Indonesia. The inclusion criteria were healthy rats moving actively and macroscopically there were no morphological abnormalities. Exclusion criteria were dead rats at the time of the study. The independent variable in this study is the 30% substitution of traditional ingredients with rice bran in cookies. The dependent variables were glucose levels, cholesterol levels and serum triglyceride levels of male SD rats. Determination of the average amount of feed per day is based on taking the upper margin of the average due to differences in individual rat intake. Average

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rat intake per day in several references is 12-20 g/day/head; 15-20 g/day/head; 20-30 g/day/head and in this study the amount of feed given was 15 g/day/head [24].

Study material

The ingredients used for making rice bran cookies consist of fresh rice bran, medium protein flour, mocaf flour, cocoa powder, rice bran oil, eggs, powdered sugar, sucralose sugar, and baking powder purchased at several cake ingredients shops in Yogyakarta, Indonesia. The tools used for making bran cookies consist of: bran making equipment and cookie making equipment such as scales, mixers, baking sheets, measuring cups, ring cutters, ovens, and dough mixes. Materials and in vivo test equipment for experimental animals were male white rats of the Sprague Dawley (SD) type, AIN 1993 standard feed (cornstarch, casein, sucrose, soybean oil, jelly, mineral mix, vitamin mix, L-cystin and choline bitartrate), STZ injection, glucose kit, total cholesterol, and triglycerides. The tools used were individual cages, water bottles, analytical balance, aluminum bowls, rubber gloves, disposable syringes, Eppendorf tubes, and test tubes.

Preparation for making cookies bran 30%

Making bran cookies begins with making fine bran through the roasting process of fresh bran for a maximum of 24 hours. The bran is roasted over low heat for 10 minutes while turning it over so it doesn't burn. The bran is then cooled and sifted to normal size. The results of the sieve are then ground until smooth and sieved again using an 80 mesh size sieve to obtain fine bran. Making bran flour in this simple way produces 400 g of ready-to-use fine bran per 1,000 g of fresh bran. Next is the process of mixing medium-mocaf wheat flour with a ratio of 1:1. The ingredients for making bran cookies with 30% substitution can be seen in table 1.

Table 1. Table of comparison ingredients composition of rice bran cookies 30%

Ingredients	Control (0%)	%	Substitution (30%)	%
Medium Flour-MOCAF	125 g	100	87 g	70
Rice bran	-	-	38 g	30
Chocolate powder	10 g	8	10 g	8
Baking powder	1 g	0,8	1 g	0,8
Egg white	35 g	28	35 g	28
Icing sugar	35 g	28	35 g	28
Sukralosa	6 g	4,8	6 g	4,8
Rice bran oil	95 g	76	95 g	76
Salt	¼ tsp	-	¼ tsp	-

Stages of the manufacturing process: mix the medium protein flour-mocaf, rice bran, cocoa powder, baking powder, powdered sugar, sucralose and fine salt. Mix thoroughly. Add the egg whites and bran oil, stir gently until all the ingredients are mixed and a dough forms. Roll out and flatten the dough 4 mm thick with a 4.5 cm diameter ring cutter. This press produces cookies weighing 10 g/chip. The dough is then baked in the oven for 25 minutes with a top temperature of 135 ºC and a bottom temperature of 150 ºC.

Giving a diet of bran cookies to experimental animals

The initial stage was to prepare 15 male rats of the Sprague Dawley (SD) type at the Experimental Animal Laboratory at PAU UGM and to be kept in closed cages. Rats were measured for blood glucose, total cholesterol and triglyceride levels on day 0 and were grouped into 3 groups, namely:

Group 1 (KN):

5 normal healthy rats fed standard feed AIN 1993.

Group 2 (KDM):

5 rats were given injection of streptozotocin (STS) for make rats become diabetic and fed standard AIN 1993.

Group 3 (P):

5 rats were given an injection of streptozotocin (STZ) to make the rats diabetic and fed 30% bran cookies.

Drinking water is given ad libitum and feeding is given every morning. Furthermore, weighing and analysis of blood glucose levels, total cholesterol, and triglycerides were carried out on the seventh, tenth, seventeenth, twenty-fourth, thirty-first, and thirty-eighth days.

Results

Rat Body Weight

The effect of standard diet and rice bran cookies diet on rat body weight can be seen in figure 1. The figure shows that on the seventh day of observation and the following day of observation there was a slow increase in body weight for all groups in line with increasing feed intake and continuous weight loss in the group of diabetic rats with a standard diet.

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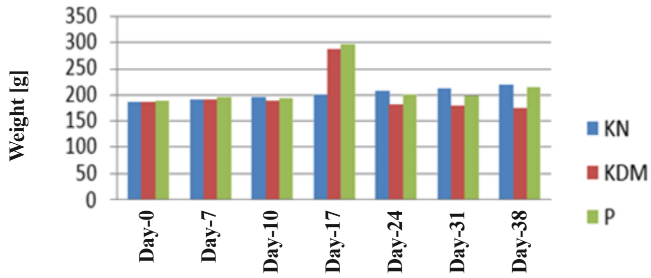

Figure 1. Image of the rat body weight

Feed Consumption

Feeding mice is done every morning as much as 15 g. On day 0 to day twenty one, the feeding is adjusted to the diet given. Consumption of rat feed in the normal rat group with standard feed (KN) tended to increase from the tenth to the twenty-fourth day, while the next day until the thirty-first day it decreased and again increased until the thirty-eighth day. The consumption of rat feed in the diabetic rat group with standard feed (KDM) tended to be stable from day 0 to the thirty-eighth day, while the consumption of rat feed in the diabetic rat group with the treated feed, namely bran cookies (P) tended to decrease from the tenth to the third day. seventeenth, while the next day until the thirty-eighth day feed consumption is stable. There was an increase in feed consumption in the rats on the standard diet group, whereas in the group of rats on the rice bran cookies diet there was a decrease in the first week. This decrease was probably due to the difference in palatability of the bran and standard cookies diet feeds. Rats don't like rice bran cookies, which results in a decrease in consumption of rice bran cookies can be seen in table 2.

Table 2. Table of comparison of feed consumption

Observation (day)	Group rats		
	KN	KDM	P
0	10	14	12
17	11	14	11
14	12	14	11
21	10	14	11
28	11	14	11

Serum glucose

After an adaptation period of 7 days, the rats in the normal group were still given standard food without injection. Whereas the diabetic group (KDM) and (P) rats were induced diabetes on the seventh day by injection of streptozotocin (STZ). During that time the rats were still given standard feed until there was an increase in serum glucose levels on the tenth day with an average serum glucose level of 216.94 mg/dl. After administration of the rice bran cookies diet, there was a decrease in serum glucose levels in the P rat group. There was a significant difference between the normal group of rats fed standard feed (KN), the group of diabetic rats fed standard feed (KDM) and the group of rats fed with bran cookies (P). Starting on the seventeenth day, there was a decrease in blood sugar levels in the diabetic rats that were fed with rice bran cookies. Mice that received standard feed experienced a gradual increase in serum glucose levels until the last day of observation, namely the thirty-eighth day. Complete data can be seen in table 3. After four weeks of feeding rice bran cookies, there was a decrease in serum glucose levels of 54.55% and higher than standard feeding on diabetic rats (KDM).

Table 3. Table of comparison of serum glucose (mg/dL)

Observation (day)	Group rats		
	KN	KDM	P
7	66.64	69.39	70.45
10	66.87	214.89	219.01
17	68.27	216.25	180.21
24	69.04	218.62	167.28
31	70.07	220.00	128.69
38	71.30	220.92	99.58

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Total cholesterol

After an adaptation period of seven days, the rats in the normal group were still given standard feed without injection. Whereas the diabetic group (KDM) and (P) rats were induced diabetes on the seventh day by injection of streptozotocin (STZ). During that time the rats were still given standard feed until there was an increase in serum glucose levels on the tenth day with an average serum glucose level of 216.94 mg/dl. The effect of feeding a standard diet and rice bran cookies on serum glucose levels can be seen in table 4. After administration of the rice bran cookies diet, there was a decrease in serum glucose levels in the P rat group. There was a significant difference between the normal group of rats fed standard feed (KN), the group of diabetic rats fed standard feed (KDM) and the group of rats fed with bran cookies (P). The decrease in total cholesterol in the group of diabetic rats fed with rice bran cookies (P) showed that rice bran cookies had hypocholesterolemic properties in diabetic rats which could be seen from the seventeenth to thirty-eighth day of observation.

Table 4. Table of comparison of total cholesterol (mg/dL)

Observation (day)	Group rats		
	KN	KDM	P
7	100.64	70.88	78.55
10	100.85	210.31	217.41
17	102.32	217.03	190.14
24	110.27	218.73	165.36
31	110.37	220.27	127.92
38	110.36	221.05	100.46

Serum triglycerides

On the tenth day of observation, there was an increase in serum triglycerides in all groups of rats after the rats were positive for diabetes. This condition indicates that diabetes can cause an increase in serum triglyceride concentrations. Table 5 shows that serum triglyceride levels in the standard-feed (KN) group of normal rats tended to increase until the end of the study. There was an increase in serum triglyceride levels of 63.33% in the diabetic rats with standard feed (KDM) compared to day-0. There was an increase in serum triglycerides of 5.7% in normal rats with standard feed (KN). The ability of rice bran cookies to reduce serum triglycerides was seen from the seventeenth day of observation. There was a decrease in the group of rats fed with bran cookies (P) by 18.5%. Triglycerides decreased from 133.87 on the tenth day to 109.03 on the thirty-eighth day.

Table 45. Table of comparison of serum tryglicerides (mg/dL)

Observation (day)	Group rats		
	KN	KDM	P
7	89.24	88.03	86.21
10	89.78	138.83	133.87
17	91.67	139.36	127.97
24	92.69	140.40	123.69
31	93.48	142.47	117.30
38	94.36	143.78	109.03

Discussion

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels [25]. Insulin resistance is caused by an excess of fatty acids and proinflammatory cytokines, which impair glucose transport and increase fat breakdown. Due to inadequate insulin response or production, the body responds by inappropriately increasing glucagon, further contributing to hyperglycemia [26]. Diabetes mellitus is a metabolic disease that can be prevented through lifestyle modification, diet control, and control of overweight and obesity [27, 26]. Patients with diabetes mellitus experience disturbances in carbohydrate metabolism. The unavailability of glucose in cells also results in excessive gluconeogenesis. The glucose produced will then be wasted through the urine. As a result, there is a significant reduction in the amount of muscle tissue and adipose tissue. Sufferers will lose a great deal of body weight despite an increased appetite (polyphagia) and normal or increased caloric intake [29].

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Giving 30% bran cookies to diabetic rats will decrease serum glucose levels. Table 1 on the seventh day after the adaptation period shows that if the rats had a serum glucose level of 70.45 then it reached its highest level on the tenth day of 219.01 and gradually decreased on the last day of observation, namely on the thirty-eighth day to 99.58. This condition proves that 30% bran cookies have the effectiveness of lowering serum glucose levels in experimental animals so that they can be recommended as a snack for people with diabetes mellitus. Rice bran cookies with a bran substitution level of 30% are preferred from various organoleptic points of view [30].

In parallel with changes in feed intake, weight loss occurs. Normal standard diet rats experienced weight gain until the end of the observation. Whereas in diabetic rats with a standard diet there was continuous weight loss. Weight loss can be caused by disturbances of carbohydrate metabolism in the presence of diabetes induction using streptozotocin injections. This weight loss is closely related to the condition of the rats which is possible due to proteolysis and lipolysis as well as severe dehydration. People with diabetes mellitus will experience insulin deficiency resulting in disruption of protein and fat metabolism which causes weight loss due to reduced number of stored calories [31]. Significant weight loss is also associated with a decrease in blood glucose [32].

Rice bran water solution significantly reduces hyperglycemia while rice bran fiber concentrate reduces hyperlipidemia in patients with type I and II diabetes mellitus, so it is recommended that this natural ingredient be used as a nutritional supplement to control both types of diabetes mellitus in humans [33]. Other studies have also shown that bran milk can be used as a nutritional supplement to control hyperglycemia and body weight in overweight and diabetic individuals [34]. Administration of a diet containing rice bran protein improved diabetes, fatty liver, and diabetic nephropathy in rats [20]. Research data on rice bran cookies show that the potential of rice bran in lowering serum glucose is much higher than standard feed. This data is in line with research which shows that the addition of functional bran to cookie and donut formulas can reduce the glycemic index (GI) value, namely from 67 in standard cookies (without bran) to 31 in bran cookies, and from 72 in standard donuts. to 39 in bran donuts [35]. Thus, bran cookies and donuts can be classified as foods that have a low GI (< 55). Food with low GI can be claimed as anti-diabetic functional food. Factors supporting the lower GI of rice bran cookies and donuts compared to standard cookies and donuts were higher fat content, protein content, dietary fiber content, and amylose content, as well as lower digestibility of starch.

The decrease in total cholesterol in the group of diabetic rats fed with bran cookies showed that bran cookies had hypocholesterolemic properties in diabetic rats. This condition can be seen in the observations on the seventeenth to the thirty-eighth day. Cholesterol is a lipophilic molecule that is very important for human life. Although it is harmful, cholesterol has many roles that contribute to normal cell function, which is an important component of cell membranes. Cholesterol also functions as a precursor molecule in the synthesis of vitamin D, steroid hormones and sex hormones (testosterone, estrogen and progesterone), and functions as a constituent of bile salts used in digestion to facilitate the absorption of soluble vitamins A, D, E and vitamin K in fat [36]. A study in Indonesia showed that analog rice with rice bran added was able to reduce cholesterol in experimental animals so that it could be used as a potential functional food that is useful for reducing the risk of coronary heart disease [37]. The reduction in total cholesterol in the group of rats fed on bran cookies (P) could be due to the arrangement and amount of carbohydrates in the bran cookies. However, other studies have found that carbohydrate intake is not related to the lipid profile in coronary heart patients [38]. Rice bran cookies can reduce cholesterol levels in rats because of their high fiber content and rice bran oil content.

In patients with mild-moderate hypercholesterolemia who were given 45 ml/day of rice bran oil without changing their diet, the result was a reduction in total cholesterol levels of 14%, and in the 15 ml/day group there was a reduction in total cholesterol levels of 7.8% [39]. The decrease in low density lipoprotein (LDL) and triglycerides and the increase in high density lipoprotein (HDL) were not significantly different between the two groups ($p > 0.05$). This study proves that gamma oryzanol and plant sterols in rice bran oil have the ability to remove cholesterol from bile salt micelles thereby reducing cholesterol absorption in the intestine. Giving rice bran oil and olive oil to junior high school teachers suffering from hypercholesterolemia can reduce total cholesterol and triglyceride levels significantly [40]. While the effect on increasing HDL and LDL has not shown consistent results. In addition to the duration of time and the number of doses given, dietary modifications are also needed to optimize the effects of bran oil and olive oil. The potential for rice bran and olive oil can be utilized to become a wider range of derivative products because in Indonesia, rice bran is abundantly available at low prices as functional food.

Neno et. al. proved that rice bran cereal with a dose of 810 mg/kg body weight had an effect on changes in total cholesterol levels of 21.72%, the study also showed that rice bran cereal therapy can significantly affect the reduction of total cholesterol and improve the histopathology of the aortic organs in hypercholesterolemic rats [41]. This research is not in the form of cereal but in the form of cookies and is proven to reduce cholesterol. Rice bran is known to contain a bioactive component, namely oryzanol which has several effects in improving human health, one of which is lowering cholesterol levels. It was also found that the use of rice bran flour as a substitute for cereal products with a 50% substitution of rice bran flour was able to reduce serum cholesterol and triglyceride levels in mice [42].

Table 5 shows that rice bran cookies were able to reduce serum triglycerides from the seventeenth day of observation. There was a decrease in the group of rats fed with bran cookies (P) by 18.5%. The decrease in triglycerides occurred from point 133.87 on the tenth day to 109.03 on the thirty-eighth day. Triglycerides consist of glycerol and three fatty acids. Triglyceride hydrolysis resides in the liver and provides fatty acids for β-oxidation, signaling, and substrates for very low density lipoprotein (VLDL) triglyceride assembly. Triglycerides cannot penetrate cell membranes and are not present in the blood simply because they are hydrophobic [43]. Normal triglyceride levels are 26-145 mg/dL. Rice bran contains crude fiber and antioxidants that can be used to treat this condition.

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Research by Mahdi et.al. showed that rice bran therapy could significantly reduce triglyceride levels ($p < 0.01$) at a dose of 57%/head/day until triglyceride levels fell. Rice bran therapy also improved the histopathology of aortic tissue in rats with a high cholesterol diet [44].

The ability of rice bran to reduce lipid profiles such as cholesterol and triglycerides because it contains active compounds such as γ-oryzanol, γ-aminobutyric acid, tocopherols and tocotrienols. These active compounds have properties in reducing blood fat levels by interfering with the absorption of cholesterol in the intestine, increasing the formation of bile acids, increasing the excretion of cholesterol through the feces and preventing peroxidation of low density lipoprotein (LDL). Research comparing several kinds of solvents for rice bran extraction, found that 96% ethanol can produce the optimum active component to reduce blood fat levels. Various studies have shown that giving bran can reduce levels of fat in the blood [45]. Furthermore, it is recommended that bran oil can be used as an option as a non-pharmacological therapy for hyperlipidemia because it contains bioactive components γ-oryzanol, tocopherols and tocotrienols which can reduce levels of total cholesterol, triglycerides, Low Density Lipoprotein (LDL) and increase High Density Lipoprotein (HDL) in the body.

Research on the study of 30% bran cookies is very important for people with diabetes mellitus and hypercholesterolemia. Rice bran cookies applied to rats have been shown to be effective in reducing serum glucose levels, cholesterol levels and triglyceride levels. Cookies can be implemented in collaboration with the bakery industry to be made on a larger scale and make good packaging accompanied by labeling of nutritional content and expiration date. Thus, rice bran which is a by-product of rice milling is very beneficial for health. Indonesia and countries that have a staple food of rice can develop rice bran production in a better and hygienic way to be used as a health food ingredient. A research weakness that can be corrected is how to prepare bran that is really fresh and doesn't smell musty. Bran can be selected from rice which has a fragrant aroma so that the bran produced also smells good.

Conclusion

This study found if testing in vivo by administering 30% bran cookies diet to serum glucose, cholesterol and triglyceride levels of experimental animals on the thirty-eighth day showed a decrease in blood (serum) glucose levels, total cholesterol levels and serum triglyceride levels so that 30% bran cookies can be recommended as cookies low fat and low sugar diet for diabetes mellitus and dyslipidemia.

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