

CONSUMPTION OF FERMENTED BLACK GLUTINOUS RICE TO PREVENT
METABOLIC SYNDROME

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Abstract— Background:Adult Treatment Panel III (ATP III) Metabolic Syndrome Incidence of the National Cholesterol Education Program at 40 years and above 24 % and WHO 21 %. The prevalence of metabolic syndrome in the US was 25 %, 31 % in Padang City, Jakarta, and 21.6 %. Fermented black glutinous rice has a phenolic, flavonoid, anthocyanin, and fiber component believed to prevent regulated metabolic syndrome. **Objective:**This study aimed to determine the relationship between fermented black glutinous rice consumption and the prevention of metabolic syndrome at age 40 and above in West Bandung Regency, West Java Province. **Design:**The research used a case-control design. Samples in this study were respondents aged 40 years and over in West Bandung, West Java province, with 57 cases and 57 controls. Data were collected through interviews and physical examinations. **Results:**The cut-off point at least daily intake of fermented black glutinous rice can prevent the occurrence of metabolic syndrome by more than 11,5 grams per day. The percentage of metabolic syndrome is greater than the proportion of respondents who eat black fermented glutinous rice ≤ 11.5 grams a day (82.1 a cent). The proportion of non-metabolic syndrome was higher among respondents who used fermented black gluten. **Conclusion:**It can be inferred that people who eat more than 11,5 grams a day of fermented black glutinous rice have a preventive effect on the occurrence of metabolic syndrome nine times with control variables of fiber consumption and nutritional status.

Keywords: Fermented black glutinous rice, metabolic syndrome

Introduction:- Metabolic syndrome is a cluster of multiple symptoms like increased waist circumference, increased blood triglycerides, decreased high-density lipoprotein (HDL), high blood pressure, and impaired glucose tolerance.[1]The prevalence of metabolic syndrome increases with the increasing incidence of obesity. The results of the current study showed that the incidence of metabolic syndrome is directly proportional to obesity.About 50% of obese patients suffer from metabolic syndrome.[2]Epidemiological studies indicate that the prevalence of metabolic syndrome and type 2 diabetes in the population of Southeast Asia region is higher than in the population of Western countries. Also,most of the population in the Southeast Asia region had lower HDL.[3] According to the National cholesterol education program, adult treatment panel III (ATP III), the prevalence of metabolic syndrome in the adult population of the United States is 24%. The WHO data shows that 7 – 36% of European men and 5 – 22% of European females suffer from the syndrome.[4]According to researches carried out in different countries, the incidence of metabolic syndrome in the US is 25% (1)Jakarta and surrounding areas are 21.6%.[5]

Several studies have shown that the intake of cyanidin-rich foods can prevent obesity and hyperglycemia.[5] Anthocyanin administration affects adiponectin secretion and expression of certain adipocyte genes in mice.[6] Anthocyanins can regulate adipocytokine gene expression, which affects the prevention of obesity and diabetes.[7] Anthocyanins can also regulate adipocyte function, which is thought to prevent metabolic syndrome.[8]

One of the foods in Indonesia based black sticky rice is fermented Black Glutinous Rice also contains anthocyanins, phenols, and antioxidant activity. Fermented black glutinous rice is fermented food products consumed by the people of Indonesia as easy to make, inexpensive, and has a texture that is soft and juicy with a sweet and sour flavor.

Based on the description above, the incidence of metabolic syndrome is quite high in those aged 40 years and over. Anthocyanin content and phenolic antioxidants, which have antioxidant activity and fiber in fermented black glutinous rice, are expected to prevent metabolic syndrome. The research was conducted in West Bandung Regency as the location of the production center for fermented black glutinous rice, which is quite large in West Java. This study would show the significance of the relationship between the intake of fermented glutinous rice and the prevention of metabolic syndrome in the elderly (40 years and older) in West Bandung Regency, West Java Province. The goal of this study was to establish the relationship between the consumption of fermented glutinous rice and the prevention of metabolic syndrome.

METHODS

Study design

It is an analytic observational study with a case-control design. A total of 114 people from Cililin and Cihampelas Districts, West Bandung City, West Java Province participated in this study. The sample was divided into two groups: the case group and the control group with the same number of samples. Samples were selected after matching for age and gender. The number of samples was calculated using the hypothesis testing formula for two proportions, with $Z_{1-\alpha} = 5\%$ and power = 90%. The study was conducted in April 2014 to March 2015 in District Cililin and Cihampelas West Bandung Municipal West Java Province. All participants gave written consent to participate, and the ethics committee approved the research protocol of the faculty of the Medical University of Indonesia.

Study participants

The inclusion criteria for the case include having 3 out of 5 of metabolic syndrome criteria, aged 40 years above. Inclusion criteria for control were didn't have any criteria of metabolic syndrome and or 1 or 2 out of 5 metabolic syndrome criteria, aged 40 years above.

Metabolic syndrome definition.

We used the joint interim statement consensus criteria for diagnosing MetSyn, which require the presence of any 3 of the following five risk factors: elevated waist circumference (>102 cm in men and >88 cm in women), elevated TGs, or drug treatment (>150 mg/dL), reduced HDL cholesterol or drug treatment (<40 mg/dL for men and <50 mg/dL for women), elevated blood pressure or drug treatment (>130 mm Hg and/or diastolic blood pressure >85 mm Hg), and elevated fasting glucose (>100 mg/dL), which included those classified as having diabetes as ascertained simply by laboratory measures at baseline.

RESULTS:

Table 1 showed that the incidence of metabolic syndrome was higher in the age group of 40 – 49 years (47.4%); it is more common in women (68.4%). Participants who studied elementary school showed a high incidence (59.6%). People suffering from high stress and people doing low physical activity showed a high incidence of the syndrome.

Table 1 The relationship between age, sex, education, occupation, smoking, physical activity, stress, and nutritional status and the incidence of metabolic syndrome at the age above 40 years

Variable	Case		Control		OR	95%CI	p-value
	N	%	n	%			
Age (year)							
>60	14	24,6	15	26,3	1,14	0,46-2,77	0,771 ^{**})
50-59	16	28,1	9	15,8	2,17	0,83-5,68	0,114 ^{**})
40-49	27	47,4	33	57,9	<i>Reference</i>		0,281 ^{**})
Sex							
Man	18	31,6	18	31,6	<i>Reference</i>	0,45-2,20	1,000 [*])
Woman	39	68,4	39	68,4	1,00		
Education							
No	4	7,0	1	1,8	6,40	0,54-74,89	0,139 ^{**})

Elementary School	34	59,6	33	57,9	1,65	0,48-5,56	0,420 ^{**})
Junior High School	6	10,5	9	15,8	1,07	0,23-4,89	0,934 ^{**})
Senior High School	8	14,0	6	10,5	2,13	0,46-9,94	0,335 ^{**})
College	5	8,8	8	14,0	Reference		0,541 ^{**})
Occupation							
No	39	68,4	36	63,2	1,26		
Yes	18	31,6	21	36,8	Reference	0,58-2,74	0,693 [*])
Smoking							
Medium smoker	4	7,0	1	1,8	4,10	0,44-38,28	0,216 ^{**})
Mild smoker	13	22,8	15	26,3	0,89	0,38-2,10	0,788 ^{**})
Non smoker	40	70,2	41	71,9	Reference		0,430 ^{**})
Physical activity							
Mild	33	57,9	30	52,6	1,24		
Medium	24	42,1	27	47,4	Reference	0,59-2,59	0,706 [*])
Stress							
High	48	84,2	50	87,7	1,34		
Low	9	15,8	7	12,3	Reference	0,46-3,88	0,787 [*])

^{*)} Chi-Square Test ^{**)} Simple Logistic Regression

Table 2 shows that the incidence of metabolic syndrome more in respondents with a BMI ≥ 25 kg / m² of 56.1%, and the statistical test showed that there was a significant relationship between BMI with the incidence of metabolic syndrome at the age of 40 years and above. Incidence of metabolic syndrome more in respondents with more energy intake (59.6%), but statistically, there was no significant correlation energy intake with the incidence of metabolic syndrome. Incidence of metabolic syndrome more in respondents with less fiber intake (77.2%) and statistically significant correlation in fiber intake with the incidence of metabolic syndrome and fiber intake > 11.82 grams per day had a protective effect on the incidence of metabolic syndrome by nine times compared if fiber intake $\leq 11,82$ grams per day.

Table 2 The relationship between nutritional status, energy intake, fiber intake, and consumption of fermented black glutinous rice with the incidence of metabolic syndrome at the age above 40 years

Variable	Case		Control		OR	95% CI	P-value
	N	%	n	%			
Nutritional status							
Normal	13	22,8	24	42,1	Reference		0,145 ^{**})
Underweight	2	3,5	1	1,8	1,69	0,31-44,69	0,305 ^{**})
Overweight	11	19,3	11	19,3	1,85	0,63-5,40	0,263 ^{**})
Obesity	31	54,4	21	36,8	2,73	1,14-6,53	0,024 ^{**})
Energy intake							
Excessive intake	34	59,6	34	59,6	1,00		
Sufficient intake	23	40,4	23	40,4	Reference	0,47-2,11	1,000 [*])
Fiber intake							
Less intake	44	77,2	16	28,1	Reference	0,05-0,27	<0,001 [*])
Sufficient intake	13	22,8	41	71,9	0,11		
Consumption of Fermented Black Glutinous Rice							
No	35	62,5	7	12,3	Reference	0,03-0,22	<0,001
Yes	21	37,5	50	87,7	0,08		

) Chi-Square Test *) Simple Logistic Regression*

Overall more respondents in this study had more energy intake by 59.6%, and fiber intake is less by 52.6%. Overall more respondents in this study had a habit of fermented black glutinous rice consumption by 62.3%. The final model of the correlation between the consumption of fermented glutinous rice with the incidence of prevention of metabolic syndrome is described in Table 3.

DISCUSSION

Consumption of fermented black glutinous rice can prevent metabolic syndrome at the age of 40 years and over, considering the factors of fiber intake and nutritional status (p-value <0.001), with an OR of 0.11. It shows that the consumption of fermented glutinous black rice > 11.5 grams per day has a protective effect against the risk of metabolic syndrome incidence by nine times.

Statistical analysis showed a significant relationship between BMI with the incidence of metabolic syndrome at the age of 40 years and over, according to the results of other studies indicate that there are significant differences in the proportion of obesity in cases and controls.

The average intake of fiber has in common that patients with metabolic syndrome are lower than non-sufferers of metabolic syndrome. However, this difference is based on significance because the fiber intake in the study of Minang Padang ethnicity, West Sumatra, is different from the results of the study in West Bandung Regency, West Java Province. The Sundanese have a habit of eating more vegetables and are easy to get. Overall, more respondents in this study had more energy intake and less fiber intake. Respondents in this study tended to be homogeneous, namely consuming rice and vegetables available in the yard and salted fish available at the nearest shop. Respondents' houses are located far from the market, so they tend to eat food in the garden without buying vegetables, beans, mustard greens, carrots, and tomatoes. Respondents with high consumption of fiber showed an increase in HDL cholesterol levels is meaningful.

The respondents have been consuming fermented black glutinous rice for years, even since they were children until now. The Sundanese ethnic who were involved in this study consumed fermented black glutinous rice 9.78 grams per day. The location of this research is the center of the biggest producers of black sticky tape in West Java, so the tape is available every day, in contrast to other locations that tend to have tape available at a given time, for instance, feast or wedding celebration. The results of the statistical analysis show that there is no significant difference in the consumption of black sticky rice tape between men and women aged 40 years and over. It is because, at the research location, there is fermented black glutinous rice for consumption and is available in shops or markets near where the respondents live. Following the results of studies showing that black sticky tape consumed by respondents value antioxidant activity and generally increased after fermentation as compared to before fermentation. It is in line with the change in total phenolic components, flavonoids, and anthocyanins in black rice. They tend to increase with fermentation and a correlation phytochemical components (phenolic, flavonoids, and anthocyanins) and antioxidant activity.[9]

Anthocyanin source of food consumption is the main red fruit such as berries and red wine, cereals, purple corn, and vegetables such as red cabbage. Tsuda T research results (2008) indicate that anthocyanins regulate adipocyte function that allegedly prevents metabolic syndrome. Research conducted by Tsuda et al. (2003) also showed that the intake of rich purple corn cyanidin could prevent obesity and hyperglycemia in mice.[5] Research Tsuda et al. (2004) showed that the Anthocyanin affects the secretion of adiponectin and adipocyte-specific gene expression in mice (8). Anthocyanins can regulate gene expression adipocytokine that affects the prevention of obesity and diabetes.[10] Cyanidin intake increases the oxidation resistance of serum in mice.[12] Giving cyanidin can prevent hyperglycemia and regulate insulin sensitivity. Zang Lie et al. (2015) showed that pure anthocyanin supplementation prevents insulin resistance in diabetic patients.[11]

Research results Aedin C et al. (2011) showed that some anthocyanins and flavonoids and flavan could contribute to the prevention of hypertension. Fermented black glutinous rice consumed

respondents in this study contains a total phenol and is one of the food sources that contain polyphenols. The polyphenol content of each food has different bioavailability. The main cause is your intake of polyphenols varied variety of food preferences of each individual. Consumption of one food source, such as berries for anthocyanins and coffee for hydrodynamic acid, can affect and change the total polyphenols. The total intake of polyphenols may generally be achieved 1 gram per day in people who eat several vegetables and fruit daily. Very difficult to follow a diet about total polyphenols, due to polyphenol intake is difficult to evaluate the questionnaire.[13] The biological role and implications of polyphenols are the antioxidant activity of polyphenols. The intake of polyphenols has shown an important role in health. The high intake of vegetables and fruits and whole grains are rich in polyphenols, which is expected to prevent several diseases such as cancer, cardiovascular, chronic inflammatory, and degenerative diseases.

Recent studies have shown that some of the diseases associated with oxidative stress of reactive oxygen and nitrogen. Phytochemicals, in particular, polyphenols as the predominant contributor to the antioxidant activity than vitamin C. Fruit Polyphenols are found to be a powerful antioxidant that can neutralize free radicals by giving an electron and a hydrogen atom.[14] The role of polyphenols also plays a role in the inflammatory process, regulation of metabolism, cancer, cardiovascular diseases, and neurodegenerative diseases.[15] In the fermented black glutinous rice contains flavonoids that can prevent high triglycerides. And according to the results of research Octavia ZF et al. (2014) showed that there is the effect of flavonoids from sweet potato leaf juice to lower triglyceride levels of male Wistar rats were fed a high-fat. Triglyceride levels in both groups after the intervention increased. The mean increase in levels of triglycerides in the control group amounted to 12.28 mg / dL, while the treatment group means an increase in blood triglyceride levels were lower at 2.15 mg / dL. Sweet potato leaves are flavonoid with antioxidant effects that can counteract free radicals that can protect against oxidative damage to macromolecules epidermis cells. The highest amount of flavonoids in leaves of sweet potato juice is quercetin.[16] The content of flavonoids in leaves of sweet potato has the effect of covering atheroprotective very strong antioxidant effect, increases the ability platelet to release nitrogen, and inhibits the formation of thrombus.

Flavonoids are closely related to antioxidant activity. Also, flavonoids that improve the endothelial function of blood can be hypolipidemic, anti-inflammatory, and antioxidant. Flavonoids can capture free radicals and prevent lipid peroxidation in microsomes and liposomes.[17] Fermented black glutinous rice, besides having phenolic components, flavonoids, and anthocyanins, fermented black glutinous rice also contains fiber.[28] In contrast to the generally white rice, black rice as a basic ingredient of fermented black glutinous rice, has a greater fiber content. In this study, respondents habitually consume fermented black glutinous rice, which contains more insoluble fiber. Respondents have the habit of consuming vegetables and fruit as a source of soluble fiber such as nuts, mustard greens, carrots, which tend to be easier to consume and easy to obtain.

Fibers have properties WHC (Water Holding Capacity) so that the fiber can provide the mass of food in the gastrointestinal, thus providing a sense of satiety and decrease hunger and ultimately reduce calorie intake (30). Fiber also slows the rate of gastric emptying by slowing the transit of nutrients during digestion, resulting in the improvement of glucose slowly. It stimulates the release of insulin in small amounts[18]—the relationship between the frequency of consumption of foods with high glycemic index sources of metabolic syndrome. Carbohydrates with a high glycemic index are more rapidly digested, and an increase in serum glucose. Conversely, a low glycemic index is accepted and absorbed more slowly. It gives the advantage of increased serum glucose slowly and does not stimulate the release of insulin in large quantities. Insulin resistance is often found at higher intake of carbohydrates with a high glycemic index.[18] The results showed a relationship between the frequency of high glycemic index foods with metabolic syndrome ($p = 0.028$). Triglyceride levels are one of dyslipidemia frequently encountered on insulin resistance or type 2 diabetes, although with blood sugar control. Specific characteristic dyslipidemia in insulin resistance is increased triglycerides, decreased HDL, increased small dense LDL, although the total LDL is sometimes normal. Dyslipidemia is associated with hyperinsulinemia. Octavia's research results ZF et al. (2014) showed significantly giving fiber from sweet potato leaf juice to lower triglyceride levels of male

Wistar rats fed a high-fat. Triglyceride levels in both groups after the intervention increased.[16] The mean increase in levels of triglycerides in the control group amounted to 12.28 mg / dL.

In contrast, the treatment group means an increase in blood triglyceride levels were lower at 2,15mg / dL. Giving sweet potato leaf juice, which contains fiber, has a hypolipidemic effect on rats. The fiber in sweet potato leaf juice controls triglyceride levels by inhibiting lipid absorption in the intestine. The fiber in the intestine can bind to fatty acids and cause the binding of lipids along the fibers through the feces.[27]

Research Yamashita et al. (1980) showed that the administration of a high-fiber diet could lower triglyceride levels in rats with diabetes. Triglyceride levels were lower in the group, given a high-fiber diet compared to the control group. Research Yamashita et al. (1980) showed that the administration of a high-fiber diet could increase HDL in diabetic mice. HDL cholesterol and the ratio of total cholesterol to HDL cholesterol in rats fed a high-fiber diet was higher than the control group. A high-fiber diet can increase HDL cholesterol showed that a diet high in fiber has the advantage when the metabolism is not good in the diabetic state.[19]

Research Bazzano LA (2008) shows that there is the effect of soluble fiber on reducing LDL cholesterol and reduce the risk of coronary heart disease.[20] A recent study showed that a high intake of fiber, especially soluble fiber, can reduce the risk of cardiovascular disease. Several types of soluble fiber, including β -glucan, pectin, and gum, have shown that dietary intervention studies were controlled very well to lower LDL cholesterol; soluble fiber is in vegetables and nuts lower LDL cholesterol. So it needs to be studied further and deeper to test the potential synergy between fiber intake with other phytochemicals that make lower cholesterol. Another study with a cohort design needs to be done to produce the deterrent effect of fiber intake on the development of coronary heart disease and other cardiovascular diseases.

One of the mechanisms that lead to metabolic syndrome to date originated in abdominal obesity (visceral). Visceral fat is metabolically more active than peripheral fat. The buildup of fat cells will increase the free fatty acids from the lipolysis, which will decrease the sensitivity to insulin. The results of other studies indicate that intake of fruits fairly. They consume more than eight types of fruits are protective factors for metabolic syndrome, each with an OR of 0.52 (95% CI 0.28 to 0.98) and OR 0, 31 (95% CI 0.12 to 0.70). In contrast, the consumption of saturated fat, more than 10% of total energy, indicates the risk of metabolic syndrome with an OR of 2.00 (95% CI 1.04 to 3.84).[21]

The study (OFL, 2006) shows that consuming adequate fiber can increase insulin sensitivity in overweight and obese women. A cohort study of 17 people who ate fiber fortified bread generally increased insulin sensitivity by 8% better than subjects who did not eat fiber fortified bread, only receiving drug treatment. Consumption of fibers derived from cereals associated with reduced risk of type 2 diabetes and cardiovascular disease in this prospective cohort study. Results of this study significantly after confounding controlled by variable changes in body weight, age, exercise, fat intake, smoking, alcohol intake, and family history of diabetes mellitus. Allegedly consumption of insoluble fiber, which is the predominant fraction of fiber in cereals, can significantly improve insulin sensitivity in overweight and obese women in a very short period, is for three days.[22]

The results showed that a high intake of insoluble fiber significant effect on the improvement in insulin sensitivity. Subjects with insulin resistance will develop into diabetes so that improvement in insulin sensitivity can contribute to reducing the risk of diabetes by consuming insoluble dietary fiber. Research Caroline L et al. (2012) showed that the intake of fiber could improve the early-phase insulin secretion in individuals who are overweight. Fasting blood glucose concentration was significantly lower at week four after fiber supplementation than the control group.[23]

Research Hiroki F et al. (2013) showed that fiber intake on blood glucose control, lowering the risk factors for cardiovascular and chronic kidney disease in patients with type II diabetes in Japan.[24] BMI, fasting glucose, HbA1c, triglycerides, and high-sensitivity C-reactive protein was negatively

correlated with high fiber intake after controlling factors of age, sex, duration of diabetes, smoking and drinking alcohol, total energy intake, fat intake, intake of fatty acids saturated, low physical activity and the use of hypoglycemic drugs or insulin. Insulin sensitivity and HDL cholesterol were positively correlated with the intake of dietary fiber. Fiber intake is associated with decreased abdominal obesity, hypertension, and metabolic syndrome.[30] Furthermore, fiber intake is also associated with the prevalence of albuminuria and chronic kidney disease after controlling protein intake. Insulin resistance increasingly heavy and ultimately decreases insulin secretion, resulting in Impaired Glucose Tolerance and the manifestation of diabetes mellitus type 2.[29] Research Yamashita et al. (1980) showed that the administration of a high-fiber diet could increase HDL in diabetic mice. Fasting blood sugar levels were lower in the group, given a high-fiber diet compared to the control group.[19]

Components of the metabolic syndrome are generally found in individuals who are overweight or obese. Obesity based on BMI was positively correlated with increased waist circumference. The person with a waist circumference above normal usually has a high BMI and vice versa BMI above normal, usually followed by accumulation of abdominal fat and insulin resistance. That said, obesity is strongly associated with metabolic syndrome. Nutrition and obesity with BMI > 27 kg / m² increased considerably in different countries and different age groups that cause health problems. The results of a 30-year prospective study show that approximately 75% of women and 90% of men develop overweight, and 40-50% become obese. Subjects with a BMI > 35 kg / m² had a 16-21% risk of death due to cardiovascular complications.[25] Obesity is an independent risk factor for dyslipidemia, hypertension, type 2 diabetes, and cardiovascular disease, which further complication and cause of death.[26]

CONCLUSION

There is a relationship between the consumption of black sticky rice and the prevention of metabolic syndrome at the age of 40 years and over by considering fiber intake and nutritional status as confounding factors (p-value <0.001) an OR of 0.11. It shows that the consumption of tape > 11.5 grams per day has a protective effect on the risk of metabolic syndrome nine times greater. Intake of fiber with OR 0.34 shows that an adequate intake of fiber has a preventive effect on the occurrence of metabolic syndrome by 3.29, meaning that the nutritional status of obesity is three times higher than that of average nutritional status than the likelihood of event metabolic syndrome.

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