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EFFECT OF *AMORPHOPHALLUSONCOPHYLLUS* PRAIN EX. HOOK. F. TUBERS ADMINISTRATION IN PREVENTING METABOLIC SYNDROME

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ABSTRACT

Epidemiological studies showed that the prevalence of global metabolic syndrome had increased. The main cause of metabolic syndrome was excessive consumption of carbohydrate. Therefore, the purpose of this study was to find the alternative source of carbohydrate that could suppress the occurrence of metabolic syndrome. One of the potential plants was Amorphophallusoncophyllus tubers (AOT), because of its high glucomannan content. This study was performed in in vivo method by using 3 groups of animals, that were administered food without carbohydrates, food with rice as carbohydrate, and AOT as carbohydrate for 42 days. Parameters measured were body weight, HDL and triglyceride level, insulin sensitivity (value of K_{ITT}), and blood pressure. The results showed body weight in the control group, rice, and AOT were 250.3 g, 316.4 g, 115.0 g; HDL levels 11.2 mg / dL, 9.6 mg / dL, 16.5 mg / dL; triglyceride levels 31.6 mg / dL, 84.1 mg / dL, 44.9 mg / dL; K_{ITT} value 1.58, 0.78, 2.06; and blood pressure 113/77 mmHg, 152/96 mmHg, and 101/75 mmHg; respectively. It could be concluded that the AOT as a source of carbohydrates could prevent the occurrence of metabolic syndrome.

INTRODUCTION

Metabolic syndrome, first known as the syndrome X, is a group of syndromes of metabolic abnormalities that are closely related to cardiovascular, cardiovascular, hyperlipidemia, type 2 diabetes, hypertension, cancer, gallstones, arthritis, and gout (1). Metabolic syndrome is characterized by at least three of the five criteria according to WHO, IDF and NCEP-ATPIII (the National Cholesterol Education Program - Adult Treatment Panel III), that are central obesity (obesity with abdominal circumference that exceeds 80 cm in women and 90 cm in men), elevated triglyceride levels, decreased HDL-cholesterol, fasting glucose up to 110-126 mg / mL (due to decreased insulin sensitivity), and elevated blood pressure (2, 3, 4). Based on the studies, metabolic syndrome are more related to central obesity compared with general obesity. Central obesity is thought to be the main cause of insulin resistance, which is one of the main markers of metabolic syndrome. besides, central obesity can also trigger the release of proinflammatory compounds that are responsible for the emergence of diabetes mellitus, hyperlipidemia, and cardiovascular disease. (5).

According to WHO, in 2014 more than 1.9 billion adults (> 18 years) were overweight, with 600 million of them being obese. And in 2016, overweight patients increased to 1.9 billion (> 18 years) with 650 million of whom are obese (2). Overall, one in ten of the world's adult population is obese. Overweight and obesity are risk factors for death, at least 2.8 million people die each year. Based on the study, 44% of diabetics, 23% of patients with ischemic heart disease, and 41% of people with cancer were also caused by obesity (2). Because obesity results from an imbalance of energy intake and energy expenditure, the treatment of obesity lies in efforts to balance these energy. To reduce the energy intake is by regulating the amount and or the composition of food. Carbohydrates, fats, and proteins are the macronutrients needed by the body. Many studies had concluded that carbohydrates could cause obesity. The types of food recommended in the prevention of metabolic syndrome, one of which is high fiber diet, especially water soluble fiber. The mechanism of water soluble fiber in preventing and reducing obesity is by replacing energy intake from other nutrients and also providing a sense of satiety because this kind of fiber will absorb water and swell in the digestive tract (6). *Amorphophallusoncophyllus* tubers (AOT) are one of the food ingredients that have the potential to be used to prevent metabolic syndrome because of its high glucomannan content. Glucomannan is a water-soluble and low-caloriepolysaccharide.Amorphophallusonc ophyllus is one of the plants that can thrive in Indonesia, although local people have not used it as a food ingredient. Nevertheless, export demand to Japan continues to increase every year. Japanese people use flour obtained from AOT or what they call konjac flour as dietary fiber in the food industry. Based on the previous research, AOT has the activity of decresing body weight, reducing total cholesterol and blood sugar levels, and increasing HDL cholesterol levels (7, 8, 9). According to this studies, the study was aimed to evaluate the activity of *Amorphophallusoncophyllus* flour as a source of carbohydrates that could prevent the metabolic syndrome.

MATERIALS AND METHODS

Animals: Male Swiss–Webster mice 2-3 months old weighing 20-30 g were kept at standard laboratory conditions at 24-26°C, humidity 70-75%, and 12 hours light/dark cycle. Animals were fed with standard chow and water ad libitum. The methods in this study were performed in accordance with ethics and guide for animals care and used. Ethical approval was published by the Ethics Committee Padjajaran University numbered 139/UN6.KEP/EC/2018.

Anti metabolic syndrome evaluation of *Amorphophallusoncophyllus* flour

Rats were randomly divided into 3 groups: control group, rice group, and AOT group. Each group was given with different composition food with the same amount for 42 days. Food compositions could be seen in **Table 1** (10). Parameters measured were body weight, food intake, HDL and triglycerides level, value of insulin tolerance test constant, and blood pressure before treatment and 42 days after treatment.

Insulin Tolerance Test: An insulin tolerance test was an examination to evaluate the level of insulin sensitivity. This evaluation was carried out before treatment and 42 days after treatment. Before evaluation, all mice were fasted for ± 4 hours, then the initial blood glucose level was measured. Then, insulin was injected intraperitoneally at a dose of 0.05 IU / kgBW and blood glucose level was measured in the 15th, 30th, 45th and 60th minutes (11).

RESULTS AND DISCUSSION

Effect of different source of carbohydrate on body weight

Body weight measurement could be seen in Table 2. The result showed that body weight before treatment did not show significant differences (p> 0.05). This mean that the weight of all groups at the time before treatment was homogeneous. While body weight at 42 days after treatment showed significant differences (p <0.05). It could be interpreted that feeding with a different composition of carbohydrate sources would affect body weight. According to **Table 2**, there was significant difference in body weight between the groups given control food, food containing rice flour as a source of carbohydrates, and food containing AOT flour as a source of carbohydrates. In the control and rice group, body weight tended to increase every week. Even so, the rice group experienced a significantly higher body weight elevation compared to the control group. While, the AOT flour group experienced weight loss each week compared to the control and rice group. AOT flour was obtained from Amorphophallusoncophyllus tuber that contains high level of glucomannan. Glucomannan is a water-soluble polysaccharide known as water soluble and low-calories fiber. The mechanism of action of glucomannan in losing weight was related to its ability to absorb a lot of water and form a thick mass (gel), so that it would extend the emptying time of the stomach and the transit time of food in the stomach. This condition would cause satiety longer. Glucomannan consumption would also automatically reduce the amount of energy produced per unit weight of food consumed, because glucomannan is a low glycemic index food (12). The ability of glucomannan to prolong satiety was shown in **Figure 1**. Based on **Figure 1**, the amount of food intake in the AOT group was the lowest compared to the control and rice groups. Meanwhile, the highest amount of food intake was shown by the rice group. Another study had shown that consumption of low glycemic index food ccouldprolong satiety and delay hunger so that it would affect the food intake compared to the high glycemic index food (13).

Effect of different source of carbohydrate on HDL and triglyceride level

The triglyceride and HDL level at before and after treatment was shown in **Table 3**.Based on the **Table 3**, triglyceride and HDL level at the beginning of the evaluation did not show any significant difference (p> 0.05), which means the lipid levels of all groups before evaluation were equivalent. After being treated for 42 days with different source of carbohydrate food, triglyceride and HDL level experienced significant changes. The triglyceride level of control group, rice group, and AOT group on day 42 experienced -39%, 60%, and -16% changes compared to the triglyceride level before experiment, respectively. From these results, it could be seen that rice as a carbohydrate source caused the highest and significant increase in triglyceride level compared to the control group and AOT group. Elevation in triglyceride level was directly proportional to the elevation of blood glucose level (hyperglycemia) due to high carbohydrate intake. Hyperglycemia would trigger an increase in insulin requirements resulting in hyperinsulinemia. This condition would eventually cause insulin resistance. Insulin resistance would cause a decrease in the activity of the lipoprotein lipase enzyme; the lower the activity of the lipoprotein lipase enzyme, the higher triglyceride level in blood. Then with elevation of triglyceride level, the HDL catabolism would also increase, thus causing a decrease in HDL level (14, 15). Although based on **Table 3**, HDL level experienced no decrease in HDL in the rice group.

Table 1. Food Composition

Ingredients	Normal Group Food (kg)	Rice Group Food (kg)	AOT Group Food (kg)
Rice flour	-	4,25	-
AOT flour	-	-	4,25
Flour	1,7	1,7	1,7
Fish flour	0,8	0,8	0,8
Green bean flour	0,7	0,7	0,7
Fat	0,5	0,5	0,5

Table 2. Body Weight during treatment

Group	Body weight (g) at days-						
	1	7	14	21	28	35	42
Control	209±22	215±15	218±17	223±17	235±18	244±19	250±19
Rice	208±22	224±16	242±16	258±12	275±12	293±16	316±14
AOT	207±23	187±31	184±30	168±30	153±30	136±24	115±20

Note: data was presented as mean±SD; n=7 mice/ group; * means significantly different compared to the control group; # means significantly different compared to the rice group

Table 3 Triglyceride and HDL level during treatment

Group	Triglyceride level at day- (m/dl)		Percentage of change (%)	HDL level at day- (mg/dl)		Percentage of change (%)
	0	42		0	42	
Control	51.6±1.99	31.6±2.2#	-39	8.2±0.54	11.2±0.9#	36
Rice	52.5±2.49	84.1±3.0*	60	8.0±0.43	9.6±0.3*	20
AOT	53.7±3.21	44.9±4.4*#	-16	8.4±0.60	16.5±1.4*#	96

Note: data was presented as mean±SD; n=7 mice/ group; * means significantly different compared to the control group; # means significantly different compared to the rice group.

Table 4 K_{ITT} value during treatment

Group	KITT value at day-		Persentage of change (%)
	0	42	
Control	1.39±0.05	1.58±0.10#	14
Rice	1.42±0.05	0.78±0.03*	-45
AOT	1.39±0.05	2.06±0.07*#	48

Note: data was presented as mean±SD; n=7 mice/ group; * means significantly different compared to the control group; # means significantly different compared to the rice group.

Table 5 Blood Pressure during treatment

Group	Systolic blood pressure at day- (mmHg)		Percentage of change (%)	Diastolic blood pressure at day- (mmHg)		Percentage of change (%)
	0	42		0	42	
Control	112.4±1.82	112.6±4.9#	00.02	73.9±2.79	76.8±1.9#	4
Rice	113.4±2.30	151.8±8.9*	34	76.6±2.70	96.2±1.9*	25
AOT	113.4±2.70	100.6±2.6*#	-11	74.0±2.34	75.2±1.6#	2

Note: data was presented as mean±SD; n=7 mice/ group; * means significantly different compared to the control group; # means significantly different compared to the rice group.

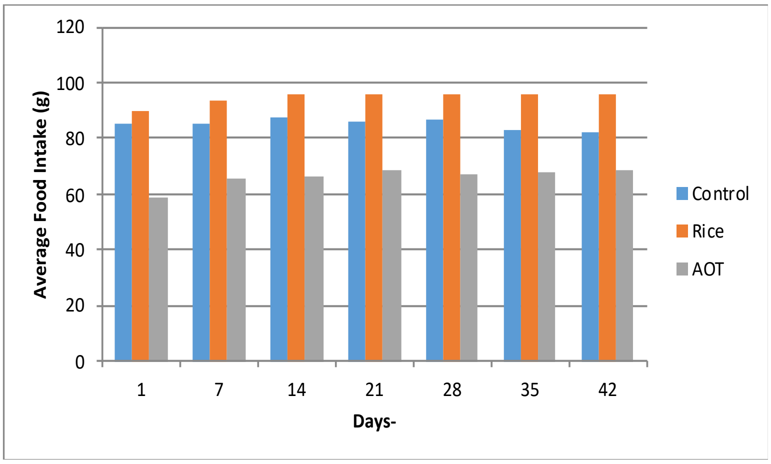

Figure 1 Food intake during treatment

But when compared with the control group and the AOT group, the increase in HDL level in the rice group was the lowest. And the group given AOT experienced the highest HDL increase of 96%. Another study also showed that high fiber diet could improve the lipid metabolism disorder (16).

Effect of different source of carbohydrate on insulin sensitivity

Insulin sensitivity determined the body's respond to the presence of insulin. Decreasing in insulin sensitivity resulted in a condition known as insulin resistance (17). The condition of insulin resistance was in line with the increasing prevalence of obesity (18). Evaluation of insulin sensitivity was carried out using an insulin tolerance test and expressed by the value of constant of insulin tolerance test (K_{ITT}). **Table 4** showed that the rice group experienced the highest decrease in insulin sensitivity compared to the control group and AOT. This proved that elevation in body weight would increase the insulin resistance risk. While the AOT group experienced the highest increase in insulin sensitivity by 48%. Studies showed that low-calories and high fiber food could improve insulin sensitivity (19, 20). Another study also showed that a reduction in carbohydrates and replacing them with unsaturated fats could increase insulin sensitivity (21). This was thought to be one of the mechanism of action of AOT in improving insulin sensitivity and glucomannan content in AOT was responsible for this activity.

Effect of different source of carbohydrate on blood pressure

Replacement of rice with AOT showed changes in blood pressure as shown in **Table 5**.The rice group showed elevated systolic and diastolic blood glucose level, while the control and AOT group didn't. Food with a low glycemic index had the ability to lower blood pressure (22). Based on the results of the experiment, AOT as a source of carbohydrates could reduce body weight, reduce triglyceride level, increase HDL level, increase insulin sensitivity, and reduce blood pressure. These effects are very influential in AOT activities in preventing or reducing symptoms of metabolic syndrome. The antimetabolic ability of the AOT syndrome is thought to be caused by its high glucomannan content. These result was comparable with another study (23).. It could be concluded that the AOT as a source of carbohydrate could prevent the occurrence of metabolic syndrome.

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