06 Hypocholesterolemic and Hypoglycemic Effects of Modified Water 2 1 1* Yam (Dioscorea alata) on Wistar Rats

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Hypocholesterolemic and Hypoglycemic Effects of Modified Water Yam (*Dioscorea alata*) on Wistar Rats

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Abstract

This study was inspired due to the potential use of water yam as functional food. This is because it has both high starch and resistant starch. In Indonesia, water yam is differentiated by its flesh color, such as purple, yellow and white. The modified water yam flour was made by three-cycle autoclaving-cooling process in order to increase the resistance of the starch content (RS type 3). The objective of this study was to evaluate the hypocholesterolemic and hypoglycemic effect of modified water yam in hypercholesterolemic rats. The study was carried out using 32 Wistar rats. They were made hypercholesterolemic by a certain diet that contained high lipid and cholesterol and were divided into four groups. Each group was fed with different diet such as purple, yellow and white water yam flour and

standard diet (AIN93) respectively. The treatments were assigned for four weeks and every week the serum lipid profile and glucose content were analyzed. The results showed that rats which were fed with modified water yam flour had lower concentration of total cholesterol, LDL cholesterol, triglyceride, and blood glucose than those which were fed with standard diet (AIN93). The higher reduction of total cholesterol and glucose level (approximately 39.8% and 58.1% respectively) was found in the group fed with modified white water yam. It can be concluded that modified white water yam was proved to pose hypocholesterolemic and hypoglycemic effects and could be developed as functional food. The findings of this research can facilitate the development of functional food for the healthiness of human, and for diabetic and hypercholesterolemic patients.

Keywords: Modified water yam, Hypocholesterolemic, Hypoglycemic

Introduction

Indonesia had various traditional food which was potential to be developed as functional food, however they were not used optimally. One of the postharvest which had not yet used optimally was water yam. Water yam (*Dioscorea alata*) is known as Ubi Kelapa or Uwi in Indonesia. Water yam is usually differentiated by its flesh color, such as white, yellow and purple water yam.

Water yam is usually boiled or steamed and consumed as staple food in village society. Being processed, Resistant Starch type III (retrograded starch) is formed and it has positive effect to human health. The previous study revealed that three cycle treatment of arrowroot starch increased resistant

content of 10.91% (Sugiyono *et al*., 2009). Autoclaving-cooling treatments of water yam resulted in a significant increase in crystallinity of the starches, swelling power, and water absorption capacity (Rosida *et al.,* 2017) Autoclaving-cooling cycle could produce more retrograded amylose fraction (re-crystalization) and was known as RS3 formation (Mutungi *et al*., 2009). Retrograded amylose (RS3) had heat-stable properties, very complex and resistant to amylase enzyme.

So *et al.* (2007) reported that feeding RS3 to experimental rats had significant effect on lipid metabolism. Anderson *et al.* (2009) stated that an effort in decreasing blood cholesterol level was to consume high dietary fiber food. Dietary fiber can inhibit cholesterol absorption in the intestine so that reducing cholesterol level in the blood and increasing cholesterol excretion in the feces.

Hypercholesterolemia is a condition which cholesterol level in blood plasma over its normal limit, that is over than 200 mg/L whereas LDL level is over than 130 mg/dL and HDL level is lower than 40 mg/dL. The high cholesterol level in the blood serum cholesterol was one factor which had the risk of cardiovascular disease (Cheng and Lai, 2000). Cholesterol level in the blood was influenced by many factors, such as the amount and kind of fat intake, dietary fiber intake, exercise, and so on. The cholesterol reduction could be done by therapeutic diet. Some of dietary fiber and resistant starch could lower LDL cholesterol level. So that consuming high resistant starch food in sufficient quantity could give healthy effect to human body (Anderson *et al.,* 2009)

Hernawati *et al*. (2013) reported that dietary fiber from rice bran could reduce serum cholesterol total, triglycerides, and LDL level and increased HDL level of hypercholesterolemic rats. Additionally, it supported blood glucose level balance especially to the type 2-diabetic mellitus patients. The consumption of dietary fiber diet intensively in long period of times, could reduce serum glucose level, by slowing down of glucose absorption and

insulin response. The soluble fiber retarded glucose diffusion and delayed carbohydrate absorption and digestion. So it had positive effect to lower glucose absorption rate so the body had never suffered hyperglycemic condition.

The aim of this study was to evaluate the hypocholesterolemic and hypoglycemic effects of modified water yam in hypercholesterolemic rats. Presumably, the effect in reducing blood glucose level was due to some polysaccharides in water yam, such as resistant starch and dietary fiber.

Materials and Methods

Materials

Selected purple, yellow, and white water yam tuber (*Dioscorea alata)* were heated in an autoclave for 15 minutes (120°C) and cooled in a refrigerator for 24 hours (4°C). The autoclaving-cooling treatment was repeated up to 3 times prior to slicing, drying and milling in order to make modified water yam flour. Reagent used in this research were analytical grade, such as cholesterol kit, glucose kit, HDL precipitate, ethanol.

Methods

Selected 32 male Wistar rats (*Ratus norvegicus* Wistar) 2-3 months of age weighing 150-225 g were used in the experiment. Acclimatization was conducted for three days with standard feed of AIN93 (Reeves et al., 1993). The AIN93 standard diet was consisted of corn starch (670,7g/kg), casein (140g/kg), sucrose 9100g/kg), soybean oil (40mg/kg), AIN mineral mix (35 mg/kg), AIN vitamin mix (10 mg/kg), choline bitartrate (2.5 g/kg), L-cystine (1.8 g/kg), except carboxymethylcellulose addition (fiber-free diets).

After that the rats were fed hypercholesterol diets for seven days, i.e standard feed which was supplemented with 1% cholesterol and PTU (prophyl thio uracyl), so that all the rats were suffered hypercholesterolemic (cholesterol total over than 200 mg/dL). The rats were randomly assigned into four groups of eight rats per group. Rats in group 1 served as control and fed standard diet (AIN93), while group 2, 3, and 4 were fed purple, yellow and white modified water yam flour respectively. The treatment diets and water were given *ad libitum* for four weeks. The measurement was performed on days 0, 7, 14, 21 and 28. Blood were taken from a retro-orbital plexus after fasting for 16 hours and were measured for cholesterol total and HDL by CHOD-PAP method; blood Triglyceride by GPO-PAP method and blood glucose by the GOD/PAP method. LDL was measured by Friedewald formulation as followed:

$$\text{LDL} = \text{cholesterol total} - (\text{HDL} + \frac{\text{TG}}{5})$$

All data were analyzed by Analysis of Variance (ANOVA) and followed by Duncan Multiple Range Test (DMRT's).

Results and Discussion

Resistant Starch and Dietary Fiber content

Modification process by autoclaving-cooling cycles in order to increase RS content was reported by many researchers, such as Zabar *et al* (2008) and Sugiono *et al* (2009). In this research, purple, yellow and white water yam flour had resistant starch content of 7.55%, 7.14%, 9.04%, respectively. The previous study revealed that water yam modification by three cycle

autoclaving-cooling treatment was able to increase RS and DF content, thus able to decrease blood glucose level (Rosida *et al*., 2016).

Cholesterol Total

After 28 day intervention, serum cholesterol total of purple, yellow, and white water yam group decreased by 39.44%, 37.33% and 39.87%, respectively. However, those of control group were constant (201.5 - 203.8 mg/dL). The data proved that modified water yam flour had potency to reduce blood cholesterol due to its resistant starch and dietary fiber content. So *et al*. (2007) reported that feeding RS3 to experimental rats had significant effect on lipid metabolism. Resistant starch could arrive in the colon without changing and had the function as dietary fiber.

One method in reducing blood cholesterol level was to consume more dietary fiber diet. Dietary fiber diet could inhibit cholesterol absorption in the small intestine and finally reduce cholesterol level in the blood plasma and increase cholesterol production in the liver, bile acid production and cholesterol excretion in the feces. So that dietary fiber had been used intensively and recommended to keep blood cholesterol level at normal level (Anderson *et al.,* 1994).

Triglyceride (TAG), HDL and LDL level

At the beginning, after hypercholesterolemic diet intervention, triglyceride, LDL and HDL level of all rats were not different significantly ($p<0.05$). However, after feeding treatment, those of modified water yam flour groups were lower than standard diet group. The reduction of cholesterol

(Fig1) was in accordance with triglyceride and LDL level reduction (Fig2). It indicated that modified water yam flour had potency in lowering blood cholesterol, LDL and triglyceride level. This phenomenon revealed that modified water yam flour had hypocholesterolemic effect due to its resistant starch and dietary fiber content.

The high fiber and high resistant starch diet could increase LDL receptor activity in the liver. This activity fulfilled the availability of tissue cholesterol, so more blood cholesterol was used that reduced blood cholesterol level (Anderson *et al.,* 2009)

Blood Glucose Level

Statistically, there was a significant decrease ($p<0.05$) in blood glucose kevel during 4 week feeding experiment. After 28 day intervention, the serum glucose of purple, yellow and white water yam group reduced by 49.88%, 53.62%, and 58.10%, respectively, while those of standard group were constant (146.01-148.98 mg/dL). The data showed that modified water yam flour was potential in decreasing serum glucose level due to its resistant starch content. The availability of resistant starch in small intestine could lower glycemic and insulemic response on diabetic patients (Okoniewska and Witwer, 2007).

Some factors which probably influenced the blood glucose reduction were dietary fiber and resistant starch. Dietary fiber, especially soluble fiber, had viscous properties and could decrease glucose response (Marsono, 2002). The plan could serve as a great therapeutic diet in the management of diabetes.

Conclusion

The research revealed that rats which were fed with modified water yam flour had lowered cholesterol total, LDL and glucose and higher HDL level than those of control rats with AIN93 standard diet. The modified white water yam flour had higher reduction in the cholesterol and glucose level due to its high RS and Dietary Fiber content. It can be concluded that modified water yam flour has hypocholesterolemic and hypoglycemic effect on experimental rats.

Acknowledgement

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References

Anderson, J.W., Baird, P., Davis, R.H.Jr., Ferreri, S., Knudtson, M. and Korarym, A. 2009. Health benefits of dietary fiber. Nutrition Review 67(4): 188-205.

Cheng, H.H., and Lai, M.H. 2000. Fermentation of resistant rice starch produces propionate reducing serum and hepatic cholesterol in rats. Journal of Nutrition 130: 1991-1995.

Hernawati, Manalu, W., Suprayogi, A. and Astuti, D.A. 2013. The improvement of blood lipid parameters on hypocholesterolemic rats with rice bran fed supplement. Majalah Kedokteran Bandung 45(1): 1-9.

Marsono. 2002. Hypoglycemic and hypolipidemic properties of edible podded peas (*Pisum sativum* Linn) and soybean (*Glycine max* Merr) diets in aloxan induced diabetic spargue dawley rats. Agritech 6 vol. 22(4): 137-143.

Mutungi, C., Rost, F., Onyango, C., Jaros, D. and Rohm, H. 2009. Cystalinity, thermal and morphological characteristics of resistant starch type III Produced by hydrothermal treatment of debranched cassava starch. Starch/Starke 61(11): 634-645.

Okoniewska, M. and Witwer, R.S. 2007. Natural resistant starch: an overview of health properties a useful replacement for flour, resistant starch may also boost insulin sensivity and satiety. New York (US): Nutritional Outlook.

Reeves, P.G. 1997. Components of AIN-93 diets as improvements in the AIN-76A diet. Journal of Nutrition 127: 838S-841S.

Rosida, Harijono, Estiasih, T., and Sriwahyuni, E. 2016. Hypoglycemic effect of modified water yam flour (*Dioscorea alata*) on diabetic rats (*Rattus norvegicus*). Journal of Food and Nutrition Research 4(1): 20-25.

Rosida, Harijono, Estiasih, T., and Sriwahyuni, E. 2017. Functional and pasting characteristics of modified water yam flour (*Diocorea alata*). International Food Research Journal 24(5): 1880-1888.

So, P.W., Yu, W.S., Kuo, Y.T., Wasserfall, C., Goldstone, A.P., Bell, J.D., and Frost, G. 2007. Impact of resistant starch on body fat patterning and central appetite regulation. PLOS One 2(12): e1309.

Sugiyono, Pratiwi, R., and Faridah, D.N. 2009. Arrowroot (*Marantha arundinaceae L*) starch modification through autoclaving-cooling cycling treatment to produce resistant starch type III. Jurnal Teknologi dan Industri Pangan 20(1): 17-24.

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Zabar, S., Shimoni, E., and Peled, H.B. 2008. Development of nanostructure in resistant starch type III during thermal treatment and cycling. Journal of Macromolecule Bioscience 8(2): 163-170.

Table 1. Resistant Starch and Dietary Fiber content of modified water yam flour

Water Yam Flour	Dietary Fiber (%)	Resistant Starch (%)
Purple	13.04	7.55
Yellow	13.42	7.14
White	13.81	9.04

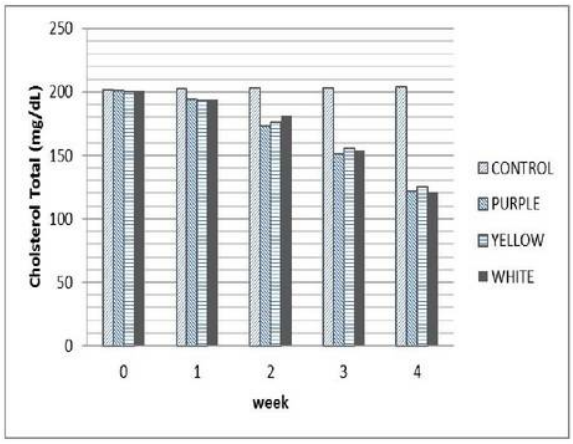

Fig 1. Changes of serum cholesterol total of rats after 28 day intervention by standard diet and modified water yam flour diets

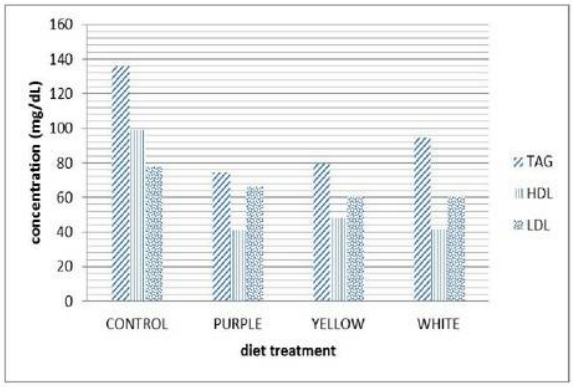

Fig2. Triglyceride (TAG), HDL and LDL level of hypercholesterolemic rats after 28 days intervention by standard diet and modified water yam flour diets.

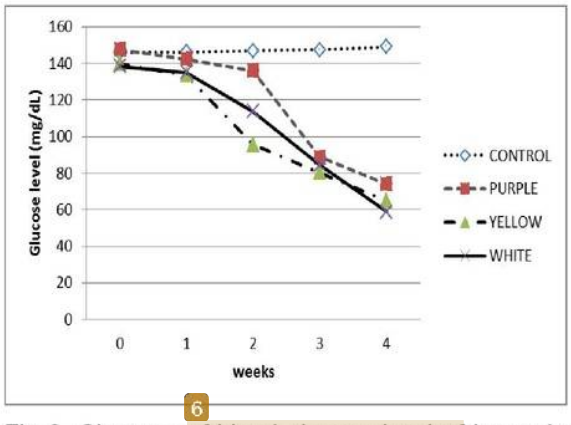

Fig 3. Changes of blood glucose level of hypercholesterolemic rats during 4 week feeding of standard diet and modified water yam flour diets

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