FULL- A063 Siska Ariftiyana_rev1

by Zeen Zee

Submission date: 20-Jan-2022 12:29AM (UTC-0600)
Submission ID: 1744618931
File name: FULL-_A063_Siska_Ariftiyana_rev1.docx (65.2K)
Word count: 3047
Character count: 17205

Porang (*Amorphophallus oncophyllus*) flour with *Strobilanthes crispus* maceration reduced blood glucose level in streptozotocin-induced diabetic rats

Siska Ariftiyana[1], Lieyan Nurfikasari[2,3], Dwi Murniyati[3], Agus Prastowo[4], Yulinda Kurniasari[3], Hamam Hadi[1], Veriani Aprilia[3*]

[1]*Graduate School of Public Health, Universitas Alma Ata, Jl. Brawijaya No. 99, Tamantirto, Kasihan, Bantul, Yogyakarta 55183, Indonesia*
[2]*PKU Muhammadiyah Gombong, Jl. Yos Sudarso No. 461, Sangkalputung, Semondo, Gombong, Kabupaten Kebumen, Jawa Tengah 54412*
[3]*Department of Nutrition, Faculty of Health Sciences, Universitas Alma Ata, Jl. Brawijaya No. 99, Tamantirto, Kasihan, Bantul, Yogyakarta 55183, Indonesia*
[4]*Prof. Dr. Margono Soekarjo Hospital, Purwokerto, Jawa Tengah*

Corresponding author: Veriani Aprilia, *Department of Nutrition, Faculty of Health Sciences, Universitas Alma Ata, Jl. Brawijaya No. 99, Tamantirto, Kasihan, Bantul, Yogyakarta 55183, Indonesia.*
E-mail: verianiaprilia@almaata.ac.id. ORCID iD: 0000-0002-6231-6487

Short title: Porang (*Amorphophallus oncophyllus*) with *Strobilanthes crispus* reduced blood glucose level

Funding: This research was supported by Universitas Alma Ata

Porang (*Amorphophallus oncophyllus*) flour with *Strobilanthes crispus* maceration reduced blood glucose level in streptozotocin-induced diabetic rats

Abstract

BACKGROUND: Diabetes mellitus (DM) is a metabolic disease indicated by hyperglicemia. Dietary regulation is an alternative way to control blood glucose levels. *Amorphophallus oncophyllus* or porang is a local tuber that has low glycemic index due to glucomannan content. Its combination with *Strobilanthes crispus* (SC) that is rich in antioxidant is potential for diabetes treatment.
OBJECTIVES: This study aimed to know the effect of porang flour macerated with SC on blood glucose levels in diabetic rats.
METHODS: Thirty-five Wistar (*Rattus norvegicus*) rats were divided into 5 groups, based on the types of diets. They were standard AIN-93 diet for NC group (normal/negative control, non-diabetic), PC group (positive control, streptozotocin (STZ)-induced diabetic), GB group (STZ-induced diabetic, medicated with glibenclamide 100 mg/200 g body weight (BW)). The treatment groups were fed with a modified AIN-93 diet substituted its fiber with 11% (equal with 1.1 g/200 g BW) of porang (NP) group and SC-macerated porang (SP) group. Food intake, stools, and BW were recorded during the study, while blood glucose levels were measured before, 6 d after the induction of STZ, and at the end of the study (14 d of treatments periods). The data were statistically analyzed by one-way analysis of variance (ANOVA) continued with Duncan's multiple range test.
RESULTS: Feed intake of rats during 14 d of treatment were almost the same and influence the bodyweight. After the STZ induction, the body weight of rats seemed down, but statistically not different. This weight loss may be better controlled in treatment groups because of the role of glucomannan content in the improvement of glucose metabolism, especially in NP and SP. Stools looked normal in consistency and moisture and confirmed that there was no diarrhea incident. The role of glucomannan also proved to decrease blood glucose levels in NP and SP groups. SP groups showed the best performance in decreasing glucose levels due to the addition of SC as the source of antioxidant.
CONCLUSION: Porang had antidiabetic activity that was comparable with glibenclamide as a commercial drug. It was forced by combination with SC that contains many antioxidants. It should be studied further to optimize its antidiabetic potency and its uses as functional food or nutraceuticals.

Keywords: *Diabetes mellitus, blood glucose, Amorphophallus oncophyllus, Strobilanthes crispus, porang*

Introduction

Diabetes mellitus (DM) is a metabolic disease indicated by hyperglicemia that is caused by insulin function or secretion disorder (1,2). The bad impact of DM is very influential on other comorbidities, like multiple secondary complications micro- and macro-vascular, also neuropathic disorder (3). If it is not taken seriously, it may decrease the quality of human resources and increase health costs.

Dietary regulation is a way that patients can do to control blood glucose levels, in addition to consuming hypoglycemic drugs. A diet with foods that have a low glycemic index had a positive effect on lowering blood glucose levels (4). *Amorphophallus oncophyllus* or known as porang is a kind of konjac tuber that is widely cultivated in Indonesia. It has low glycemic index (5) because of its glucomannan content. The study about the health effect (6,7) and its application has been carried out (8–14), but its uses as raw porang flour are still very rare due to the limited availability of calcium oxalate-free flour.

Porang flour macerated with *Strobilanthes crispus* (SC) has been studied for its safety (15) and low content of calcium oxalate (16). The SC content that is rich in flavonoid and phenolic acid (17) in porang potentially to add benefits in diabetes treatment. However, the study to prove that potency has not been studied. The aim of this study was to know the effect of porang flour macerated with SC on blood glucose levels in diabetic rats.

Methods

Plant material

Porang tuber was obtained from the farmer in Madiun, East Java. The tuber was cleaned from the sand, sliced, and dried. It was then ground and sifted 40 mesh to make powder. The flour was macerated with SC as described in Patent Application No. S00202006668 (16).

Experimental animals

This study was carried out according to Health Research Ethics Committee Universitas Alma Ata with the Ref No: KE/AA/VI/273/EC/2017. Thirty-five Wistar (*Rattus norvegicus*) rats with the category of eight weeks of ages and the body weight of 121-159 g were used in this study. The rats were divided into 5 groups, based on the types of diets. Each group was treated with standard AIN-93 diet (18) for NC group (normal/negative control, non-diabetic), PC group (positive control, streptozotocin (STZ)-induced diabetic), and GB group (STZ-induced diabetic, medicated with glibenclamide 100 mg/200 g bodyweight (BW)). The treatment groups were fed with a modified AIN-93 diet substituted its fiber with 11% (equal with 1.1 g/200 g BW) of porang (NP) group and SC-macerated porang (SP) group. They were individually housed in wire cages under an ambient temperature with 12 h light-dark cycle. Food intake, stools, and bodyweight (BW) were recorded during the study, while blood glucose levels were measured before, 3 d after the induction of STZ, and at the end of the study (14 d of treatments periods).

Induction of diabetes, blood preparation, and biochemical analysis

The intraperitoneal injection of nicotinamide 110 mg/kg BW was done before diabetic inducement with 8 mg/200 g BW of STZ. The rats were categorized as diabetic when glucose level was more than 126 mg/dL (1). The blood glucose levels were determined by GOD-PAP (glucose oxidase–peroxidase aminoantypirin) enzymatic methods from the rat plasma samples. This plasma was prepared from centrifugation of blood samples (at 400 rpm for 15 minutes) that were drawn from the vena retroorbital part by microcapillary technique.

Statistical analysis

Data were presented as mean±standard deviation (SD). They were analyzed by one-way analysis of variance (ANOVA) continued with Duncan's Multiple Range Test (DMRT) at $p<0.05$ to compare

the data between groups. Paired T-test analysis was also used to compare the data between before and after the treatment. All of the analysis used statistical package for the social sciences (SPSS) software (version 16.0 SPSS Inc., Chicago, USA).

Results and Discussions

Feed intake, body weight of rat, and observation of stools

Feed intake of rats during 14 d of treatment periods could be seen in Table 1. The amount of intake was almost the same every day with the mean value recorded in the range of 6.18-9.59 g/dL. Among the groups, NC showed the lowest amount of feed intake and was statistically different from others ($p<0.05$). It may be due to NC rats' behavior that looked more active than other groups. It caused some feeds were fallen or be mixed in the drinking water, so that could not be weighed. The feed intake of NC was also statistically different with PC ($p<0.05$). It indicated that the inducement of diabetes influenced the feed intake or rat's appetite.

Feed intake relates to the body weight of rats. The body weight of rats during the study could be seen in Table 1. During 14 d of treatment, the bodyweight of rats seemed down, but not statistically different ($p>0.05$). This weight loss value increased after STZ induction that may be caused by insufficient insulin. It leads to an inability of glucose to be used as energy, therefore the availability in the body was provided by fat catabolism. If it was happened continuously can lose body weight (19,20,21). However, the body weight in treatment groups (GB, NP, and SP) could be controlled by increasing the insulin sensitivity resulting in the improvement of glucose metabolism (22) for GB groups or by the role of glucomannan as fiber in NP and SP groups that fulfilled the intestine and decrease the feed intake (6,23). It may also decrease postprandial glucose and improve insulin sensitivity (24,25). The previous study has also been studied for the potency of porang glucomannan as a prebiotic that increased short-chain fatty acid (SCFA) in the colon (6) leading to the improvement of glucose and lipid metabolism (23,26) and resulting in controlling of body weight (24).

The inability of body weight to increase in this study was also confirmed by the observation of stools that could be seen in Table 1, especially to know whether there was diarrhea or other disorder in gastrointestinal. The data showed that stools in all groups were in normal moisture and consistency. It meant that there was no diarrhea, instead there were also no difficulties in defecating process. The previous study proved that glucomannan absorbed much water and influenced the dry and wet stool weight, the defecation frequency, and colonic flora in stool (27). The porang consumption and its combination with SC did not affect the gastrointestinal response.

Table 1: Feed intake, body weight, and stool character of rats during 14 d of treatment periods

Groups	Feed intake (g)	Stools character		Body weight (g)		
		Water content (%)	Consistency	Before intervention	After intervention	Δ.K
NC	6.18±0.8^{a}	39.40 ±2.2^{a}	Slightly hard	133.2±7.3	130.4±13.0	-2.8^{a}
PC	9.56±1.1^{b}	76.20 ± 5.3^{a}	Soft	134.4±11.8	123.4±13.8	-11.0^{a}
GB	9.59±1.9^{b}	71.40 ± 3.0^{a}	Soft	141.2±9.9	133.0±10.3	-8.2^{a}
NP	9.64±0.6^{b}	78.80 ± 5.1^{a}	Soft	150.0±6.0	142.6±27.6	-7.4^{a}
SP	8.84±.8^{b}	70.20 ± 2.8^{a}	Soft	138.8±13.4	132.80±4.1	-6.0^{a}

*Different superscript letter in the same columns indicated significantly different result ($p<0.05$). NC group (normal/negative control, non-diabetic, AIN-93 diets), PC group (positive control, streptozotocin (STZ)-induced diabetic, AIN-93 diets), GB group (STZ-induced diabetic, AIN-93 diets, medicated with glibenclamide), NP group (STZ-induced diabetic, AIN-93 modified diets with 11% porang flour), SP group (STZ-induced diabetic, AIN-93 modified diets with 11% SC-macerated porang flour).

Blood glucose levels

Table 2 showed that the initial blood glucose levels were in the range of 50-135 mg/dL. It meant that all intervention groups were normal. The measurement of initial blood glucose levels of rats aimed to ensure that the rats were in normal condition. After being induced with STZ, blood glucose levels in diabetic groups increased in the range value between 217-244 mg/dL. The rats with blood glucose levels more than 126 mg/dL were included in diabetic groups (1). STZ induced diabetes by damaging β-cells through the production of radicals NO that may block the Fe-containing enzymes and the breakdown of secondary radicals caused peroxide of lipids, reduced antioxidant, and led to DNA damage (28, 29).

The intervention of commercial drug (GB group) and porang flour (NP and SP) significantly decreased blood glucose levels ($p<0.05$), although they were still above 126 mg/dL, especially for NP and SP (Table 2). GB worked by stimulating the insulin secretion in the pancreas gland through sensitizing of β-cells allowing glucose-induced changes in the synthesis and release of insulin (22). NP and SP worked as the fiber that has high water absorption and is very viscous (6) that may decrease food absorption in the small intestine and decrease postprandial glucose and insulin secretion leads to the improvement of insulin sensitivity (24,25). This was also confirmed by the histopathological study of the pancreas that showed the maintaining of pancreatic structure in diabetic rats treated by konjac glucomannan (24).

This study also presented that SP groups had a similar antihyperglycemic ability with GB. The role of fiber in porang was strengthened by the existence of SC. SC is the source of flavonoids and phenolic acids that possessed antidiabetic activity in diabetic rats (17). SC was also useful in decreasing calcium oxalate in porang and had no acute toxicity result (15) which allows its use as a functional food.

Table 2: Blood glucose levels of rats in various treatment during 14 days of treatment

Groups	Blood glucose levels (mg/dL)			
	Before STZ induction	After STZ induction	After intervention	ΔK
NC	69.6 ± 0.9^{b}	67.17±1.4	67.4±2.0	0.67^{a}
PC	66.7 ± 1.1^{a}	244.4±7.4	215.7±6.1	1.26^{a}
GB	70.4 ± 2.2^{b}	217.40±7.8	121.8±5.3	-96.0^{b}
NP	68.3±1.1^{ab}	217.4±9.2	156.8±4.3	-62.9^{c}
SP	68.7±1.9^{ab}	224.5±7.3	133.2±1.9	-91.3^{b}

* Different superscript letter in the same coloumn indicated significantly different result ($p<0.05$). ΔK showed the different value between 0 d and 14 d using T-test. NC group (normal/negative control, non-diabetic, AIN-93 diets), PC group (positive control, streptozotocin (STZ)-induced diabetic, AIN-93 diets), GB group (STZ-induced diabetic, AIN-93 diets, medicated with glibenclamide), NP group (STZ-induced diabetic, AIN-93 modified diets with 11% porang flour), SP group (STZ-induced diabetic, AIN-93 modified diets with 11% SC-macerated porang flour).

Conclusions

This study concluded that porang had antidiabetic capacity. This capacity was forced by the presence of SC and proved the comparable result with the glibenclamide as a commercial drug. Further study is needed in the optimalization of doses to improve the antidiabetic capacity and probability uses as functional food or nutraceuticals.

Acknowledgements

The authors would like to thank Alma Ata University and ACHEAF (Alma Ata Centre for Healthy Food) for the many facilities for this study.

References

1. Association AD. Classification and Diagnosis of Diabetes Melitus. Diabetes Care. 2015;38.
2. Roglic G. WHO Global report on diabetes: A summary. Int J Noncommunicable Dis. 2016;1(1):3.
3. Ganong WF. Fisiologi Kedokteran. Jakarta, Indonesia: EGC; 2008. 725–756 p.
4. Augustin, L. S., Franceschi, S., Jenkins, D. J. A., Kendall, C. W. C., La Vecchia C. Glycemic index in chronic disease: a review. Eur J Clin Nutr. 2002;56(11):1049.
5. Faridah DN. Sifat fisiko-kimia tepung suweg (Amorphophallus campanulatus B1) dan indeks glikemiknya. J Teknol dan Ind Pangan. 2005;XVI(3):254–9.
6. Harmayani E, Aprilia V, Marsono Y. Characterization of glucomannan from Amorphophallus oncophyllus and its prebiotic activity in vivo. Carbohydr Polym [Internet]. 2014 Nov 4 [cited 2015 Jan 12];112:475–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25129770
7. Nissa C, Madjid IJ. Potensi glukomanan pada tepung porang sebagai agen anti-obesitas pada tikus dengan induksi diet tinggi lemak. J Gizi Klin Indones (The Indones J Clin Nutr. 2016;13(1):1–6.
8. Harianto H, Thohari I, Purwadi. Adding porang flour (Amophophallus ocophyllus) in yoghurt ice cream in terms of physical characteristic and total of lactic acid bacteria. Universitas Brawijaya; 2013.
9. Kalsum U, Malaka R, Yuliati FN. Kualitas organoleptik dan kecepatan meleleh es krim dengan penambahan tepung porang. Universitas Hasanudin; 2012.
10. Putri VN, Susilo B, Hendrawan Y. Pengaruh penambahan tepung porang (Amorphophallus onchophyllus) pada pembuatan es krim instan ditinjau dari kualitas fisik dan organoleptik. J Keteknikan Pertan Trop dan Biosist. 2014;2(3):188–97.
11. Evanuarini H, Hastuti P. Characteristic of low fat mayonnaise containing porang flour as stabilizer. Pakistan J Nutr. 2015;14(7):392–5.
12. Faridah A, Bambang Widjanarko S. Penambahan tepung porang pada pembuatan mi dengan substitusi tepung mocaf (modified cassava flour). J Teknol dan Ind Pangan [Internet]. 2014;25(1):98–105. Available from: http://journal.ipb.ac.id/index.php/jtip/article/view/8309
13. Sudaryati, Mulyani T, Hansyah ER. Sifat fisik dan mekanis edible film dari tepung porang (Amorphopallus oncophyllus) dan karboksimetilselulosa. J Teknol Pertan. 2010;11(3):196–201.
14. Setyawati A, Purwadi, Thohari I. Kualitas fisik dan organoleptik (aroma, warna) keju olahan dengan penambahan pengemulsi tepung porang. Malang, Indonesia; 2013.
15. A RQ, Hasanah U, Hadi H, Mustofa M, Nurinda E, Kurniasari Y, et al. Acute Toxicity Study of Porang (Amorphophallus oncophyllus) Flour Macerated with Strobilanthes crispus in Wistar Rats. 2021;9:976–81.
16. Aprilia V, Nurinda E, Alpina L, Hadi H, Ariftiyana S, Kurniasari Y. Proses reduksi kalsium oksalat pada tepung porang (Amorphophallus oncophyllus) dengan maserasi ekstrak daun keji beling (Strobilanthes crispa) [Internet]. Indonesia; S00202006668, 2020. Available from: https://pdki-indonesia.dgip.go.id/detail/S00202006668?type=patent&keyword=proses+reduksi+kalsium+oksalat
17. Fadzelly ABM, Asmah R, Fauziah O. Effects of Strobilanthes crispus tea aqueous extracts on glucose and lipid profile in normal and streptozotocin-induced hyperglycemic rats. Plant Foods Hum Nutr. 2006;61(1):7–12.
18. Reeves PG, Neilsen FH, Fahey, G. C J. AIN-93 purified diets for laboratory rodents: Final Report of the American Institute of Nutrition Ad Hoc Writing Committee on the Formulation of the AIN-76A Rodent Diet. J Nutr. 1993;123(11):1939–51.
19. Suriani Nida. Gangguan Metabolisme Karbohidrat pada Diabetes Melitus. [Malang]: Fakultas Kedokteran Universitas Brawijaya Malang; 2012.

20. Zakia U, Nurdiana, Fajar NA. Efek Pemberian Susu Sapi Bubuk Terhadap Kadar Serum HDL (High Density Lipoprotein) Pada Tikus Putih (Rattus norvegicus) Galur Wistar Model Diabetes Mellitus Tipe 2. J Gizi Pangan. 2015;10(1):1–8.
21. Rias YR, Sutikno E. Hubungan Antara Berat Badan Dengan Kadar Gula Darah Acak Pada Tikus Diabetes Mellitus. J Wiyata. 2017;4(1):72–7.
22. Ling Z, Wang Q, Stange G, In P, Pipeleers D. Glibenclamide treatment recruits β-cell subpopulation into elevated and sustained basal insulin synthetic activity. Diabetes. 2006;55:78–85.
23. Grover GJ, Koetzner L, Wicks J, Gahler RJ, Lyon MR, Reimer RA, et al. Effects of the soluble fiber complex PolyGlycopleX® (PGX®) on glycemic control, insulin secretion, and GLP-1 levels in Zucker diabetic rats. Life Sci. 2011;88(9–10):392–9.
24. Chen H, Nie Q, Hu J, Huang X, Zhang K, Pan S, et al. Hypoglycemic and Hypolipidemic Effects of Glucomannan Extracted from Konjac on Type 2 Diabetic Rats. J Agric Food Chem. 2019;67(18):5278–88.
25. Donowarti I, Widjanarko SB, Yunianta Y, Pudjiastuti P. Acute toxicity test of low calcium oxalate porang (Amorphophallus mueleri Blume) flour. Iraqi J Agric Sci. 2021;52(1):218–31.
26. Deng J, Zhong J, Long J, Zou X, Wang D, Song Y, et al. Hypoglycemic effects and mechanism of different molecular weights of konjac glucomannans in type 2 diabetic rats. Int J Biol Macromol [Internet]. 2020; Available from: https://doi.org/10.1016/j.ijbiomac.2020.10.021
27. Chen H, Cheng H, Liu Y, Liu S, Wu W. Konjac acts as a natural laxative by increasing stool bulk and improving colonic ecology in healthy adults. Appl Nutr Investig. 2006;22:1112–9.
28. Lu XJ, Chen XM, Fu DX, Cong W, Ouyang F. Effect of Amorphophallus Konjac oligosaccharides on STZ-induced diabetes model of isolated islets. Life Sci. 2002;72(6):711–9.
29. Szkudelski T. The Mechanism of Alloxan and Streptozotoci Action in β Cells of The Rat Pancreas. Pysiol Res. 2001;(50):536–46.

FULL- A063 Siska Ariftiyana_rev1

ORIGINALITY REPORT

10%	8%	7%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.science.gov Internet Source	2%
2	ejournal.almaata.ac.id Internet Source	1%
3	Rizka Qurrota A'yun, Uswatun Hasanah, Hamam Hadi, Mustofa Mustofa, Eva Nurinda, Yulinda Kurniasari, Veriani Aprilia. "Acute Toxicity Study of Porang (Amorphophallus oncophyllus) Flour Macerated with Strobilanthes crispus in Wistar Rats", Open Access Macedonian Journal of Medical Sciences, 2021 Publication	1%
4	tjpr.org Internet Source	1%
5	Nurliyani, Eni Harmayani, Sunarti. "Synbiotic kefir lowered peroxisome proliferator activated receptor gamma (PPARγ) gene expression in rat fed high-fat and high-fructose diet", Research Square, 2020 Publication	1%

6	etd.repository.ugm.ac.id Internet Source	1 %
7	www.spandidos-publications.com Internet Source	1 %
8	Jinn Chyi Wang, Shu Hui Hu, Jih Terng Wang, Ker Shaw Chen, Yi Chen Chia. "Hypoglycemic effect of extract ofHericium erinaceus", Journal of the Science of Food and Agriculture, 2005 Publication	1 %
9	Qiwei Du, Jianhua Liu, Yuting Ding. "Recent progress in biological activities and health benefits of konjac glucomannan and its derivatives", Bioactive Carbohydrates and Dietary Fibre, 2021 Publication	1 %
10	core.ac.uk Internet Source	1 %
11	eprints.ums.ac.id Internet Source	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		