

ORIGINAL ARTICLE

The Effect of Purple Sweet Potato Jelly on Malondialdehyde and Fasting Blood Sugar in Experimental Type 2 Diabetic Rat Model

Titik Dwi Noviati^{1*}, Didik Gunawan Tamtomo^{1,2}, Sugiarto Sugiarto¹

1. Postgraduate of Nutrition Sciences, Sebelas Maret University, surakarta, Indonesia

2. Department of Anatomy, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia

ARTICLE INFO

Keywords:

Ipomoea batatas L. Poir

Purple sweet potato

Type 2 diabetes mellitus

Malondialdehyde

Fasting blood sugar

ABSTRACT

Background: Purple sweet potato jelly (*Ipomoea batatas L. Poir*) can potentially be rich in anthocyanin and fiber with antioxidant and hypoglycemic properties that may be beneficial to T2DM sufferers. This study aimed to find out the influence of purple sweet potato jelly on MDA and FBS in experimental T2DM of rats.

Methods: In an experimental research, 20 male Wistar rats were divided into four groups. Group 1 consisted of T2DM rats fed on standard diet (G1), while group 2, 3 and 4 were fed on standard diet of 7.47 g per 200 g of body weight containing 1.35 g (G2), 2.7 g (G3) and 5.4 g (G4) of purple sweet potato jelly, respectively. The MDA and FBS levels were checked at day 0 and 14.

Results: After 14th day of intervention, the mean MDA level decreased 0.28 ± 0.84 in G1, -4.08 ± 0.54 in G2, -5.81 ± 0.45 in G3 and -6.56 ± 0.50 nmol/ml in G4, while the MDA level in G1 was significantly different from other groups ($P=0.001$). The mean FBS level decreased 3.95 ± 0.68 in G1, -114.06 ± 3.11 in G2, -129.96 ± 4.23 in G3 and -136.78 ± 3.94 mg/dL in G4, whereas the FBS level of G1 was significantly different from other groups ($P=0.001$).

Conclusion: Our findings revealed that purple sweet potato jelly when consumed for 14 days could significantly decrease MDA and FBS levels in type 2 diabetes mellitus rat model. Therefore, purple sweet potato can be introduced in literature an alternative herbal medicine in treatment of type 2 diabetes mellitus.

*Corresponding author:

Titik Dwi Noviati,
Postgraduate of Nutrition Sciences,
Sebelas Maret University, Surakarta,
Indonesia.

Tel: +62-822-42045300

Email: Noviatitikdwi@gmail.com

Received: August 16, 2019

Revised: October 28, 2019

Accepted: November 3, 2019

Please cite this article as: Noviati TD, Tamtomo DG, Sugiarto S. The Effect of Purple Sweet Potato Jelly on Malondialdehyde and Fasting Blood Sugar in Experimental Type 2 Diabetic Rat Model. Int J Nutr Sci. 2019;4(4):181-185.

Introduction

Type 2 diabetes mellitus (T2DM) is a disease with a global prevalence of 80-90% among all diabetes mellitus sufferers (1). It may occur due to oxidative stress in pancreas, degeneration of beta cells in pancreas, decreased insulin secretion, and

increased insulin resistance (2-5). Oxidative stress is caused by formation of free radicals which may trigger beta cells dysfunction in pancreas, and consequently, increase fasting blood glucose (FBG) and complicate the risk factors (6, 7).

Furthermore, it can stimulate an increase in

corticosterone levels leading to a change in glucose and fat levels as energy reservoirs responding to stress, and accordingly, cause a decrease in weight (8). Malondialdehyde (MDA) is an indicator that can be used to determine lipid damages caused by oxidative stress. A retardation or reduction in oxidative process seems necessary to prevent or postpone complications related to diabetes (9, 10). The prevention can be achieved by increasing antioxidants in the body (11).

Several plants and herbals have been introduced in experimentally induced diabetes mellitus of animal models (12-15). One of the foods with antioxidant effects is purple sweet potato (*Ipomoea batatas L. Poir*) that contains anthocyanin responsible for its antioxidant effects at a dose of 110.5 mg/dl (16). A previous study indicated that purple sweet potato has high anthocyanin level and can decrease the blood glucose and malondialdehyde levels, and increase the whole blood total oxidant level leading to an improvement in beta cells of pancreas (17).

Anthocyanin in purple sweet potato can act as an antioxidant by reducing MDA level as an oxidative stress indicator, improving the superoxide dismutase (SOD) level and acting as a catalase and an antioxidant enzyme in diabetes mellitus. In addition to flavonoids, fibers in purple sweet potato have also hypoglycemic effect by delaying digestion and absorption of carbohydrates, increasing feeling of fullness, delaying gastric emptying, and decreasing α -amylase activities which accordingly retard glucose absorption (18). Seaweed *Gracilaria sp* is a food source containing high soluble fiber and is in jelly form which is used together with purple sweet potato modifying it to a jelly form (19). Therefore, this study was undertaken to determine the effect of purple sweet potato in jelly form on MDA and FBS levels in experimental T2DM model of rats is conducted.

Materials and Methods

In a randomized experimental study pre- and post-test control groups were employed to design the research. Twenty male Wistar rats (*Rattus norvegicus*) of 8-10 weeks old, and 150-250 g of weight were enrolled. The exclusion criteria were when the animals were sick and died during the treatment. The rats were collected and maintained in House of Experimental Rats of CFNS, Graduate School, Gajah Mada University of Yogyakarta, Indonesia. They were maintained in a cage made of stainless steel with the 20 cm length, 30 cm width, and 17 cm height. The standard food and the drink were available ad libitum. The room was managed by the temperature of 25-28°C, the light was set 12

hours of bright light and 12 hours of the dark one, and the humidity level was 70-75%.

The purple sweet potatoes were obtained from local farmers in Boyolali, Indonesia with the harvest age of 60 days and stored about 14 days. A plain jelly powder was added later to the sweet potatoes and were steamed and boiled for five minutes. The purple sweet potato jelly was made in three different forms to determine the effect of each formulation. In Jelly-A₁, the purple sweet potato was 100 g, Jelly powder was 3.5 g, and water was 450 mL. These figures for Jelly-A₂ were 200 g, 3.5 g and 300 mL and for Jelly-A₃ were 400 g, 3.5 g and 150 mL. The resulting jelly was then tested for anthocyanin content using pH differentiation method. It was also tested for crude fiber content using strong acids and strong bases hydrolysis method. The data obtained from the two tests were made as complementary data in finding out the influence of purple sweet potato on MDA level in T2DM rat model.

The T2DM model was induced by using streptozotocin (STZ) and nicotinamide (NA) (20). They were fasted for a night, and were then intraperitoneally injected using a single dose of nicotinamide (230 mg/kg) dissolved with normal saline solution. Fifteen minutes later, they received a single dose of STZ (65 mg/kg) dissolved in citrate buffer (pH=4.5) intraperitoneally. The 20 rats were divided into 4 treatment groups on the basis of simple random sampling, comprising a control group that was fed on standard diet and water ad libitum (G1), second group that received standard diet and water+Jelly A₁ ad libitum (G2), third group that was nourished with standard diet and water+Jelly A₂ ad libitum (G3), and the final and fourth group that was fed on standard diet and water+Jelly A₃ ad libitum (G4). Table 1 shows the different jelly components of each group (A₁-A₃). The jelly was administered once daily through a nasogastric tube (NGT) in the morning time. The rats were then investigated for MDA and FBS levels before (day 0) and after the intervention (day 14th).

The MDA levels were measured using thiobarbituric acid reactive substance (TBARS) method, and the FBS level was assessed by enzymatic colorimetric method (ECM). All stages of the research were approved by the Health Research Ethics Committee of Medical Faculty, Sebelas Maret University, Indonesia (no. 459/UN27.06/KEPK/2019). After the data were collected, the normality distribution of data was tested using Saphiro-Wilks test, their homogeneity via Levene's test, and the difference between the groups by Independent-sample t-test. All the data was analyzed by using the statistical package for the social sciences

Table 1: The malondialdehyde level before and after 14 day of intervention

Group	Day 0	Day 14	Δ MDA level (Mean±SD) (nmol/ml)
	(Mean±SD) (nmol/ml)	(Mean±SD) (nmol/ml)	
G1	9.27±0.31	9.55±0.29	0.28±0.84
G2	9.00±0.48	4.92±0.37	-4.08±0.54
G3	9.03±0.38	3.21±0.19	-5.81±0.45
G4	8.95±0.31	2.39±0.20	-6.56±0.50

Δ MDA: mean difference of malondialdehyde

software (SPSS, Version 21, Chicago, IL, USA). A p value less than 0.05 was considered statistically significant.

Results

We found that 100 g of A₁, A₂, and A₃ jelly formulation contained anthocyanin levels of 824.47 ppm, 2031.73 ppm and 2523.06 ppm respectively. Meanwhile, the fiber content in 100 g of A₁, A₂, and A₃ jelly were 0.42%, 0.69% and 1.00%, respectively. Regarding MDA level in T2DM rat model, after 14 days of intervention, the MDA level of the group treated by purple sweet potato jelly (G2, G3, and G4) significantly decreased. The decrease ranged from -4.08±0.54 nmol/ml in G2 to -6.56±0.50 nmol/ml in G4 (Table 1). The MDA level of G1 that received standard diet and water ad libitum illustrated an increase. The lowest mean of MDA level was observed in G4 (2.39±0.20 nmol/ml), while the highest one was noted in G1 (9.55±0.29

nmol/ml) (Table 1). The mean of MDA level in G1 was significantly different from other groups (P=0.001) (Table 2).

Fasting blood sugar (FBS) level in T2DM rat model after 14 days of purple sweet potato jelly administration significantly decreased in G2, G3, and G4. The decrease ranged from -14.06±3.11 mg/dL in G2 to -136.78±3.94 mg/dL in G4 (Table 3). The FBS level in G1 fed on standard and water ad libitum diet showed an increasing trend. The lowest mean for FBS level was noticed in G4 (124.69±1.96 mg/dL) and the highest in G1 (268.30±1.69 mg/dL). The change in the mean of FBS level in G1 was significantly different from other groups (P=0.001) (Table 4).

Discussion

T2DM is characterized by hyperglycemia as a result of degeneration in β cells of pancreatic tissue, and consequently, an insulin resistance (20-

Table 2: The comparison of the malondialdehyde level between groups

Group	Δ Malondialdehyde level (Mean±SD) (nmol/ml)		P value
	K1	K2	
G1:G2	0.28±0.84	-4.08±0.54	0.001*
G1:G3	0.28±0.84	-5.81±0.45	0.001*
G1:G4	0.28±0.84	-6.56±0.50	0.001*

Δ Malondialdehyde: mean difference of malondialdehyde, *P<0.05 (Independent t-test)

Table 3: The fasting blood sugar level before and after 14 days of intervention

Group	Day 0	Day 14	Δ FBS Level (Mean±SD) (mg/dL)
	(Mean±SD) (mg/dL)	(Mean±SD) (mg/dL)	
G1	264.35±1.36	268.30±1.69	3.95±0.68
G2	265.60±3.75	151.53±1.96	-114.06±3.11
G3	263.73±1.85	133.76±2.69	-129.96±4.23
G4	261.47±2.43	124.69±1.96	-136.78±3.94

Δ FBS: mean difference of fasting blood sugar

Table 4: The comparison of fasting blood sugar level between groups

Group	Δ Fasting blood sugar level (Mean±SD) (mg/dL)		P value
	G1	G2	
G1:G2	3.95±0.68	-114.06±3.11	0.001*
G1:G3	3.95±0.68	-129.96±4.23	0.001*
G1:G4	3.95±0.68	-136.78±3.94	0.001*

Δ fasting blood sugar: comparison mean difference of fasting blood sugar, *P<0.05 (Independent t-test)

22). Oxidative stress plays an important role in development of various complications in T2DM. A reduction in antioxidants was shown to affect the balance of free radicals (7). MDA is formed due to lipid peroxidation that can be measured to assess peroxidized lipids after reacting to thiobarbiturate acids (9). FBS assay can be beneficial to evaluate the effectiveness of a given intervention to control diabetes mellitus.

In our study, T2DM model was induced using STZ and NA and purple sweet potato jelly was applied as a source of high anthocyanin and fiber. The decrease in MDA and FBS levels after consumption of purple sweet potato occurred because of anthocyanin and fiber contents in purple sweet potato with antioxidant and hypoglycemic effects. Anthocyanin was shown to have a reactive nature to counteract free radicals revealing that the higher the anthocyanin content in the jelly, the greater the MDA level decrease in T2DM rats (23).

Therefore, in line with a previous research on use of ethanol extract of purple sweet potato (*Ipomoea Batatas L*) in rats at dose of 2 mL/day for a week was demonstrated to effectively decrease the blood glucose and MDA levels, and also the total antioxidant content (24). The anthocyanin content in purple sweet potato is responsible for protective effects of purple sweet potato in insulin resistance through oxidative stress and endoplasmic reticulum stress blocking system. So it was safely used for treatment of nonalcoholic fatty liver disease and diabetes (23).

Conclusion

Our findings revealed that purple sweet potato jelly when consumed for 14 days could significantly decrease MDA and FBS levels in type 2 diabetes mellitus rat model. Therefore, purple sweet potato can be introduced in literature as an alternative herbal medicine in treatment of type 2 diabetes mellitus.

Acknowledgement

We would like to show our gratitude to Sebelas Maret University for their kind support during this research. We are also immensely grateful to Mr. Yulianto, staff of the food laboratory and nutrition study center, Gadjah Mada University who helped with maintenance and testing of sample during this research.

Conflict of Interest

None declared.

References

- 1 Chen L, Magliano DJ, Zimmet PJ. Diabetes mellitus - present and future perspectives. *Nat Rev Endocrinol*. 2011;8:228-36. DOI:10.1038/nrendo.2011.183. PMID:22064493.
- 2 Bukhari SA, Waseem AS, Muhammad Zia-ul-haq, et al. Computer aided screening of secreted frizzled-related protein 4 (sfrp4): a potential control for diabetes mellitus. *Molecules*. 2014;19:10129-36. DOI:10.3390/molecules190710129. PMID:25019556.
- 3 Khanra R, Dewanjee S, Dua TK, et al. *Abroma Augusta L. (Malvaceae)* Leaf Extract Attenuates Diabetes Induced Nephropathy and Cardiomyopathy via Inhibition of Oxidative Stress and Inflammatory Response. *J Transl Med*. 2015;13:6. DOI:10.1186/s12967-014-0364-1. PMID:25591455.
- 4 Sultan MT, Butt MS, Karim R, et al. Effect of *Nigella Sativa* Fixed and Essential Oils on Antioxidant Status, Hepatic Enzymes and Immunity in Streptozotocin Induced Diabetes Mellitus. *BMC Complement Altern Med*. 2014;14:193. DOI:10.1186/1472-6882-14-193. PMID:24939518.
- 5 Zia-ul-Haq M, Ahmad S, Bukhari SZ, et al. Compositional Studies and Biological Activities of Some Mash Bean (*Vigna Mungo (L.) Hepper*) Cultivars Commonly Consumed in Pakistan. *Biol Res*. 2014;47:23. DOI:10.1186/0717-6287-47-23. PMID:25028256.
- 6 Kangralkar VA, Shivraj D, Patil R, et al. Oxidative Stress and Diabetes: An Overview. *Asian J Pharmaceut Clin Res*. 2015;1:38-45.
- 7 Giacco F, Brownlee M. Oxidative stress and diabetic complications. *Circ Res*. 2010;107:1058-70. DOI:10.1161/CIRCRESAHA.110.223545. PMID:21030723.
- 8 Fernandes SM, Cordeiro PM, Watanabe M, et al. The Role of Oxidative Stress in Streptozotocin-Induced Diabetic Nephropathy in Rats. *Arch Endocrinol Metab*. 2016;60:443-9. DOI:10.1590/2359-3997000000188. PMID:27812607.
- 9 Tiwari BK, Pandey KB, Abidi AB, et al. Markers of Oxidative Stress during Diabetes Mellitus. *J Biomark*. 2013;2013:378790. DOI:10.1155/2013/378790. PMID:26317014.
- 10 Asmat U, Khan A, Khan I. Diabetes Mellitus and Oxidative Stress-A Concise Review. *Saudi Pharm J*. 2016;24:547-53. DOI:10.1016/j.jsps.2015.03.013. PMID:27752226.
- 11 Feshani AM, Kouhsari SM, Mohammadi S. *Vaccinium Arctostaphylos*, a Common Herbal Medicine in Iran: Molecular and Biochemical Study of Its Antidiabetic Effects on Alloxan-Diabetic Wistar Rats. *J Ethnopharmacol*.

- 2011;133:67-74. DOI:10.1016/j.jep.2010.09.002. PMID:20850514.
- 12 Hosseini SE, Mehrabani D, Rezaei E. Effects of pomegranate juice on liver enzymes (ALT, ALP, AST) in diabetic and non-diabetic rats. *J Anim Physiol Develop.* 2014;24:59-64.
 - 13 Hosseini SE, Mehrabani D, Ghaedi HR. The effect of pomegranate juice on hemogram and weight profile in streptozotocin-induced diabetic adult male rats. *Damghan J Zool.* 2013;6:1-8.
 - 14 Hosseini SE, Rezaei E, Mehrabani D, et al. Effect of pomegranate juice on lipid profile in streptozotocin-induced diabetic adult male rats. *J Exp Anim Biol.* 2013;2:13-20.
 - 15 Rezaei E, Hosseini SE, Mehrabani D. Effects of pomegranate juice on insulin and glucose in diabetic and non-diabetic male rats. *Birjand J Univ Med Sci.* 2013;20:1-8.
 - 16 Hendarto L, Siregar M. Pemanfaatan Ubi Jalar Ungu (*Ipomea Batatas L.Poir*) Sebagai Pengganti Sebagian Tepung Terigu Dan Sumber Antioksidan Pada Roti Tawar. *Hasil Penelitian J Teknol dan Industri Pangan.* 2010;21.
 - 17 Jawi IM, Sutirta Yasa IWP, Suprpta DN, et al. Hypoglycemic and Antioxidant Activities of Balinese Purple Sweet Potato (*Ipomoea Batatas L*) in Induced- Diabetic Rats. *CIB Tech J Pharm Sci.* 2012;1:1-6.
 - 18 Post RE, Arch GM, Dana EK, et al. Dietary Fiber for the Treatment of Type 2 Diabetes Mellitus : A Meta-Analysis. *J Am Board Fam Med.* 2012;25:16-23. DOI:10.3122/jabfm.2012.01.110148. PMID:22218620.
 - 19 Harismah K, Hidayati N, Latfah ATW, et al. Pembuatan Kudapan Fungsional Agar-Agar Ubi Jalar dengan Substitusi Pemanis Alami Daun Stevia (*Stevia Rebaudiana*). *Simposium Nasional Teknologi Terapan.* 2015.
 - 20 Ghasemi A, Khalifi S, Jedi S. Streptozotocin-Nicotinamide Induce rat Model Of type 2 Diabetes. *Acta Physiol Hung.* 2014;101:408-20. DOI:10.1556/APhysiol.101.2014.4.2. PMID:25532953.
 - 21 Ismawanti Z, Suparyatmo JB, Wiboworini B. The effects of papaya fruit as anti-diabetes: A review. *Int J Nutr Sci.* 2019;4:65-70. DOI:10.30476/IJNS.2019.81751.1013.
 - 22 Shahriari S, Hejazi N, Eftekhari MH. The Role of Camel Milk in Treatment of Type 2 Diabetes: A Review. *Int J Nutr Sci.* 2018;3:120-6.
 - 23 Zhang ZF, Lu J, Zheng YL, et al. Purple Sweet Potato Color Attenuates Hepatic Insulin Resistance via Blocking Oxidative Stress and Endoplasmic Reticulum Stress in High-Fat-Diet-Treated Mice. *J Nutr Biochem.* 2013;24:1008-18. DOI:10.1016/j.jnutbio.2012.07.009. PMID:22995384.
 - 24 Sutirta Yasa IWPS, Jawi IM, Mahendra AN. Ethanol Extract of Purple Sweet Potato Tubers (*Ipomoea batatas L*) Decreases Blood Glucose and Increase Total Antioxidant Level in Rats with High Glucose Intake. *J US-China Med Sci.* 2013;10:52-56.