

The Pharmacological Mechanisms of Anthocyanin in Aqueous Extract of Purple Sweet Potato as Antihyperglycemic Herbal Remedy

I Made Jawi¹

¹ Udayana University

Received: 6 December 2015 Accepted: 1 January 2016 Published: 15 January 2016

Abstract

Aims/hypothesis: The aqueous extracts of purple sweet potatoes contained highly anthocyanin and has a hypoglycemic effect and prevent oxidative stress. The pharmacological mechanisms of this anthocyanin is not clear. The antioxidant effect of anthocyanin is proposed could protect the oxidative stress of pancreatic β -cell and recovery their function. **Methods:** The fifteen Wistar-rats were randomly assigned into three groups, each group consist of 5 rats. Two groups were diabetic induced by injection of streptozotocin and one was control group. One of diabetic induced group was administrated orally aqueous extract of purple sweet potato tuber at the dose of 4 mL/day for 2 weeks along before induced streptozotocin and while the observation time. The body weigh, blood glucose level and number pancreatic β -cell of rats were determinate. **Results:** The injection of streptozotocin afforded a damaging of pancreatic β -cell of rats from 50 to 14.8 cells / 5 field views and introduced hyperglycemic rats. The blood glucose levels of this diabetic rat were ranged between (200 -600) mg/dL in average 422 mg/dL. The aqueous the purple sweet potato extract prevented this pancreatic β -cell damaging and decreased the blood glucose level into the normal level.

Index terms— purple sweet potato, pancreatic β -cell, diabetic rat.

1 I. Introduction

he diabetes mellitus (DM) is a chronic disease, which need lifelong therapy. Herbal remedies are most popular choice for this condition. Purple sweet potatoes (*Ipomoea batata* L) tuber is an interlude snacks for Balinese people. The aqueous extracts of purple sweet potatoes, which are ingested into rats, introduced a hypoglycemic effect and prevent oxidative stress [1]. This extract could reduce a blood glucose level on rats, which were administrated high dose glucose [2]. The antioxidant agents of this potatoes increased antioxidant enzymes, which is superoxide dismutase (SOD) [3]. The pharmacological mechanism of this hypoglycemic effect is still studied. One of the proposed mechanisms is a protection of pancreatic β cells by the antioxidant agents of this sweet potato.

The consequence of hyperglycemia on DM patients is a vulnerable pancreatic β -cells to the reactive oxidative stress (ROS). In this condition, the β cells are not able to compensate the insulin resistance. The hyperglycemia can be a trigger for the free radical production [4]. This state can also lead to glycation reactions, which could be increase, the β -cell apoptosis [5], and also lower levels of antioxidant enzymes in pancreatic tissue such as: catalase, SOD and glutathione peroxidase [6]. This condition introduces the β -cell dysfunction.

On in vitro and in vivo studies were reported that the acetylated anthocyanins in purple sweet potato tubers are the potential antioxidant agent to overcome ROS reaction (7)(8)(9)(10). The aqueous extract of purple sweet potatoes, which were harvested in Bali, contained relatively high anthocyanin [11] and evinced a as prevent

3 III. RESULTS

oxidative stress and anti-hyperglycemic effect [1,10]. The aim of this study was to describe the mechanism of the acetylated anthocyanins in purple sweet potato tubers to prevent the ROS on pancreatic β -cells of hyperglycemia rats.

2 II. Materials and Methods

Materials: The male Wistar rats obtained from animal house facility of Pharmacology Laboratory, Medicine Faculty, Udayana University, Denpasar-Bali-Indonesia, streptozotocin (Sigma, St. Louis, Mo, USA), animal laboratory, citrate buffer (pH 4.5), sweet potato tubers from Balinese farmers, 5% glucose solution, formalin, ethanol, xylene, aldehyde, phosphate buffered (the chemicals were analysis grade from Merck, Germany), distilled water, commercial pellet diet.

Intruments: Histoplast (Thermo Scientific, UK), microtome Leica 820 (Germany), Gomori's Aldehyde Fuschine stain and counterstaining with Nuclear Fast Red. Briefly (Sigma-Aldrich, USA), blood glucose level control (Roche, Germany), Olympus CX41 Microscope and Optilab camera (Optilab, Indonesia) for five Aqueous Extract of Purple Sweet potato: The washed and peeled purple sweet potato tubers from Balinese farmers were trimmed into cubical a form 2.0-2.5 cm³. One kg of these cubical forms was mixed with 1 liter water and then was blended. This doughy was filtered through three layers of gauze. The filtered aqueous extract was boiled up for 30 minutes. The extract was keep sterile till the administration. . The male Wistar rats: The study was proved and allowed by the ethic commission of Medicine Faculty -Udayana University on number:792/UN.14.2/Litbang 2012. The 15 male Wistar rats were 3-4 months, 175-225 g weigh. They lived under standard laboratory conditions at 25 $\pm$ 2°C, relative humidity (50 $\pm$ 15%) and normal photoperiod (12-hour light-dark cycle). Commercial pellet diet and water were provided ad libitum. The rats were divided into 3 groups and each consisted of 5 rats. Group 1 was a diabetic group, which's induced by intraperitoneal injection single dose of 40 mg/kg streptozotocine in freshly dissolved of citrate buffer (pH 4.5). After injection, the rats had free access on food and water and were administrated 5% glucose solution to drink overnight to counter hypoglycaemic shock. Group 2 was the treated group. The rats on this group were administrated orally aqueous extract of purple sweet potato tuber at the dose of 4 ml/day for 2 weeks along, before intraperitoneal injection single dose of streptozotocin. The administration of aqueous extract of purple sweet potato tuber was continued till 60 days after diabetic induced. Group 3 was a control group, which were administrated a placebo (citrate buffer injection) and normal diet. This study was conducted on randomized control group post-test design.

Blood glucose levels: The blood samples were collected from the retro-orbitalis sinus and the blood glucose level was determinated by orthotoluidine method. The blood glucose levels were controlled in every week of treatment.

Pancreatic β -cell Examination: This test was done at histology labor of medicine faculty of Udayana University, Denpasar, Bali, Indonesia. After the treatment all rats were sacrificed and the pancreas was immediately removed for the examination of β -cell structure. The removed pancreas were immersed in phosphate buffered-formalin 10% for 24 hours, after that dehydrated using serial ethanol 50%, 70%, 80%, 95%, 100% for 2 hours each phase respectively. The Clearing was done using xylene two times for 1 hour respectively. Embedding was done using Histoplast (Thermo Scientific, UK) at 60°C two times for 30 minutes respectively and finally blocking was done. The specimen was trimmed using rotary microtome Leica 820 for 5 μ m sections and mount on glass microscope slide. Staining for β -cells was done by Gomori's Aldehyde Fuschine stain and counterstaining with Nuclear Fast Red. Briefly, the paraffin section were rehydrated by using xylene two times for 5 minutes each phase, 100% ethanol one times for 2 minutes, 95% ethanol two times for 2 minutes each phase, 70% ethanol for 2 minutes and distilled water for 2 minutes. Immerse slide in filtered aldehyde fuschin stain for 10 minutes and wash in 95% ethanol two times for 30 seconds -1 minute each phase. Wash slide again briefly in 70% ethanol and distilled water. Immerse slide in Nuclear Fast Red for 5 minutes then washed with distilled water. Dehydrated the slide by immersing in 70% ethanol 20 seconds, 95% ethanol two times each phase 20 seconds, 100% ethanol 20 seconds, xylene two times each phase 2 minutes. Coverslips were mounted on sections using xylene-based mounting medium (DPX). Cells with pink nucleus and purple granules in their cytoplasm are pancreatic β -cells. Photomicrograph was done using Olympus CX41 Microscope and Optilab camera (Optilab, Indonesia) for five Langerhans Island each slide at 400X-600X magnification. Quantification was done by ImageRaster software (Optilab, Indonesia).

Statistical analysis: Statistical analysis was carried out using SPSS for Window 15.0. All data were expressed as mean $\pm$ SD. Groups of data were compared with one way ANOVA. Values were considered statistically significant, when $p < 0.05$.

3 III. Results

The body weight of rats before treatment was statistically similar ($p > 0.05$). The body weight outgrowth of rats along observation is presented on Fig. 1. The diabetic group rats were losing their body weight significantly compared to other groups ($p < 0.05$). The blood glucose levels of rats before treatment were ranged 115-117 mg/dl. These outgrowth levels are presented on Fig. ???. The blood glucose levels of diabetic group were ranged between (200 -600) mg/dl with average 422 mg/dl, between (102 -361) mg/dl with average 152 mg / dl for administrated aqueous purple sweet potato extract group, and between (113 -118) mg/dl with average 116 mg/dl

for control group, respectively. The blood glucose levels of diabetic group were significantly higher than other groups. The treatment group was presented a significantly lower blood glucose levels than diabetic group ($p < 0.5$).

4 Volume XVI Issue II Version I

5 Figure 2 : The outgrowth of blood glucose level during observation

The figure ?? shows the number of pancreatic β -cells of rats after 60 days blood glucose level observation time. The pancreatic histological pictures of all rat-groups are presented in figure ???. The average of β -cell was 50 ± 2.5 cells/5 fields-views for control group, 40 ± 2 cells/5 fields-views for treatment group, and 14.8 ± 0.8 cells/5 fields-views for diabetic group, respectively. The amount of pancreatic β -cells of rats in diabetic group was lowest than other groups and significantly difference ($p < 0.5$).

6 IV. Discussion

The induction of intraperitoneal streptozotocin could decrease the amount of pancreatic β -cells and increase the blood glucose level of rats significantly ($p < 0.5$), which are compared to the control group. Administration of streptozotocin induced an oxidative stress in the pancreatic tissue, which due to increased formation of free radical [12]. The streptozotocin was reported has a diabetogenic effect in rats by cytotoxic action on the pancreatic β -cells and increasing free radical generation in pancreatic tissue [13].

The administration of aqueous extract of purple sweet potato tuber before and after induced streptozotocin presented the protection of ROS in pancreatic tissue of rats. The purple sweet potato tuber from Balinese farmers was reported containing a high anthocyanins [11] and has well anti oxidant activity [3]. The protective of ROS on rats-treatment group could due to the contained anthocyanins in aqueous extract of purple sweet potato tuber. The anthocyanin has reported, has ability to prevent apoptosis induced by streptozotocin on pancreatic cells through regulation of caspase-3, Bax, and Bcl-2 proteins [14]. Based on this study, we concluded that the contained anthocyanins on purple sweet potato from Balinese farmers could be covered for ROS after induced streptozotocin in pancreatic β -cells in rats.

The anthocyanin could regulate the blood glucose level by inhibit the alpha-glucosidase [15] and could also increase the phosphorylation of insulin receptor [14]. These effects could prevent the increasing of blood glucose after meal and increase the concerting the blood glucose into glycogen. The administration of the ethanol extract of purple sweet potato tuber from Balinese farmers could maintain the blood glucose level of mice after administrated a high doses glucose load [2]. The high blood glucose level increased intracellular peroxide levels in the pancreatic β -cell, this also will be introduced the intensive ROS in the pancreatic tissue [16]. The study presented, that the blood glucose level of treatment rats group increased to maximum at the first week after induced streptozotocin then decreased along observation time to normal level after the continuing administration of the aqueous extract of purple sweet potato. The study showed that the administration of aqueous extract of purple sweet potato on this study could reduce the blood glucose level into a normal level. The effects of anthocyanin in this potato on damaging protection of pancreatic β -cells, inhibiting the alpha-glucosidase and induction of converting blood glucose into glycogen were the proposed pharmacological mechanisms to the observed outgrowth blood glucose level in the treatment rats group. The anthocyanin is an important part of the human diet, which can be highly found in purple sweet potato. This potato can be used as herbal medicine for against ROS-induced degenerative diseases.

7 Volume XVI Issue II Version I

8 V. Conclusion

The acetylated anthocyanin on purple sweet potato tuber cloud protect the damaging the pancreatic β -cells by induced streptozotocin and reduced the blood glucose into the normal level.

9 Volume XVI Issue II Version I

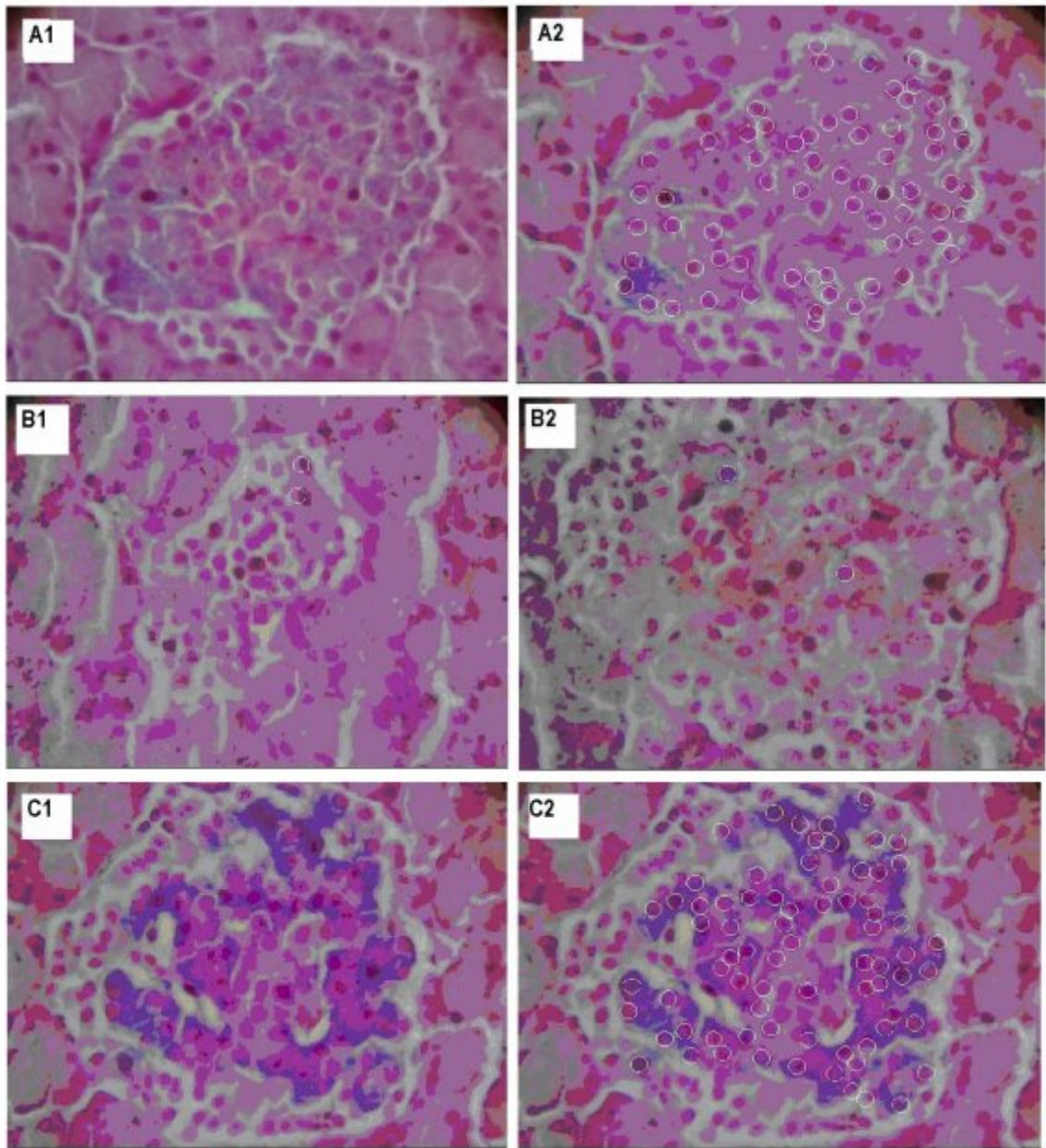
1 2

¹© 2016 Global Journals Inc. (US)

²© 2016 Global Journals Inc. (US)The Pharmacological Mechanisms of Anthocyanin in Aqueous Extract of Purple Sweet Potato as Antihyperglycemic Herbal Remedy



Figure 1: T



1

Figure 2: Figure 1 :

-
- [CIBTech J Pharmaceutical Sciences] , *CIBTech J Pharmaceutical Sciences* 1 (2-3) p. .
- [Tanaka et al. ()] 'A role for glutathione peroxidase in protecting pancreatic β cells against oxidative stress in a model of glucose toxicity'. Y Tanaka , P O T Tran , J Harmon , Robertson R P . *PNAS* 2002. 19. 99 p. .
- [Srinivasan ()] 'Animal models in type 2 diabetes research: an overview'. Ramarao Srinivasan . *Indian J Med Res* 2007. 125 (3) p. .
- [Ghosh and Konishi ()] 'Anthocyanins and anthocyanin-rich extracts: role in diabetes and eye function'. D Ghosh , T Konishi . *Asia Pac J Clin Nutr* 2007. 16 (2) p. .
- [Shi et al. ()] 'Antihypertriglyceridemia and Anti-Inflammatory Activities of Monascus-Fermented Dioscorea in Streptozotocin-Induced Diabetic Rats'. Y C Shi , J Liao , T M W And Pan . *Exp Diabetes Res* 2011. 2011. p. 710635.
- [Kano et al. ()] 'Antioxidative activity of anthocyanins from purple sweet potato, *Ipomoea batatas* cultivar ayamurasaki'. M Kano , T Takayanagi , K Harada , K Makino , F Ishikawa . *Biosci Biotechnol Biochem* 2005. 69 (5) p. .
- [Lachman et al. ()] 'Cultivar differences of total anthocyanins and anthocyanidins in red and purple-fleshed potatoes and their relation to antioxidant activity'. J Lachman , K Hamouz , M Sulc , M Orsak , V Pivec , A Hejtmankova , P Dvorak . *Food Chemistry* 2009. 144 p. .
- [Jawi and Budiasa ()] 'Ekstrak air umbi ubijalar ungu menurunkan total kolesterol serta meningkatkan total antioksidan pada darah kelinci'. I M Jawi , K Budiasa . *J Veteriner Jurnal Kedokteran Hewan Indonesia* 2011. 12 (2) p. .
- [Sutirta-Yasa I W P et al. ()] 'Ethanol extract of purple sweet potato tubers (*Ipomoea batatas* L) decreases blood glucose and increase total antioxidant level in rats with high glucose intake'. Sutirta-Yasa I W P , I M Jawi , A Mahendra . *J of US-China Medical Science* 2013. 10 (90) p. .
- [Jawi et al. ()] I M Jawi , Sutirta-Yasa I W P , D N Suprpta , A Mahendra . *Hypoglycemic and antioxidant activities of Balinese purple sweet potato (*Ipomoea batatas* L) in induced-diabetic rats*, 2012.
- [Suprpta et al. ()] 'Kajian aspek pembibitan, budidaya dan pemanfaatan umbi-umbian sebagai sumber pangan alternatif'. D N Suprpta , M Antara , N Arya , M Sudana , A S Danuaji , M Sudarma . *Laporan Hasil Penelitian. Kerjasama BAPEDA Propinsi Bali dengan Fakultas Pertanian UNUD* 2004. (unpublish)
- [Jiao et al. ()] 'Studies on antioxidant capacity of anthocyanin extract from purple sweet potato (*Ipomoea batatas* L)'. Y Jiao , Y Jiang , W Zhai , YangZ . *African J of Biotechnology* 2012. 11 (27) p. .
- [Nizamutdinova et al. ()] 'The anti-diabetic effect of anthocyanins in streptozotocin-induced diabetic rats through glucose transporter 4 regulation and prevention of insulin resistance and pancreatic apoptosis'. I T Nizamutdinova , Y C Jin , J I Chung , S C Shin , S J Lee , H G Seo , J H Lee , K C Chang , Kim H J . *Mol Nutr Food Res* 2009. 53 (11) p. .
- [Ahren ()] 'Type 2 diabetes, insulin secretion and β -cell mass'. B Ahren . *Current Molecular Med* 2005. 89 p. .
- [Evans et al. ()] 'Type 2 diabetes, insulin secretion and β -cell mass'. J L Evans , I D Goldfine , B A Maddux , M P Grodsky . *Current Molecular Medicine* 2003. 89 p. .
- [Jawi et al. ()] 'Ubi jalar ungu menurunkan kadar MDA dalam darah dan hati mencit setelah aktivitas fisik maksimal'. I M Jawi , D N Suprpta , S U Dwi , I Wiwiek . *J Veteriner Jurnal Kedokteran Hewan Indonesia* 2008. 9 (2) p. .
- [Gao and Mann ()] 'vascular nad (p)h oxidase activation in diabetes; a double-edge sword in redox signaling'. L Gao , G E Mann . *Cardiovascular Research* 2009. 82 p. .