In vitro α-glucosidase inhibitory activity of Monascus-fermented durian seed extracts

by Ignatius Srianta

International Food Research Journal 20(2): 533-536 (2013)
Journal homepage: *http://www.ifrj.upm.edu.my*

In vitro α-glucosidase inhibitory activity of *Monascus*-fermented durian seed extracts

[1,2*]Srianta, I., [2]Kusumawati, N., [2]Nugerahani, I., [3]Artanti, N. and [4]Xu, G.R.

[1]*Center for Food and Nutrition Research, Widya Mandala Catholic University Surabaya, Jalan Dinoyo 42-44 Surabaya 60625, Indonesia*
[2]*Department of Food Technology, Widya Mandala Surabaya Catholic University, Jalan Dinoyo 42-44 Surabaya 60625, Indonesia*
[3]*Research Center for Chemistry, Indonesian Institute of Science, Kawasan PUSPIPTEK Serpong 15314, Indonesia*
[4]*School of Biotechnology, Jiangnan University, 1800, Li Hu Road, Wuxi, 214122, Jiangsu Province, China*

Article history

Received: 2 November 2012
Received in revised form: 7 Disember 2012
Accepted: 9 Disember 2012

Keywords

α-glucosidase inhibition activity
durian seed
Monascus
total phenol

Abstract

Study on the *in vitro* α-glucosidase inhibitory activity of *Monascus*-fermented durian seed extracts was carried out by inoculating the spore suspension of *Monascus* sp. KJR2 into boiled durian seed cuts and then incubated at room temperature for 14 days. The durian seed (DS) and powdered *Monascus*-fermented durian seed (MFDS) were extracted with distilled water and ethanol. The extracts were analyzed for the *in vitro* α-glucosidase inhibition activity and total phenol content. The results show that DS and MFDS ethanolic extracts have α-glucosidase inhibitory activity with IC_{50} of 199.1µg/mL and 70.7µg/mL, respectively. Water extract of DS and MFDS have low α-glucosidase inhibitory activity (<10%). The total phenol contents of MFDS extracts were higher than that of DS extracts. MFDS is potential for diabetes mellitus management.

Introduction

Traditionally, angkak is produced by solid state fermentation with *Monascus* sp. on rice as the substrate. Many studies showed that it grows on a wide variety of natural substrates i.e. corn, cassava, wheat, potato and adlay (Yongsmith *et al.*, 1998; Ganrong *et al.*, 1998; Carvalho *et al.*, 2007; Pattanagul *et al.*, 2008), and various agro-industrial residues i.e. rice bran, wheat bran, cassava bagasse, jack fruit seed and durian seed (Dufosse *et al.*, 2005; Babitha *et al.*, 2006; Srianta *et al.*, 2012a; 2012b). Researchers worldwide focus their attention on the health effects, such as for antidiabetes, anticancer, antiobesity and stimulating bone formation. The frequency of diabetes in the world population is high and still increasing. In the course of the metabolic disorder, the concentrations of blood glucose frequently differ from normal especially after food intake. A reasonable way to control the carbohydrate-dependent disease would be to limit intestinal carbohydrate digestion. α-glucosidase is the enzyme that catalyzes the cleavage of glycosidic bonds in oligosaccharides. Compound that can inhibit the activity of this enzyme is considered having antidiabetes activity because it could help preventing postprandial hyperglycemia by decreasing the rate of carbohydrate degradation to glucose (Kim *et al.*, 2004). Some researchers showed that *Monascus*-fermented products have great potential as antidiabetes (Chen and Liu, 2006; Chang *et al.*, 2006; Shi and Pan, 2012).

Shi and Pan (2010) reported that different types of *Monascus*-fermented products (*Monascus*-fermented rice, *Monascus*-fermented adlay and Monascus-fermented dioscorea) reduced the blood glucose levels in diabetic rats. Some researchers reported that phenolic content of the *Monascus*-fermented products are higher than that of unfermented materials (Tseng *et al.*, 2006; Lee *et al.*, 2009; Shi *et al.*, 2011). On the other hand, many researchers showed that α-glucosidase inhibitory activity have positive correlation to their phenolic content (Yoshikawa *et al.*, 2001; McDougall *et al.*, 2005; Mai *et al.*, 2007; Ramkumar *et al.*, 2010; Adefegha and Oboh, 2012). The aim of this research was to study the potency of *Monascus*-fermented durian seed on *in vitro*

*Corresponding author.
Email: *srianta_wm@yahoo.com*

α-glucosidase inhibitory activity.

Materials and Methods

Materials

Durian seeds were obtained from local durian seller. Durian seeds were stored in a freezer (-4oC) until used. *Monascus* sp. KJR2 was obtained from Center for Food and Nutrition Research, Widya Mandala Surabaya Catholic University. It was maintained on Saboraud's Dextrose Agar (SDA) slant, preserved at 4°C and subcultured monthly. After *Monascus* sp. KJR2 was grown on SDA slants at room temperature (30°C) under static conditions for 14 days, 10 mL of sterile distilled water was added and the spores were scraped under aseptic conditions. 0.1 mL of the spore suspension was inoculated into Saboraud's Dextrose Broth (SDB) and then was incubated at room temperature (30°C) for 10 days. It was used as starter to produce *Monascus*-fermented durian seed.

Monascus-fermented durian seeds production

Durian seeds were boiled in a $CaCO_3$ solution of 5% w/v for 10 min to remove the mucus. After the seed coat were peeled off, the seeds were cut into small size of 0.3 cm x 0.3 cm x 0.5 cm. A 50 g of small cut durian seed was transferred into 300 mL flask, mixed thoroughly, autoclaved at 121oC for 15 min, then left to cool to room temperature, inoculated with the spore suspension of *Monascus* sp. KJR2 and incubated at room temperature (30°C) for 14 days in static conditions (with manual shaking daily). *Monascus*-fermented durian seed were dried in an oven at 45°C for 24 hours, ground and analyzed for *in vitro* α-glucosidase inhibition activity.

Preparation of water and ethanolic extracts

One g of *Monascus*-fermented durian seed (MFDS) and durian seed (DS, as a control) were transferred into a 250-mL conical flask and mixed with distilled water or 70% ethanol at a ratio of 5 mL of solvent per gram of fermented matter. The content was mixed by shaking at 2 rpm for 1 hour, left to stand for 15 min, and then filtered through Whatman No 1 filter paper. The filtrate was dried at 45°C and then used for in vitro α-glucosidase inhibitor activity assay.

In vitro α-glucosidase inhibitor activity assay

The α-glucosidase inhibitory assay was conducted according to Artanti *et al.* (2012). Sample (0.1 ml) was added to a test tube containing 0.1 ml of 20 mM pNPG (p-Nitrophenyl α-D-glucopyranoside) and 2.2 ml of 100 mM phosphate buffer at pH 7.0, and then incubated for 5 mins at 37°C. The reaction was initiated by addition of 0.1 ml of enzyme solution (1mg/0.1ml) followed by 15 min incubation at 37°C. The reaction was stopped by addition of 2.5 ml of 200 mM Na_2CO_3. The absorbance of p-nitrophenol released from PNPG at 400 nm was measured with a spectrophotometer. Percentage of inhibition on the α-glucosidase activity was calculated by the equation: [1 - (B/A)] x 100%; whereas A is absorbance in the absence of sample and B is absorbance in the presence of sample. IC_{50} value is denotes the concentration of sample required to inhibit 50% α-glucosidase activity.

Determination of total phenol content

Total phenol was determined according to Gupta and Prakash (2009). by using folin-ciocalteau (analytical grade, Merck) reaction in basic condition and the absorbance measured spectrophotometrically at 765 nm. Gallic acid was used as a reference. Total phenol content of the extract was expressed as µg Gallic Acid Equivalent (GAE)/mL.

Results and Discussion

Table 1 show the α-glucosidase inhibition activity of durian seed and *Monascus*-fermented durian seed. Water extract of DS and MFDS have low α-glucosidase inhibition activity, less than 10%. IC50 of both water extracts were not detected. Different results were found on ethanolic extracts. Ethanolic extracts of DS and MFDS have high α-glucosidase inhibition activity with IC_{50} of 70.7 µg /mL and 199.1 µg /mL, respectively. Elsewhere, other researchers have also reported on the α-glucosidase inhibition activity of ethanolic extract obtained from the of *Barringtonia racemosa* Roxb. and *Paeonia lactiflora*, *Syzygium cumini* (Linn.) (Gowri *et al.*, 2007; Choi *et al.*, 2009; Kumar *et al.*, 2012). The α-glucosidase inhibition activity of ethanolic extract of DS reflected that naturally durian seed contain substances with inhibition activity. Higher α-glucosidase inhibition activity of ethanolic extract of MFDS reflected that during fermentation, the Monascus produce metabolites, which could increase the α-glucosidase inhibition activity.

Table 2 shows the total phenol contents of DS and MFDS extracts. This finding was similar to results reported for other *Monascus*-fermented products (Tseng *et al.*, 2006; Lee *et al.*, 2009; Shi *et al.*, 2011). Shi and Pan (2011) found that phenolic compounds in *Monascus*-fermented dioscorea are gallic acid, vanillic acid, caffeic acid, epicatechin and coumaric. Enhancement of total phenolic soluble in ethanol was higher than that of soluble in water. The phenolic

Table 1. α-glucosidase inhibition activity of durian seed and *Monascus*-fermented durian seed extracts

Extract	Concentration (µg/mL)	% Inhibition	IC_{50} (µg/mL)
DS water extract	50	5.9	n.d.
	100	6.9	
	150	6.7	
MFDS water extract	50	9.7	n.d.
	100	8.1	
	150	9.2	
DS ethanolic extract	50	27.1	199.1
	100	36.7	
	150	46.2	
MFDS ethanolic extract	50	35.3	70.7
	100	65.3	
	150	80.7	

IC_{50} = concentration of extract with 50% of α-glucosidase inhibitory activity
Note: n.d. = not determined

Table 2. Total phenol contents of durian seed and *Monascus*-fermented durian seed extracts

Extract	Total phenol content (µg GAE/mL)		Enhancement (µg GAE/mL)
	DS	MFDS	
Waterextract	325.8	589.8	264.0
Ethanolicextract	132.0	473.3	341.3

soluble in ethanol produced during fermentation possibly contribute to the α-glucosidase inhibition activity.

Conclusions

DS and MFDS ethanolic extracts have higher α-glucosidase inhibition activity than that of water extracts. DS and MFDS ethanolic extracts have α-glucosidase inhibition activity with IC_{50} of 199.1µg/mL and 70.7 µg/mL, respectively. Hence, MFDS has potential for application in diabetes mellitus management.

Acknowledgement

Thanks to Kopertis VII and Directorate General of Higher Education, Ministry of National Education, Republic of Indonesia for the financial support through competitive research Penelitian Hibah Bersaing with contract number of 0006/SP2H/PP/K7/KL/II/2012.

References

Adefegha, S.A. and Oboh, G. 2012. *In vitro* inhibition activity of polyphenol-rich extracts from *Syzygium aromaticum* (L.) Merr. and *Perry* (Clove) buds against carbohydrate hydrolyzing enzymes linked to type 2 diabetes and Fe^{2+}-induced lipid peroxidation in rat pancreas. Asian Pacific Journal of Tropical Biomedicine 774-781.

Artanti, N., Firmansyah, T. and Darmawan, A. 2012. Bioactivities Evaluation of Indonesian Mistletoes (*Dendrophthoe pentandra* (L.) *Miq*.) Leaves Extracts. Journal of Applied Pharmaceutical Science 2 (01): 24-27.

Babitha, S., Soccol, C.R. and Pandey, A. 2007. Solid-state fermentation for the production of *Monascus* pigments from jackfruit seed. Bioresource Technology 98(8): 1554-1560.

Carvalho, J.C., Oishi, B.O., Woiciechowski, A.L., Pandey, A., Babitha, S. and Soccol, C.R. 2007. Effect of substrates on the production of *Monascus* biopigments by solid-state fermentation and pigment extraction using different solvents. Indian Journal of Biotechnology 6: 194-199.

Chang, J.C., Wu, M.C., Liu, I.M. and Cheng, J.T. 2006 Plasma glucoselowering action of Hon-Chi in streptozotocin-induced diabetic rats. Hormone and Metabolic Research 38:76–81.

Chen, C. C. and Liu, I.M. 2006. Release of acetylcholine by Hon-Chi to raise insulin secretion in Wistar rats. Neuroscience Letters 404: 117–121

Choi, C.W., Yeon Hee Choi, Y.H., Cha, M.R., Park, J.H., Kim, Y.S., Kim, Y.K., Choi, S.U., Yon, G.H., Hong, K.S., Kim, Y.H. and Ryu, S.Y. 2009. α-Glucosidase Inhibitiors from Seed Extract of Paeonia lactiflora. Journal of the Korean Society for Applied Biological Chemistry 52(6): 638-642.

Dufosse, L., Galaup, P., Yaron, A., Arad, S.M., Blanc, P., Murthy, K.N.C. and Ravishankar, G.A. 2005. Microorganisms and microalgae as sources of pigments for food use: a scientific oddity or an industrial reality? Trends in Food Science and Technology 16: 389–406.

Ganrong, X., Yue, C., Yun, C., Xiaorong, L. and Xing, L. 2005. Production of monacolin K in solid-state fermentation of Monascus sp. 9901 that does not produce citrinin. Key Laboratory of Industrial Biotechnology of Ministry of Education, School of Biotechnology in Southern Yangtze University, Wuxi, 214036, Jiangsu, China. *www.plantpro.doae.go.th/worldfermentedfood/p16_xu.pdf*.

Gowri, P.M., Tiwari, A.K., Ali, A.Z. and Rao, J.M. 2007. Inhibition of alpha-glucosidase and amylase by bartogenic acid isolated from Barringtonia racemosa Roxb. seeds. Phytotherapy Research 21 (8): 796-799.

Gupta, S. and Prakash, J. 2009. Studies on Indian green leafy vegetables for their antioxidant activity. Plant Foods for Human Nutrition 64:39-45.

Kim, Y.M, Wang, M.H. and Rhee, H.I. 2004. A novel α-glucosidase inhibitor from pine bark. Carbohydrate Research 339: 715-717

Kim, J.H., Kim, H.J., Park, H.W., Youn, S.H., Choi, D.Y and Shin, C.S. 2007. Development of inhibitors against lipase and alpha-glucosidase from derivatives of monascus pigments. FEMS Microbiology Letters 276(1): 93-98.

Kumar, S., Kumar, V., Rana, M. and Kumar, D. 2012. Enzymes inhibitors from plants: an alternate approach to treat diabetes. Pharmacognosy Communications 2(2). DOI: 10.5530/pc.2012.2.4

Lee, Y.L., Yang, J.H. and Mau, J.L. 2009. Antioxidant properties of ethanolic and methanolic extracts from monascus-fermented soybeans. Journal of Food

Biochemistry 33: 707–727.

Mai, T.T., Thu, N.N., Tien, P.G. and Van Chuyen, N. 2007. Alpha-glucosidase inhibitory and antioxidant activities of Vietnamese edible plants and their relationships with polyphenol contents. Journal of Nutritional Science and Vitaminology 53(3): 267–276.

Matsui, T., Ebuchi, S., Kobayashi, M., Fukui, K., Sugita, K. and Terahara. N. 2002. Anti-hyperglycemic effect of diacylated anthocyanin from Ipomea batatas cultivar Ayamurasaki can be achieved by through the α-glucosidase inhibitory action. Journal of Agricultural and Food Chemistry 50: 7244–7248.

McDougall, G.J., Shpiro, F., Dobson, P., Smith, P., Blake, A. and Stewart, D. 2005. Different polyphenolic components of soft fruits inhibit alpha-amylase and alpha-glucosidase. Journal of Agricultural and Food Chemistry 53(7): 2760–2766.

Pattanagul, P., Pinthong, R., Phianmongkhol, A. and Tharatha, S. 2008. Mevinolin, citrinin and pigments of adlay angkak fermented by *Monascus* sp. International Journal of Food Microbiology 126: 20-23.

Ramkumar, K.M., Thayumanavan, B., Palvannan, T. and Rajaguru, P. 2010. Inhibitory effect of *Gymnema montanum* leaves on a-glucosidase activity and a-amylase activity and their relationship with polyphenolic content. Medicinal Chemistry Research 19: 948–961.

Shi, Y.C. and Pan, T.M. 2010. Anti-diabetic effects of *Monascus purpureus* NTU 568 fermented products on streptozotocin-induced diabetic rats. Journal of Agricultural and Food Chemistry 58(13): 7634-4640.

Shi,Y.C., Liao, J.W and Pan, T.M. 2011. Antihypertriglyceridemia and Anti-Inflammatory Activities of *Monascus*-Fermented Dioscorea in Streptozotocin-Induced Diabetic Rats. Experimental Diabetes Research, Volume 2011, Article ID 710635, 11 pages, doi:10.1155/2011/710635

Shi, Y.C. and Pan, T.M. 2012. Red mold, diabetes, and oxidative stress: a review. Applied Microbiology and Biotechnology 94: 47–55.

Srianta, I., Novita, Y. and Kusumawati, N. 2012a. Production of monascus pigments on durian seed: effect of supplementation of carbon source. Journal of Pure and Applied Microbiology 6(1): 59-63.

Srianta, I., Hendrawan, B., Kusumawati, N. and Blanc, P.J. 2012b. Study on durian seed as a new substrate for angkak production. International Food Research Journal 19(3): 941-945.

Tseng, Y.H., Yang, J.H., Chang, H.L., Lee, Y.L. and Mau, J.L. 2006. Antioxidant properties of methanolic extracts from monascal adlay. Food Chemistry 97(3): 375–381.

Yoshikawa, M., Nishida, N., Shimoda, H., Takada, M., Kawahara, Y. and Matsuda, H. 2001. Polyphenol constituents from *Salacia* species: quantitative analysis of mangiferin with alpha-glucosidase and aldose reductase inhibitory activities. Yakugaku Zasshi 121(5): 371–378

In vitro α-glucosidase inhibitory activity of Monascus-fermented durian seed extracts

ORIGINALITY REPORT

%18	%12	%14	%5
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.scialert.net Internet Source	%7
2	K. Koga. "Effects of 50% Ethanol Extract from Rosemary (Rosmarinus officinalis) on ?-Glucosidase Inhibitory Activity and the Elevation of Plasma Glucose Level in Rats, and Its Active Compound", Journal of Food Science, 9/2006 Publication	%2
3	Megawati Megawati, Endang Saepudin, Muhammad Hanafi, Akhmad Darmawan, Puspa Dewi N Lotulung. "Identification and Bioactivity Studies of Flavonoid Compounds from Macaranga hispida (Blume) Mull.Arg", Makara Journal of Science, 2015 Publication	%2
4	worldwidescience.org Internet Source	%1
5	Yuqing Tan, Sam K.C. Chang, Yan Zhang.	

	"Comparison of α-amylase, α-glucosidase and lipase inhibitory activity of the phenolic substances in two black legumes of different genera", Food Chemistry, 2017 Publication	%1
6	Submitted to Universiti Sains Malaysia Student Paper	%1
7	Amal Bakr Shori. "Screening of antidiabetic and antioxidant activities of medicinal plants", Journal of Integrative Medicine, 2015 Publication	%1
8	Muhammad Waseem Mumtaz, Mizher Hezam Al-Zuaidy, Azizah Abdul Hamid, Muhammad Danish, Muhammad Tayyab Akhtar, Hamid Mukhtar. " Metabolite profiling and inhibitory properties of leaf extracts of towards α-glucosidase and α-amylase ", International Journal of Food Properties, 2018 Publication	%1
9	www.jsirjournal.com Internet Source	%1
10	Yongiie Li, Dezhong Yao, Jiancheng Zheng, Jonathan Yao. "The application of genetic algorithm for beam directions optimization in radiotherapy", Proceedings. 2005 International Conference on Communications, Circuits and Systems, 2005., 2005	%1

Publication

11	pubs.acs.org Internet Source	%1
12	Nuraniye Eruygur, Emrah Dural. "Determination of 1-Deoxynojirimycin by a developed and validated HPLC-FLD method and assessment of In-vitro antioxidant, α-Amylase and α-Glucosidase inhibitory activity in mulberry varieties from Turkey", Phytomedicine, 2019 Publication	%1
13	krishikosh.egranth.ac.in Internet Source	%1

EXCLUDE QUOTES	ON	EXCLUDE MATCHES	< 10 WORDS
EXCLUDE BIBLIOGRAPHY	ON		