




Utilization of Functional Instant Porridge Formulated from Taro and Purple Sweet Potato as Anti-diabetic

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Abstract

BACKGROUND: Functional instant porridge is a porridge that has undergone further processing so that when it is served, no further cooking is required.

AIM: The present study was conducted to determine the anti-diabetic, antioxidant, and anthocyanin contents of the formulation of Japanese taro flour and purple sweet potato flour.

METHODS: The materials used in this study were Japanese taro, purple sweet potato, tempeh, and celery leaves. The experimental design used was Completely Randomized Design with five treatments and two replications, and the ratio of Japanese taro flour and sweet potato flour in % (w/w) were A = 75:0, B = 50:25, C = 37.5:37.5, D = 25:50 and E = 0:75.

RESULTS: The results showed that the variations in those ratios were significantly different ($p < 0.05$) on the content of anti-diabetes, antioxidants, and anthocyanins. The best formulation chosen was a ratio of Japanese taro flour and purple sweet potato flour of 37.5:37.5% (w/w) (formulation C). This formulation resulted in anti-diabetic content (inhibitory of α -glucosidase enzyme of 6.149%) antioxidant IC_{50} of 112.86 ppm and anthocyanin content of 3.19 mg/100 g).

CONCLUSION: The most significant inhibitory activity of α -glycosidic enzyme was 43.16% in formulation E of the functional instant porridge. Moreover, the most significant antioxidant activity was 45.69% in formulation C of the functional instant porridge.

Edited by: Sinisa Stojanoski
Citation: Mappiratu K, Laga A, Sirajuddin S. Utilization of Functional Instant Porridge Formulated from Taro and Purple Sweet Potato as Anti-diabetic. Open Access Maced J Med Sci. 2022 Jan 03; 10(A):357-360. https://doi.org/10.3889/oamjms.2022.7057
Keywords: Functional instant porridge; Anti-diabetic; Japanese taro; Purple sweet potato; Anthocyanin
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Received: 12-Aug-2021
Revised: 05-Sep-2021
Accepted: 13-Oct-2021
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Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist
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Introduction

Diabetes is a dangerous and deadly disease. Data from the Ministry of Health obtained from the Sample Registration Survey in 2014 showed that diabetes is the 3rd most significant cause of death in Indonesia with a percentage of 6.7%, after stroke (21.1%) and coronary heart disease (12.9%) [1]. The latest data from the International Diabetes Federation Atlas in 2017 showed that Indonesia is ranked sixth globally, with 10.3 million people with diabetes [1]. The World Health Organization even estimates that the incidence of diabetes in Indonesia will increase drastically to 21.3 million in 2030 [2].

Consumption of food with high amylose content (>25%) and low glycemic index (GI) (<55) can increase insulin sensitivity in people with diabetes mellitus, decrease glucose absorption rate, and can control blood glucose which in turn reduces the risk of complications [3]. Asweet potato is a carbohydrate group that contains about 30–40% amylose starch [4]. Foods containing high amylose can reduce the digestibility of starch *in vitro*. The latter will determine glycemic activity because it produces less glucose and, consequently, less insulin is needed to convert glucose into energy [5]. In addition, purple sweet potato (*Ipomoea batatas* L. Poir) has a relatively high antioxidant content [6].

One of the tubers that can substitute functional food for diabetics is the Japanese taro tuber (*Colocasia esculenta* Var *Antiquorum*). In addition to high economic value, Japanese taro also contains high protein but low in carbohydrates and sugar, which is safe for people with diabetes to consume [Reference(s)]. Previous studies have shown that Japanese taro tubers have moderate antioxidant activity [7]. This taro has amylase inhibitor activity as anti-diabetic [8].

Given the nutritional content and benefits of Japanese taro tubers and purple sweet potatoes, as food substitutes for diabetics, and to increase the marketability and quality value of the utilization of these tubers, the present study was conducted to determine the anti-diabetic, antioxidant, and anthocyanin contents of the formulation of Japanese taro flour and purple sweet potato flour.

Methods

This study used a factorial completely randomized design, with five treatments and two replications. The tools used for sample preparation were blender, basin, strainer, cutting board, 60 mesh sieve,

and scales. The tools used for antioxidant analysis were dropper pipettes, drip plates, test tubes, evaporators, and glassware commonly used in laboratories. The tools used in preparing functional instant porridge were stirring spoons, pans, measuring cups, analytical balances, stoves, cutting boards, and jars. Meanwhile, the main materials were Japanese taro (*C. esculenta* Var *Antiquorum*) and purple sweet potatoes (*I. batatas* L. Poir). Besides, we used ordinary filter paper, distilled water, and the reagent solvent DPPH, N-Hexan, ethanol 96%, NaOH 1 M, Ethanol-HCl 1%, NaCO₃ 20%, Gallic Acid Standard, and Folin Ciocalteu reagent.

Making functional instant porridge

The Japanese taro flour and purple sweet potato flour were weighed according to the formulation and spices, including onion, garlic, and celery, were added. The mixture was added with the protein food source, tempeh flour, of 25% of the total composition of instant porridge. After that, the mixture was added with water of 50% of the total mixture and then cooked until it forms porridge. The cooked porridge was dried with a solar dryer, then powdered and sifted. The resulting instant porridge was packaged and stored for analysis.

Functional analyses

The parameters measured in this study were α -Glucosidase analyses, β -Glucosidase analyses, and β -Galactosidase assay. The measurement process was carried out in triplicate. Then, the antioxidant activity was analyzed using a spectrophotometric method with DPPH reagent. Meanwhile, the determination of total anthocyanins was done by using the differential pH method.

Results and Discussion

The results of % inhibition of α -glucosidase enzyme by functional instant porridge based on Japanese taro flour and purple sweet potato flour were presented in (Figure 1). (Figure 1) showed that the formulation of Japanese taro flour and purple sweet potato flour in the instant porridge of A, B, C, D, and E significantly inhibited α -glucosidase enzyme activity. The more of sweeter potato flour added in the formulation, the higher was the inhibition of α -glucosidase enzyme activity as the rates of inhibition were 9.668%, 4.36%, 6.14%, 13.10%, and 43.16%, respectively, (Figure 1). The highest inhibition was achieved by instant porridge formulation E (43.16%), and the lowest was found in instant porridge B (4.36%). Purple sweet potato has a lower GI than Japanese taro. This makes the α -glucosidase enzyme inhibition

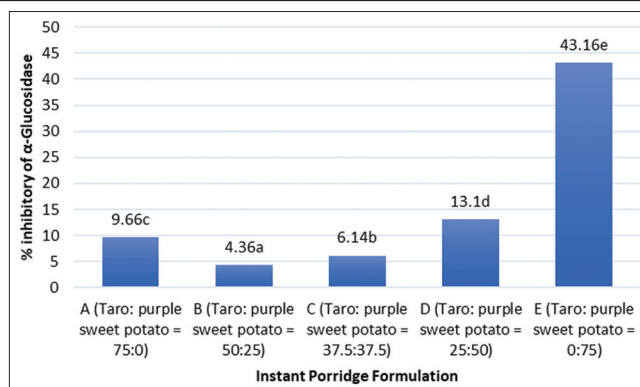


Figure 1: Inhibitory effects of Japanese taro and purple sweet potato instant porridge on α -glucosidase enzyme activity

by purple sweet potato higher than the inhibition by Japanese taro.

Based on (Figure 1) data, it was clear that the instant porridge formulation E had the best anti-diabetic activity. The ability to inhibit the enzyme α -glucosidase is related to the synergistic effect of secondary metabolites in the ethanol extract of Japanese taro flour and purple sweet potato flour. Chemical compounds such as terpenoids, flavonoids, phenolics, and tannins are potential anti-diabetic [9] due to the presence of conjugated double bonds in the form of cyclic bonds (polyphenols and their derivatives) and straight-chain bonds (aliphatic). Phytochemical compounds can inhibit the action of α -glucosidase enzyme, this ability works by imitating the transition position of the pyranocyclic unit of the natural glucosidase substrate, so it is suspected that the inhibition mechanism that occurs is in the form of competitive inhibition [10].

Figure 2 showed that Japanese taro flour and purple sweet potato flour formulations in instant porridge A, B, C, D, and E significantly affected their antioxidant activity as expressed in IC₅₀ concentration. The amount of antioxidant activity is inversely proportional to the concentration of IC₅₀. The lower concentration of IC₅₀ obtained, the greater the antioxidant activity of the instant porridge. The antioxidant activities obtained for instant porridge A, B, C, D, and E were 165.31 ppm, 147.06 ppm, 112.86 ppm, 167.45 ppm, 173.53 ppm,

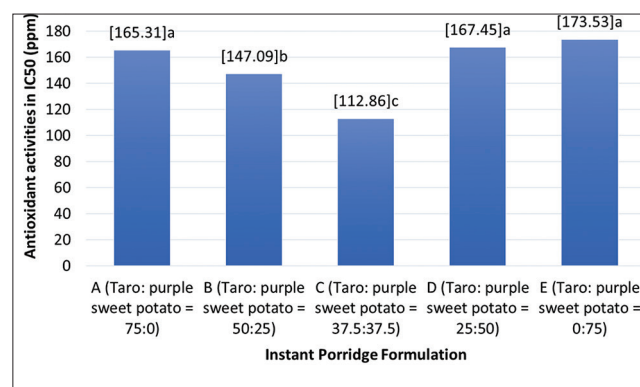


Figure 2: Antioxidant activities (IC₅₀) for Japanese taro and purple sweet potato instant porridge

and 173.53 ppm, respectively (Figure 2). Regarding the percentage of inhibition produced, the test solution concentration of 100ppm for each formulation of instant porridge A, B, C, D, and E was 38.07%, 41.95%, 45.69%, 39.79%, and 39.44%, respectively. The percentage of inhibition obtained for each product formulation exceeded 30%. Thus, the formulations of these instant porridges were quite good in terms of their antioxidant content.

Based on (Figure 2), the best product was instant porridge formulation C because the % inhibition produced was relatively high, 45.69% for the 100 ppm test solution, and the smallest IC_{50} concentration produced was 112.86 ppm. This was due to the same amounts of Japanese taro flour and purple sweet potato flour (Table 1). Japanese taro has active antioxidants from secondary metabolites of flavonoid glycosides [11]. Likewise, purple sweet potatoes contain high antioxidants in the form of flavonoid compounds, namely anthocyanins [12]. Another study showed that the antioxidant activity of frying products (for deep purple fried sweet potato, was 46.50% for light purple fried sweet potato was 29.35%, and for light purple chips was 41.65%) was higher than the fried sweet potato product processed by steaming, boiling, and flouring [13]. The dominant antioxidant activity in purple sweet potato is contributed by the anthocyanin content [14].

Table 1: Ingredients in the formulation of functional instant porridge

Formula	Taro (%)	Purple sweet potato (%)	Tempeh (%)
A	75	0	25
B	50	25	25
C	37.5	37.5	25
D	25	50	25
E	0	75	25

The results of the anthocyanin levels of functional instant porridge based on Japanese taro flour and purple sweet potato flour were presented in Figure 3. Figure 3 showed that the formulations of Japanese taro flour and purple sweet potato flour in instant porridge A, B, C, D, and E had significantly affected the obtained anthocyanin. This was due to the addition of purple sweet potato flour in the instant porridge formulation. The more of purple sweet potato flour added the higher was the anthocyanin content obtained. The anthocyanin levels obtained for

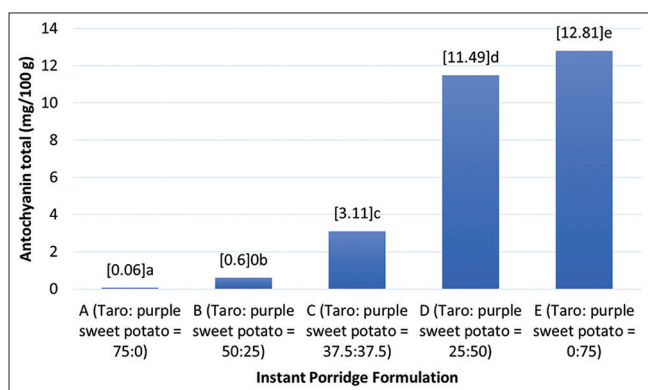


Figure 3: Total anthocyanin in Japanese taro and purple sweet potato instant porridge

instant porridge A, B, C, D, and E were 0.06 mg/100 g, 0.60 mg/100 g, 3.11 mg/100 g, 11.49 mg/100 g, and 12.81 mg/100 g, respectively (Figure 3). According to Kumalaningsih (2006), the total anthocyanin content varies in each plant, ranges from 20 mg/100 g to 600 mg/100 g wet weight. The total anthocyanin content of purple sweet potato was 519 mg/100 g wet weight. The anthocyanin content of purple sweet potato instant porridge after drying was 410.4 mg/100 g, and the results obtained in fresh purple sweet potato was 472.5 mg/100 g [15]. Another study showed that dark purple sweet potato contains 61.85 mg/100 g; 17 times greater than the anthocyanin content of light purple sweet potato (3.51 mg/100 g) [13]. The low anthocyanin levels obtained from these five formulations of instant porridge compared with the levels of anthocyanins obtained by previous studies are thought to be caused by the high cooking temperature, which affects the anthocyanin content in the instant porridge. Grated, dried, and cooked cassava paste can reduce the antioxidants in food [16].

Conclusion

The most significant inhibitory activity of α -glycosidic enzyme was 43.16% in formulation E of the functional instant porridge. Moreover, the most significant antioxidant activity was 45.69% in formulation C of the functional instant porridge.

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