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Swelling power and water solubility of cassava and sweet potatoes flour

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Abstract

The swelling power and water solubility of cassava and three sweet potatoes type were conducted by using Leach method and Kainuma method, respectively. The flour was obtained by milling the dried slices of samples using a grinder, and sieved through an 80-mesh screen. Swelling power of cassava, white sweet potatoes, yellow sweet potatoes, and purple sweet potatoes are 13.80; 3.40; 3.57; 3.68 (g/g), respectively. Moreover, their water solubility are 3.02; 9.37; 9,56; and 8,61(%), respectively. Furthermore, these flours were sucessfully processed becomes cake.

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1. Introduction

In Indonesia, cassava (Manihotesculenta Crantz) and sweet potatoes (Ipomoea batatas Lam) tubers are used as a source of energy and leaves as a source of vitamins and minerals for both humans and livestock. The crop is gradually being transformed from a famine reserve crop and rural staple food to a cash crop for urban consumption. In 2012, production, harvested area, and the level of productivity of cassava and sweet potato in Indonesia reached 24.18 ton/year, 1.13 million ha, 214.02 Ku/Ha and 2.48 ton, 178 thousand ha, 139.29 Ku/Ha [1]. Traditional utilization of cassava and sweet potatoes, in Indonesia, was limited to roasting and boiling of fresh roots for consumption. However, it was reported that tubers are also processed into flour [2]. Cassava is the fourth most

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important source of carbohydrates in the tropics region after rice, maize, and sugar cane [3]. Cassava has become a staple food for more than 500 million people because of the high starch content [3]. Cassava is very suitable to be cultivated in the tropics. Its starch rich storage tubers produce more energy per hectare as compared to other main crops [3,4]. The main drawback of the cultivation of cassava is a short shelf-life, ranging from 2-3 days after harvesting due to post-harvest physiological deterioration (PPD) [3]. Processing technologies are needed to further explore the potential of cassava in the fields of biotechnology and food and extend shelf life, for instance production of cassava flour.

Sweet potatoes are classified as soft-fleshed or firm fleshed. The soft-fleshed varieties are sweet and have orange flesh and are often called yams. The firm-fleshed varieties have purple, yellow, or even white flesh [5]. Sweet potatoes are highly nutritious vegetables that are rich in calories and biologically active phytochemicals such as b-carotene, polyphenols, ascorbic acid and dietary fiber [6,7]. Sweet potatoes are highly perishable and difficult to store. In Indonesia, there are many problems related to storage and transport of the raw sweet potatoes. Sweet potatoes are cheaper than other crops as a starch source, yet this abundant resource is still not properly utilized. It can also be processed into flour, which is less bulky and more stable than the highly perishable fresh root.

Moorthy (2002) had studied about Physicochemical and Functional Properties of Tropical Tuber Starches in India [8]. Matsuguma (2002) and Takizawa (2004) had characterization of native and oxidized starches of two varieties of peruvian carrot (arracacia xanthorrhiza, b.) from two production areas of paraná state, Brazil [9]. Based on author's knowledge the study of Indonesia's tuber flours never done yet. This study was conducted to investigate the functional properties of different types of tropical tubers flour and its apllication for bakery product.

(a) (b)

Fig. 1 Foto of Cassava (a) and Sweet potato (b)

2. Material and methods

2.1 Preparation of cassava and sweet potatoes flour

Cassava and sweet potatoes were purchased from a local market. Tubers were washed with tap water to remove dirt and soil. These tubers were peeled and kept in tap water to prevent enzymatic darkening for 30 minutes. Peeled samples were then cut into slices (1 mm thickness) using a slicing machine. The slices were dried using a tray dryier at 45°C for 12 h. The flour was obtained by milling the dried slices using a grinder, and sieved through an 80-mesh screen to obtain cassava and sweet potato flour.

2.2 Swelling power

Swelling power were determined by using Leach method [10]. The 0.1 g sample is heated in 10 ml distilled water in a water bath at 60°C for 30 minutes with constant mixing. The samples were centrifuged at 1600 rpm for 15 minutes. The precipitated part was weighted and calculated using equation (1).

$$Swelling\ power = \frac{weight\ of\ sedimental\ paste\ (g)}{weight\ of\ the\ sample\ (dry\ basis)(g)} \quad (1)$$

2.3 Water solubility

Water solubility were determined using Kainuma method [11]. The 0.5 g samples is heated in 10 ml distilled waterbath at 60°C for 30 minutes without mixing. The samples were centrifuged at 1600 rpm for 10 minutes.

The supernatant was separated (5 ml), dried, weighted and calculated using equation (2).

$$\% \, solubility = \frac{weight \; of \; the \; soluble \; starch \; (g)}{weight \; of \; the \; sample \; (dry \; basis)(g)} \times 2 \times 100\% \qquad (2)$$

3. Results and Discussion

3.1 Swelling power and solubility properties

Both swelling power and solubility properties of cassava, sweet potatoes, and commercial flour are shown in Figure 1. These properties represent an evidence of interaction between the amorphous and crystalline areas [9,10]. Furthermore, it is influenced by amylose and amylopectin characteristics (Chan, et al., 2009). Figure 1 shows the swelling power of tropical tubers flours having pattern that tend to decrease in contrast to its solubility. According to Kumoro, et al [13] greater swelling power shows harmonious with higher solubility [12]. However, there is no direct correlation between swelling and solubility that could be observed [13]. Cassava flour have high swelling power due to their higher amylopectin in comparing with potatoes flour. Moorthy (2002) also reported that the swelling power of cassava starch was vary from 42-71 (g/g) [8]. It shows that cassava flour and cassava starch have a different value of swelling power.

The swelling power and solubility of sweet potatoes from various varieties are not significantly different, ranged from 3.40 to 3.67 (g/g) and 8.61 to 9.57 (%). The lower swelling power of sweet potato starch has been attributed to a higher degree of intermolecular association and higher amylose content compared to cassava flour. Factors that may influence solubility of starches are source, swelling power, inter-associative forces within the amorphous and crystalline domains, and presence of other components (phosphorous, etc) [13].

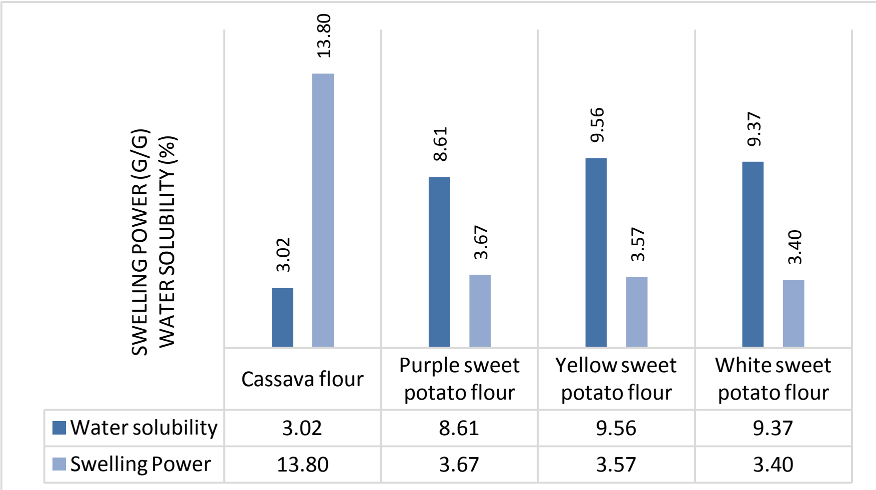
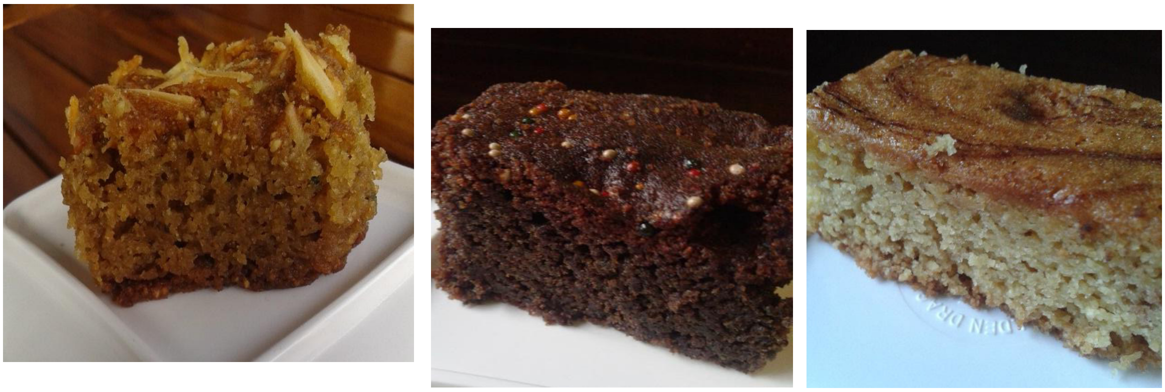


Fig. 2 Swelling power and solubility properties of tropical tubers flours

3.2 Application of cassava and sweet potatoes flours for bakery product

The application of cassava and sweet potatoes flour for bakery product is presented in Figure 3. Each flour show give the bakery product that cannot swell well. Swelling power and solubility properties may influence the characteristics of bakery product. Flour which have lower swelling power and solubility cause the bakery product will not swell well. Tropical tubers flour do not have gluten, moreover it cannot provide a stabilizing network for retention of gas during baking. To meet the demanding technological needs of today, the properties of starch are modified by physical or chemical methods. Starch modification is conducted to evaluate one or some of the short comings, which will enhance its versatility and satisfy consumer demand.



(a) (b) (c)

Fig. 3 Application of yellow sweet potato flour (a), purple sweet potato flour (b), and cassava flour (c) for bakery product.

4. Conclusion

According to functional properties of tropical tubers flour and to meet the demanding technological needs of today, therefore the properties of starch are modified by physical or chemical methods. Starch modification is conducted to evaluate one or some of the short comings, which will enhance its versatility and satisfy consumer demand.

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