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Physicochemical Properties of Butternut Pumpkin Flour as Affected by Different Age of Harvest

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Abstract. Pumpkin is famous for its high nutrition, primarily β-carotene content. However pumpkin crop is seasonal, the nutrition content is affected by harvest age, and in addition, the shape and size are not uniform which might give a problem on storage. Therefore, processing into flour is one alternative to maintain its availability throughout the year and minimize storage facility. The main purpose of this study was to evaluate the physicochemical properties of the flour processed from different ages of harvest. The experiment was arranged in a complete randomized design (CRD) with 3 replications. The harvest age studied were 15, 20, 25, and 30 days after the fruit set (DAFS). Data homogeneity and additivity were tested using the Bartlett and Tuckey Tests, then the data were subjected to analysis of variance (ANOVA), and continued tested with the least significant difference (LSD) test to find the most suitable harvest age to produce flour with the best characteristics. The results show that 30 DAFS is the best harvest age to produce flour with the water absorption of 4.4g/g, the solubility of 9.8%, and swelling power of 8.4g/g.

INTRODUCTION

Pumpkin belongs to the genus Cucurbitaceae with a high bioactive content, which more than 80% of it is in the form of carotenoids [1]. In Indonesia, pumpkin has been widely cultivated such as in East Java [2], Sulawesi [3], and Lampung. However, no specific data has been found regarding pumpkin production in Indonesia. Generally, pumpkin is processed into various food products such as soup and bread, pastries, chocolate, and candy [4].

Pumpkin has several disadvantages as a raw material for food products. For example, the shape is not uniform and bulky, so it requires larger storage space. Besides that, pumpkin is seasonal plants so that there is scarcity when it is not the harvest season, whereas there is over supply during harvest season [5]. If not processed immediately, the pumpkin will suffer from deterioration and eventually will result in losses. An alternative to overcome this problem is to process pumpkin into flour in order to save storage space, facilitate transportation and make pumpkin available all year round, and increase flexibility in its application.

In order to widen the use of pumpkin flour, it is necessary to know the physicochemical characteristics [6] to find how to further processing and suitable products produced from pumpkin flour. One of the factors that affect the physicochemical properties of pumpkin flour is the age of harvest or the level of maturity of the pumpkin. Differences in the maturity level of the pumpkin will affect the pumpkin's chemical content, affecting the quality of pumpkin flour produced [7]. Therefore, this study was aimed to determine the physicochemical properties mainly water absorption, solubility and swelling power of pumpkin flour produced from various harvest ages.

RESEARCH METHODS

Raw material: pumpkin (Cucurbita moschata) obtained from the Lampung Horticultural Park in Sabah Balau Village, Tanjung Bintang District, South Lampung. The pumpkins used were harvested 15, 20, 25, and 30 days after the fruit set (DAFS).

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Preparation of pumpkin flour: The pumpkins were washed with tap water to remove the dirt, the skin was peeled off and the seeds were removed. Then the flesh was cut into 1-2 mm of thickness using a Hobart slicer. After that, the slices were hot water-blanched using a ratio of water and sample (2:1) at a temperature of 70 - 80°C for 1 minute and then drained. After the pumpkin slices were drained, they were dried in an oven at a temperature of 50-60°C for 24 hours. The dried pumpkin samples were ground using a disk mill and then sieved to pass 60 mesh sieve size [8, 9].

Physicochemical Analysis

Water Absorption

Water absorption was calculated by weighing 2 g of pumpkin flour and mixed with 10 ml of distilled water. The mixture was put in a centrifuge tube and incubated in a water bath at 30 oC for 30 minutes, then centrifuged at 3000 rpm for 20 minutes. The volume of the resulting supernatant was measured. The portion of bound water is the difference between the volume of water added to the supernatant [10]

Swelling and Solubility

Flour suspension (1% w/v) of 10 ml was put into a 15 ml centrifuge tube with a known empty weight. Then the tube and its contents were heated at a temperature of 60oC in a water bath shaker for 30 minutes. The suspension was then centrifuged at 3000 rpm for 15 minutes, and the supernatant was separated from the swollen granules (sediment). Swollen granules were weighed for the calculation of the swelling power data. Furthermore, 5 ml of the supernatant was pipetted into a petri dish to be dried in a conventional oven at a temperature of 105°C for 4 hours until the weight was constant. The constant weight was used for solubility calculation [11].

Experimental Design: The study was arranged in a completely randomized design with a single factor and three replications. The treatments were four levels of pumpkin harvesting age used for the production of flour, which were 15, 20, 25, and 30 days after fruit set (DAFS). The resulting data were analyzed by ANOVA to determine the effect of treatment on the observed parameters and further analysis using the LSD (Least Significant Difference) test at 5% level.

RESULTS AND DISCUSSION

Water Absorption

Water binding and water absorption capacities are some of the important functional properties of flour. Flour with high water absorption is flour with better quality because the flour has good water absorption. The water absorption capacity can determine the amount of water available for the starch gelatinization process during cooking. This absorption function facilitates the homogeneity of the flour mixture when mixed with water so that flour with high water absorption tends to become homogeneous quickly [5]. Water absorption is the ability of food material to absorb and bind water. The results showed the age of harvest had a significant effect on the water absorption of pumpkin flour ($p<0.05$). Pumpkins with a higher maturity stage produced flour with greater water absorption capacity than those of flour from less mature pumpkins (Figure 1).

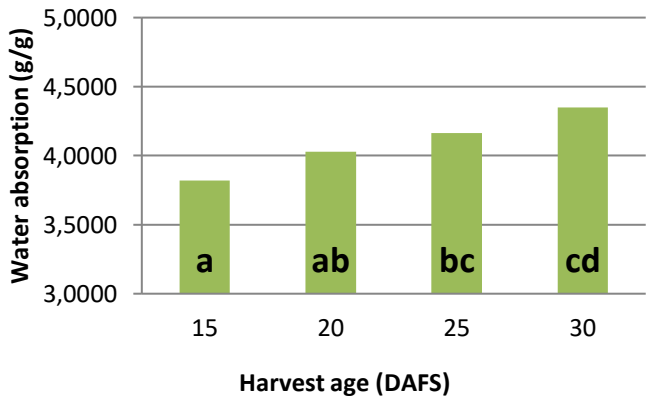

FIGURE 1. Effect of harvest age on the water absorption of pumpkin flour

Water absorption of pumpkin flour is influenced by the components contained in pumpkin. Components that are very substantial on water absorption in flour are protein and starch [12]. Pumpkin flour with a harvest age of 30 DAFS had a higher water absorption capacity compared to those of pumpkin harvested 15 and 20 DAFS, but there was no significant different with that of pumpkin flour harvested at 25 days. Along with the increase of pumpkin maturity stage, the synthesis of starch and protein components will also be higher, and this leads to the increase of water absorption capacity [4].

Swelling Power

Swelling power is an indication of the ability of water absorption of starch granules at hot temperatures. When starch is dissolved and then heated at a gelatinisation temperature, the starch granules swell and the volume increases [13]. Age of harvest on pumpkin had a significant effect on swelling of pumpkin flour ($p<0.05$). The swelling of pumpkin flour increased with the age of the pumpkin (Figure 2).

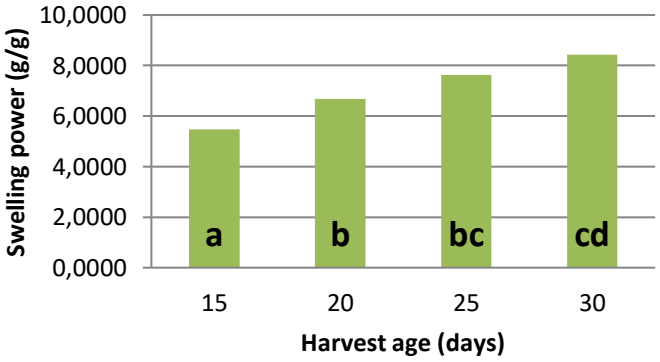

FIGURE 2. Effect of harvest age on the swelling power of pumpkin flour

Pumpkin flour with a harvest age of 30 DAFS had a higher swelling ability compared to those flour of pumpkins harvested at 12 and 20 DAFS, but did not show any significant difference from that of flour of pumpkin harvested at 25 DAFS. Factors such as the ratio of amylose, amylopectin, chain length, molecular weight distribution, degree of branching, and conformation determine swelling power [14]. Amylose and fat components can inhibit swelling power, while long amylopectin chains increase swelling power [15]. The level of maturity will affect the components contained in the pumpkin, such as starch components, molecular weight, and chain length [16].

Solubility

Solubility is a part of the sample soluble in the solvent that occurs at a temperature the same as swelling power [13]. The results showed harvest age of pumpkin had a significant effect on the solubility of pumpkin flour ($p<0.05$). The solubility of pumpkin flour decreased with the increasing age of the pumpkin (Figure 2).

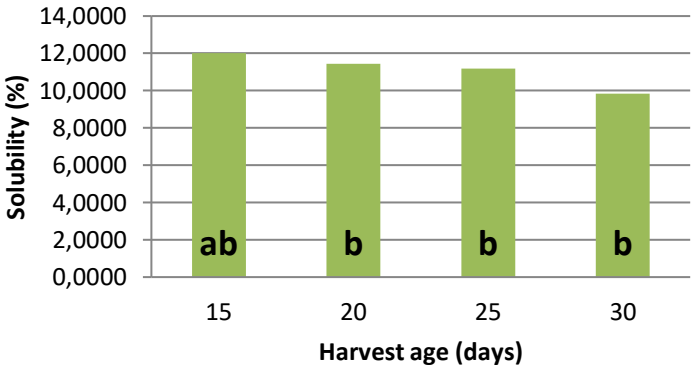

FIGURE 3. Effect of harvest age on the solubility of pumpkin flour

Pumpkin flour with a harvest age of 15 DAFS had the highest solubility compared to pumpkin flour with a harvest age of 20, 25, 30 DAFS. The solubility of pumpkin flour is inversely proportional to the swelling power. Starch or flour with lower swelling power has higher solubility and higher gelatinization initial temperature (pasting temperature). The degree of solubility of flour is influenced by the size of the granules in the flour. Similar result with Singh et al. [17] flour with a smaller starch granule size has high solubility but low swelling power and otherwise. The stage of pumpkin maturity will affect the size of the starch granular produced. Other factors that affect solubility are lipid components, the ratio of amylose and amylopectin, temperature, pH [15].

CONCLUSIONS

The study demonstrated the influence of harvest age on the physicochemical attributes of pumpkin flour for development use in food products. It was found that 30 DAFS is the best harvest age to produce pumpkin flour with the characteristics of water absorption of 4.4g/g, solubility of 9.8%, and swelling power of 8.4g/g.

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