Effect of Drying Temperature on Physiochemical Properties on Orange Sweat Potato Flour

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Abstract

Orange sweet potato flour is an innovative product that produces to commercialize the use of sweet potato in producing a food product. It can be used for baked goods, such as bread, cookies, muffins, and doughnuts, and as a thickener for sauces and gravies. It is also used as a flour option especially for those who are allergic to gluten. The objective of this study was to produce flour from orange sweet potato at different drying temperatures by using the circulation oven drying technique. The variables for this study were the drying temperatures of flour at 50°C, 55°C and 60°C for 8 hours. The flour is also determined by its moisture, ash, and beta carotene content. The best drying temperature of sweet potato flour is at 50°C with 3.47% of moisture content, and the highest ash content with 3.32%. In addition, the amount of beta carotene analysis also showed that, at 50°C, the amount of beta carotene was the highest with a reading of 0.042 mg/g compared to 55°C and 60^0C, which had only 0.035 mg/g and 0.027 mg/g. Hence, it can be recommended that the drying temperature of sweet potato flour was found to be indirectly proportional to the amount of moisture, ash and beta carotene content. Sensory evaluation shows, flour drying at 50^0C are more preferred by panellist, it imitates a market product compared to others in term of texture, elasticity, stickiness, and overall acceptance. The use of a low temperature, drying at 50^0C was chosen because the high nutrient content can still be maintained after the drying process takes place. In addition, these sweet potatoes can be used as an alternative source of flour with health benefits.

Keywords: orange sweet potato flour, gluten free, drying temperature

1.0 Introduction

Sweet potato (*Ipomoea batatas*) has been cultivated in Malaysia for many years (Salma & Zaidah, 2006). Most sweet potatoes are generally orange, but it's also found in other colours, such as white, red, pink, violet, yellow and purple. It is usually used as a basic ingredient in making snacks, flour and traditional confectionery (*kuih*) also processed into chips where it is thinly sliced and deep-fried. It is nutritious and contains high β-carotene, ascorbic acid and minerals (Jasim & Hosalli, 2006).

Sweet potatoes are contained high in dietary fibre, minerals, vitamins, and antioxidants, such as phenolic acids, anthocyanins, tocopherol and b-carotene. The phytochemicals in sweet potatoes were displayed as radical-scavenging activity and exerted several health-promoting functions in human diseases, such as cardiovascular disease, cancer, and age-related neuronal degeneration (Zhang et al., 2015).

Flour processing can convert sweet potatoes into a more stable product (Truong et al., 2007). The drying process is very important, as it deeply affects the sensory and nutritional characteristics of the end product. The different temperatures of drying will affect the physiochemical in orange sweet potato flour (Transcoso-reyes et al., 2016). The different drying temperatures affect

the colour changes after the drying process. So, the content of beta carotene changes depending on the concentration of the flour colour.

1.1 Problem statement

The different drying temperature gives effects to the colour changes in sweet potato flour. The equipment use is oven drying. High drying temperature affect the quality of flour, colour and amount of beta carotene contain in sweet potato flour.

If different drying temperatures use does the quality become worst or it's the same and the colour whether it become lighter, darker or no changes. The other problems related with drying is adding to that discoloration during preparation and drying usually called "*browning*" is caused by overheating due to difficulties in controlling the drying conditions (Ahmed et al., 2010).

Next, one of the oldest methods of food preservation is dehydration (Adams,2004) and if fresh sweet potato was converting into flour, it could contribute to minimal losses of fresh product and is less bulky and more stable than the perishable fresh root (Maruf et al., 2010).

1.2 Objective

The aim of this research was to study the effect of drying temperature on moisture, ash and beta carotene content in orange sweet potato flour.

2.0 Literature review

Orange sweet potato flour is a fine flour made from ground sweet potato. It is completely gluten free, which is made from orange sweet potato. This orange sweet potato flour can be used in a wide variety of culinary uses and is a very popular base for bakery in many Asian cuisines. It is available in purple, orange and white colour which is made from different type of sweet potato. Processing the sweet potato into flour increase its value and storage ability (Mais & Brennan, 2008).

Both types of flour work just about the same way in a recipe but have slightly different flavours and colourings. Other than that, sweet potato flour can be made by process the raw sweet potato into flour and blended with wheat flour in different ratios to produce wheat-sweet potato composite flour. (Hagenimana & Low, 1998).

To produce sweet potato flour, there is no standardized procedure, but blanching process was used before drying and then milling. Therefore, in this analysis the orange sweet potato will through the different temperature of dehydration methods which is 50^0C, 55^0C and 60^0C. Other than that, this orange sweet potatoes will treat with a sodium metabisulfite solution to prevent browning reaction. After drying process, the sweet potato will through milling process to form a fine texture as other flour. Processing of sweet potato into flour helps prevent spoilage of excess produce as flours have longer shelf life (Aprianita et al., 2009).

Other researcher has proved that sweet potato flour contains 74.5% starch, 8.7% moisture, 1.56% ash, 2.3% protein, and 9.4% dietary fiber (Singh et al., 2008). These sweet potato flour can enhance nutrient especially for baking product for example to produce breads, pasta, unleavened baked products, porridges, chips and snacks.

The orange-fleshed sweet potato consumption is an option to increase nutrient intakes from biofortified crops (Nestel et al., 2006). Therefore, the production of flour from orange sweet potato increases the product life and facilitates its incorporation in the diet and combination with other foods. The positive characteristics of orange sweet potato delineated above make it a good alternative source of flour with health benefits (Sanchez et al., 2020). Flour, when prepared from roots with high beta-carotene content, which has beneficial effects on human health, such as improving immunity and prevent too dangerous diseases as cancer, cardiovascular and cataracts.

However, there is a need to optimize the process conditions and storage of the flour to degrade the loss of carotenoids (Rodriguez-Amaya et al., 2011) and other nutrients. The carotenoids contents in sweet potato of orange or yellowish-white pulp range from <0.05 to 265 µg/g (Takahata et al.,1993).

To preserve the properties of orange sweet potato, so that their components are kept, the goal of this work is to investigate conservation methods, such as drying (Schweinberger et al., 2015). Drying is playing the important role in preserving of food products, easiest and the most common method. The orange sweet potato will be dried in oven drying at 50^0C, 55^0C and 60^0C. Then, the dried sweet potato will be milled to form flour.

3.0 Methodology

3.1 Material

The orange sweet potato was harvested and randomly selected healthy roots from a local farmer in Pagoh, Johor were stored at 30°C until used. As shown in Figure 1, before processing, the orange sweet potato will be washed and trimmed. This operations aim for cleaning and trimming are to remove soil and other foreign material from the sweet potato surface, portion damaged by weevils or other pests, and any other unwanted portions. Cleaning and trimming are manually done using knives to remove the sweet potato skin.

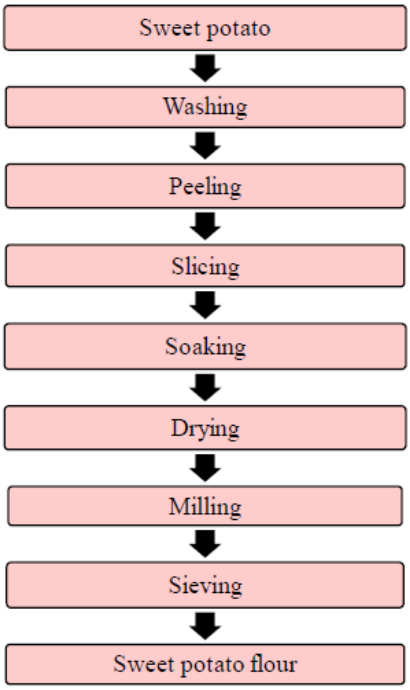

Figure 1 Flow chart of the production process for orang sweet potato flour

3.2 Preparation of orange sweet potato flour

As shown in Figure 2, the orange sweet potato was sliced separately into small physical sizes to increases their drying surface area. The slicing process is done by using slicer machine with 1mm thickness. After that, immediately placed the orange sweet potato slices at closed place to avoid undesirable browning reactions. The sweet potato slices were soaked in 0.5% w/v sodium metabisulfite solution for 5 minutes to prevent browning reaction (Ahmed et al., 2010). Sodium metabisulfite is a reducing agent, has a strong inhibitory effect on the polyphenol oxidase activity.

Figure 2 Orange sweet potato after slicing

Next, the sweet potato slices are dried in Forced Convection Oven at three different temperature which is 50°C, 60°C and 70°C for 8 hours. The dried sweet potato was milled for 4 to 5 minutes to obtain the flour followed

by sieving using a particle size analyser. As shown in Figure 3, the orange sweet potato flour has ready and then packaged for further use.

Figure 3 Orange sweet potato flour by air circulation oven

3.3 Determination of moisture content

The moisture content analysis was performed to determine the moisture content in the sweet potato flour using Moisture Balance Analyser XM50 method where each sample was analysed for three times. A total of 3 samples of sweet potato flour consisting of different drying temperatures 50°C, 55°C and 60°C were analysed.

First, the hood of moisture balance analyser was opened and placed the sample holder with an empty weighing pan onto the weighing pan holder. Next, press the " T " key. After that, weighed 5.00 gram of each orange sweet potato flour and put it in the sample holder. Closed the hood and press the " START/ STOP " key. The heating element was heated up to 105°C. The result was appeared in the measurement display in the unit of measurement set.

3.4 Determination of ash content

Ash content of flours were determined by official methods (AOAC, 1998). Ash content is conduct are to measure of the total amount of minerals present in orange sweet potato flour, whereas the mineral content is a measure of the amount of specific inorganic components present within a food, such as Ca, Na, K and Cl. A total of 3 samples of sweet potato flour consisting of different drying temperatures 50°C, 55°C and 60°C were analysed by using high temperature muffle furnace principle for triplicate.

First, 5.00g of the sweet potato flour sample was weighed in a crucible. Next, ignited slowly over a bunsen flame until no more fumes are evolved. After that, transfer the crucibles to muffle furnace set at 550°C. The sample was incinerated until it is free of black carbon particle until it is white in colour for 48 hours. The crucibles were removed in desiccators and weighed after cooling. Lastly, repeated until no further loss in weigh is indicated.

3.5 Beta carotene determination: conventional method

Beta carotene analysis was conducted to determine the total amount of carotenoids using a spectrophotometer at 450nm where each sample was analysed for duplicate. A total of 3 samples of sweet potato flour consisting of different drying temperatures 50°C, 55°C and 60°C were analysed. Beta carotene analysis was started with approximately weighed 0.5g of sweet potato

flour sample in digital weighing balance. Then, the sample was extracted with additions of 25ml of acetone were made to obtain a paste (Carvalho et al., 2012). The extraction was filtered into a Buchner funnel with Whatman No. 1 filter paper. This procedure was repeated forty times until the sample became colourless.

The extract obtained was transferred to a 500ml separatory funnel containing 15ml of petroleum ether. After that, 50ml of 5% sodium sulphate was added. The mixture was separated into two layer which is clear and cloudy layer. The cloudy layer is the solvent sample meanwhile the clear layer is the carotenoid sample. The carotenoid samples were read at 450nm by using uv vis spectrophotometer.

3.6 Sensory analysis

The sensory panellist chooses is trained panellist from Food Technology Department, Politeknik Tun Syed Nasir, Johor. Each panellist received the sample according to code sample with random three-digit numbers and presented in individually booth. This sensory test will be conducted in a sensory laboratory with good temperature and sensory room lighting. The panellist will determine the physical properties of orange sweet potato flour, based on attribute of texture, elasticity, stickiness, stiffness and overall acceptability.

3.7 Statistical analysis

All the data analysis was recorded and analysed by using Analysis of Variance (ANOVA). The Analysis of Variance (ANOVA) was performed to determine the differences and the equality between two or more means by analysing sample. The mean ± standard error of mean was determined through Tukey Test and separated by least significant difference (LSD) at $P \leq 0.05$, using IBM SPSS Version 23.0.

4.0 Discussion

4.1 Physiochemical of flour

The moisture content analysis is intended to determine the moisture or water content of the sweet potato flour using drying method by Moisture Balance Analyser XM50. As shown in Table1; the significance value (p-value) is 0.021. The p value is less than 0.05, means there was a significant difference between drying temperature of 50°C (3.47 ± 0.08^{b}) and 60°C (2.42 ± 0.39^{a}). But the results also showed that there was no significant difference between drying temperature between 55°C (2.96 ± 0.38^{ab}) and 50°C (3.47 ± 0.08^{b}).

Table 1: The drying temperature between Moisture, Ash and Beta Carotene Content Sweet Potato Flour

Temperature, °C	50	55	60
Moisture content, %	3.47 ± 0.08^{b}	2.96 ± 0.38^{ab}	2.42 ± 0.39^{a}
Ash Content, %	3.32 ± 0.03^{c}	2.37 ± 0.09^{a}	2.59 ± 0.09^{b}
Carotenoids Content, mg/g	0.042 ± 0.001^{b}	0.035 ± 0.004^{ab}	0.027 ± 0.003^{a}

The drying temperature of orange sweet potato flour for 60°C was obtained the lowest amount of moisture content compared to 55°C and 50°C. It showed that, the higher the drying temperature of orange sweet potato flour, the lower the amount of moisture content. Overall, all moisture content of flours was below 13%, which is good for maintaining flour quality (Wadchararat et al., 2004).

The ash content analysis is intended to determine the amount of mineral content of the orange sweet potato flour using high temperature muffle furnace principle. The significance value (p-value) is 0.003. The p value is less than 0.05, showed that there was a significant difference between drying temperature of 50°C (3.32 ± 0.0^{c}),55°C (2.37 ± 0.09^{a}) and 60°C (2.59 ± 0.09^{b}) at $P < 0.05$. The highest amount of ash content was at 50°C compared to 55°C and 60°C.

The beta carotene content analysis is intended to determine the carotenoid content of the orange sweet potato flour extraction of acetone. The significance value (p-value) is 0.034. The p value is less than 0.05. Based on the analysis performed, it can be concluded that there was a significant difference drying temperature between 50°C (0.042 ± 0.001^{b}) and 60°C (0.027 ± 0.003^{a}). It is shown that at lower drying temperature, which is 50^{0}C, the higher beta carotene content can be preserved in the flour.

However, there was no significant difference between drying temperature between 55°C (0.035 ± 0.004^{ab}) and 50°C (0.042 ± 0.001^{b}). The appropriate drying temperature was chosen at 50^{0}C because of its low energy consumption.

4.2 Sensory analysis

The sensory acceptance of the biscuits was evaluated by applying the scoring scale test. The scoring scale was structured with point 1 to 7 (I immensely disliked to I immensely liked). According to the sensory analysis results in the Table 2, drying temperature of sweet potato flour for 50°C is found to be more preferred by panellist, it imitates a market product compared to other in term of texture, elasticity, stickiness, and overall acceptance.

Texture is a critical attribute that can dominate quality of a product. This is because the texture of the orange sweet potato flour with drying temperature 50°C and market product have same acceptability. Therefore, texture plays an important role regarding the acceptability of product among consumer (Anton & Luciano, 2007).

Fortunately, the was preferable for the scoring value, shown higher than 4.00 in term of elasticity, stickiness and overall acceptance for all sample, and there are not significantly different with each other's except for texture attribute.

Table 2 Averages of the notes of sensory analysis (scale having points 1 to 7)

Flour type	Texture	Elasticity	Stickiness	Overall acceptance
50^0C	4.61±1.89^{ab}	6.10±1.28^{a}	4.50±1.78^{a}	4.10±1.19^{a}
55^0C	3.80±1.61^{a}	4.70±1.49^{a}	5.40±1.07^{a}	4.60±1.77^{a}
60^0C	3.30±1.49^{a}	5.00±1.41^{a}	5.50±1.08^{a}	4.80±1.87^{a}
Market product	6.20±0.78^{b}	5.50±1.17^{a}	4.30±2.11^{a}	4.00±2.35^{a}

5.0 Conclusion

This work had as purpose to evaluate the potential of orange sweet potato as alternative as wheat flour substitution in food products. The use of minimal heat in producing the flour has preserve the nutritional value and save energy consumption during heating process. All orange sweet potato flour has the same time of drying temperature which is 8 hours but with different temperatures of 50°C, 55°C and 60°C. The best drying temperature for orange sweet potato flour is 50°C. In this condition, the result for the moisture content is (3.47 ± 0.08), it is set up that the drying temperature increases, the moisture content decreases.

For the ash content, the result obtained for the drying temperature at 50 ° C is (3.32 ± 0.03), which is higher than the other temperatures. It is also supported by another study reported by Singh and colleagues in 2008, with 1.56% ash content in their sweet potato flour.

Beta carotene content for 50°C is (0.042 ± 0.001) mg/g. The lower the drying temperature of sweet potato flour, the higher the amount of beta carotene content obtained. The drying temperature of orange sweet potato flour was inversely proportional with the amount of moisture, ash and beta carotene content, because of high nutrient content is still present in the flour. Based on sensory properties, orange sweet potato with 50^0C drying temperature yielded good quality of flour.

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