



The Production of Breadfruit Flour: Effect of Heater Temperature to the Drying rate and time of the Breadfruit

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DOI 10.15294/jbat.v6i1.7168

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Article Info

Article history:

Accepted

February 2016

Approved

April 2017

Published

June 2017

Keywords :

Breadfruit

Drying

Water Level

Abstract

The composition of mineral and vitamin from breadfruit is particularly known of having benefits compared to rice which is a main source of carbohydrate consumed by societies. The process of drying is one of the factors that affects foodstuffs quality. The aim of this research was to provide an understanding of drying phenomena from data experiment and discover the influence of drying air temperature to breadfruit drying time and rates. This research was conducted in several stages which are material preparation (breadfruit) by through downsizing process, then weigh the material (breadfruit) once every 5 minutes on each drying air temperature variations (50 °C, 60 °C, 70 °C, and 80 °C). The research were conducted using breadfruit with the best drying time which is obtained at 60 °C for 100 minutes. The lowest water content obtained was 0.4%, while the highest drying rate was 0.00144 Kg²/m².s at 80 °C of temperature.

INTRODUCTION

Breadfruit belongs to *Urticaceae* family, genus of *Artocarpus* (similar to jackfruits), in the species of *Artocarpus communis*. Breadfruit (*Artocarpus communis*) is mostly known by the society due to its wide distribution in the whole nation. Its high calories and nutrition along with its wide distribution in the whole nation of Indonesia, breadfruit can be used as the alternative of carbohydrate and main source of nutrition to the society (Wulandari, 2012). Breadfruit is one of a plant which is included into *International Treaty on Genetic Resource for Food and Agriculture* data as one food security source (Almatsier, 2004). Breadfruit contains 27 % carbohydrates, meaning that 1350 grams of Breadfruit contains 365 grams of carbohydrates (Edahwati et al., 2010). Breadfruit is potential to be used as an alternative material for rice substitute in supporting food security.

Breadfruit can be processed into several products, one of them is Breadfruit flour. The processing of breadfruit to become breadfruit flour is not only able to improve its economic value, but it can also increase the timespan of breadfruit consuming duration. Another benefit of breadfruit processing is it does not contain gluten, so, it can be consumed by autistics (Sukandar et al., 2014)

Like the other fruits, breadfruit was easily browned after being peeled. The oxidation process that occurs causes browning on the breadfruit will affects the production process of breadfruit flour. To overcome the problems, there are several ways to produce breadfruit flour with good color quality. A high-quality flour is white, clear, and perfectly dried. Salt is one of the ingredients functioned as the inhibitor of browning reaction (Rahmayati et al., 2014). Breadfruit flour has an advantage because it does not contain gluten so it is suitable for people with autism.



Figure 1. Drying equipment.

One of the main concerns in producing breadfruit flour is the drying procedure. The purpose of drying is inhibiting the fermentation process, the growth of bacteria and fungi. In addition, it also slows down the chemical changes in food (Gunasekaran et al., 2012; Peglow et al., 2009). During the drying process, heat was transferred from source of heats to the product, while mass transfer processes occurred from material surface to the surrounding (Rajkumar & Kulanthaisami, 2006 in Susilo, 2012). The higher drying air temperature results higher heat energy carried by the air so that the amount of vaporized liquid from surface of dried material also increase. Therefore, appropriate drying method is very important and highly required in the food processing to obtain appropriate drying technology.

RESEARCH METHODOLOGY

Materials

Breadfruit (*Artocarpus communis*) used in this research was a local breadfruit with ± 1 kg mass from Cilegon, Banten. The used solution in submersion process was salt solution (NaCl).

Experimental Equipments

The equipment used in this research were waterbath (memmert), dryer, analytic balance (shimadzu), knife, Blender (Philips) and strainer.

Experimental Procedure

Materials Preparation

Breadfruits were peeled and split into two parts. Then, the pith and seeds of breadfruit were separated from the flesh. The flesh was then washed until it clean and respectively slightly sliced in the thickness of ± 3 mm using knife.

Immersion Process

The breadfruit chip slices were then submersed in salt water for 60 minutes. The purpose of this treatment was to avoid browning process on breadfruit.

Drying Process

After the submersion process, the breadfruit chips were then drained and dried using dryer in the temperature variation of 50 °C, 60 °C, 70 °C and 80 °C.

Milling and Straining Process

Dried breadfruit chips were then powdered using blender and strained with 80 meshes strainer.

Research Variable

This research has several variables including independent variable, dependent variable and fixed variable. The independent variable was the temperature of the heater, the fixed variables were the air heater flow rates and the initial mass of breadfruit sample, while dependent variable in this research was mass of breadfruit samples during the drying process.

RESULTS AND DISCUSSION

Effect of water content to Drying rate

In this research, experimental data obtained was then calculated to find the influence of drying time to sample (breadfruit) on different temperatures (50 °C, 60 °C, 70 °C and 80 °C) at constant dry air velocity. Figure 2 shows the relation between water content to drying rates.

In the increasing of drying rates, it occurs momentum transfer to the heat diffusion velocity from the air into the molecules of material resulting

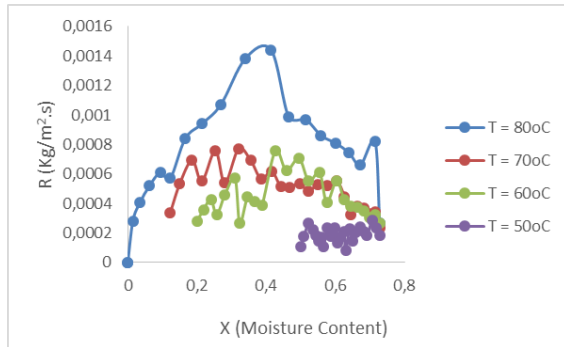


Figure 2. Relationship between moisture content with drying rates ($\text{Kg}^2/\text{m}^2.\text{s}$) at different drying temperatures.

increase of the molecule temperature. It causes an increment of vapor pressure in the molecule, therefore the water in the material will be easily released from the molecules material. The increasing heat diffusion from the air in to the feed granule is caused by the addition of air velocity from the dryer causing an increasing water to be vaporized. Generally, the graphic of relationship between water content and drying rates is categorized into three periods, adjustment periods, constant rate periods, and decreasing rate periods (Nurhikmat & Khasanah, 2009). During the adjustment periods, the water content was in equilibrium condition, since water vapor pressure was equilibrium atmospheric water vapor pressure. (Dwika et al., 2012). After the adjustment periods, the material (breadfruit) has constant drying rate. The temperature of the material was the same to the wet bulb temperature of drying air, the evaporation process occurs in unbound water.

Constant rate condition is a drying period under static condition. The second steps of drying process occurs a decrease in drying rate of material ($R=0$). At this stage, the composition inside of the material (internal moisture) is vaporized (Clair & Folkman, 1983).

The experimental results showed that drying rate of the adjustment period was seen in the initial water content, while during the constant rate period drying rate was not available since Figure 1 shows unstable result even if the average result seem constant. It is due to the difficulties in maintaining temperature remain constant, this condition affects water content in the breadfruit. Next in the decreasing rate period, the decreasing of drying rates can be seen at the final water content where drying rate value is almost 0. Based on Figure 2, it can be inferred that higher temperature will increase drying rates proportionally, it is due to higher water

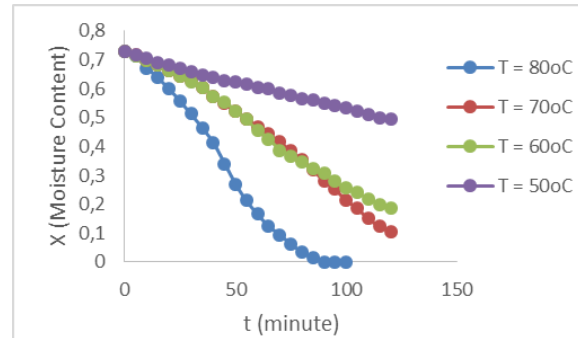


Figure 3. Relationship between moisture content with drying time at different drying temperatures.

diffusion rate resulting faster mass transfer of water in breadfruit (Djaeni, 2014).

The changes of color from breadfruit at the temperature of 50 °C, 60 °C, 70 °C, and 80 °C was occurred along with the decreasing quality of materials. It might be caused by the high temperature and also length of drying time. In the drying process browning process is also known as Maillard reaction. This process is caused by carbohydrates, specifically reducing glucose with primary amine groups. The browning reaction in food indicates decreasing of its quality (Sarastuti & Yuwono, 2015).

For the changes of texture, at the temperature of 80 °C, the texture became coarse, while the other temperature resulted less coarse surface material. It is because the temperature of drying was mostly around 60°C. Furthermore, in the temperature of 80 °C, there was a possibility of material damage. This can be seen from dark brown color produced from the drying process of breadfruit which is in accordance with Novary (1997) in Martunis (2012) which stated that duration and temperature of drying should be in the range of 40 - 60 °C. Drying is a process of vaporizing water to the air caused by the difference of water vapor composition between surrounding air with the dried material.

The air with low relative humidity can cause evaporation. The enhancement ability of the air carrying water vapor was caused by the difference of relative humidity between drying air with the air around the material. One of the influencing factor is air velocity. Static air around dried material causes moisture content become saturated and leads to decreasing in drying process. (Nirma, 2014). Thus, the time variation in this research was carried out at 100 minutes slower than

the conventional drying process which surpasses 6 - 8 hours.

Study of Water Content as Function of Drying Time

In this research, the next finding was related to the influence of drying time to the water content at different drying temperature (50 °C, 60 °C, 70 °C, and 80 °C) with constant drying air velocity. Figure 3 shows the relation of water content as a function of drying time at different drying temperatures.

In Figure 3 it can be seen that the longer the drying time, the water content will subsequently decrease during the drying process. The longer drying time, the longer breadfruit exposed by hot air, thus the water content in the breadfruit is reduced over time. Higher temperature will decrease water content, because the high temperature will make the water in the breadfruit easily vaporized. However, at the temperature of 70 °C and 60 °C, water concentration difference is very small and tend to be similar.

Study of Breadfruit Mass Reduction as a Function of Drying Time

In this research, Breadfruit Mass also studied as a function of drying time which was performed at different drying temperature (50 °C, 60 °C, 70 °C, and 80 °C) with constant drying air velocity. Figure 4 shows the relationship between breadfruit mass to the drying time at different temperatures.

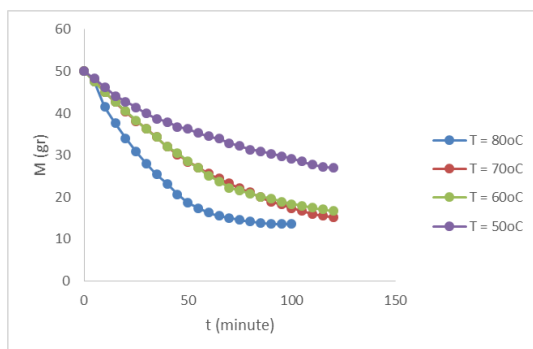


Figure 4. Relation between Breadfruit Mass weight with drying time at different drying temperature

Figure 4 shows that breadfruit mass is decreasing as a function of drying time. The longer the drying time, breadfruit mass will consequently

decrease during the drying process. Higher temperature, will also decrease breadfruit mass, since high temperature will easily make the water concentration in breadfruit vaporized resulting decrease of breadfruit mass. Figure 4 shows the decreasing mass of breadfruit was significantly occurs at the temperature of 80 °C, while in the temperature of 70 °C and 60 °C, the difference of decreasing mass of breadfruit was quite small and tend to be the same.

ACKNOWLEDGEMENT

Big thanks and gratitude is presented to Falah Ayulillah S.W., Firmansyah, Rochmatun Nazillah for the helps during the research.

CONCLUSION

This research was conducted using breadfruit with variation of temperature and best drying duration was found at 60 °C with drying time 100 minutes. It is considered best from the best appearance of the breadfruit flour production. The lowest water content was 0.4% while the highest drying rates was 0.00144 Kg²/m².s at the temperature of 80°C with dark brown color of breadfruit flour.

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