White noodles drying with air dehumidified by the solid moisture adsorbents

by Setia Budi Sasongko

White Noodles Drying with Air Dehumidified by the Solid Moisture Adsorbents

Setia Budi Sasongko[1, a)], Mohamad Djaeni[1, b)] and Maghfira Arum Lestari[1, c)]

[1]Chemical Engineering, Faculty of Engineering, Diponegoro University, Semarang, Central Java, Indonesia 50275

[a)]Corresponding author: sbudisas@live.undip.ac.id
[b)]moh.djaeni@live.undip.ac.id
[c)]maghfiraarumlestari@students.undip.ac.id

Abstract. Drying is an important step in the preparation of white noodles popular as sohun. The process aims to remove moisture content.in wet sohun up to 14.5% referring to Industry National Standard of Indonesia. White noodles were commonly dried with direct sunlight in which was weather dependency both for process continuity and product quality. The paper discusses the effect of air dehumidification with several solid moisture adsorbents such as natural zeolite and synthetic zeolite on the thermal efficiency of sohun drying. At this point, the sohun was dried under air temperature 50 ºC, 60 ºC, and ambient temperature. The moisture content in sohun was observed every 15 minutes for operational drying time 150 minutes. As a comparison, the conventional drying without heating the air was also evaluated. Results showed that the higher air temperature resulted in faster drying time. With adsorbents, the performance of the dryer can be improved where the synthetic zeolite was the most superior compare to the others.

INTRODUCTION

White noodles popular as sohun is one type of starch-based noodles that has the potential to support the food diversification program because made of various local plant [1,2]. The industry produces white noodles through the stages of making dough, shaping, cooking, and drying [3]. The industry uses raw material drying technology widely [4]. Drying is an important step of preservation in a way reduction of water content for prolonging storage life [5]. Maximum water content is 14.5% referring to Industry National Standard of Indonesia 01-3723-1995. White noodles were commonly dried with direct sunlight in which was weather dependency both for process continuity and product quality [6]. Based on this reason, its crucial to arrange the conventional drying technology so that white noodles output can be steady throughout the year.

The problem of climate or weather dependence and speed up the drying time can be overcome by conventional drying [7]. However, excessive heat or air temperatures above 70ºC can potentially reduce quality, especially for some food products [8,9]. Samples dried at high temperatures had significantly different colors as compared to other temperature applications because of an increase in the degree of browning[10]. During storage, dried noodles exhibited a slower rate of microbial growth. The sohun drying has been also modified for finding high-quality dry sohun as well as efficient energy usage. Particularly in a high relative humidity environment (70-80%) such as in tropical areas, the drying media becomes quickly saturated. At high relative humidity, the driving force of water mass transfer from product to the drying media will be low and disrupts the water evaporation process[11]. The use of adsorbents can reduce the humidity in the air [11,12]. So, drying becomes more optimal.

The paper discusses the effect of air dehumidification with several solid moisture adsorbents such as silica gel, natural zeolite, and synthetic zeolite on the thermal efficiency of sohun drying. As a comparison, the conventional drying without adsorbent was also evaluated. The data of drying rate and thermal efficiency can be used to determine effective drying time for sohun with reasonable heat usage.

MATERIALS AND METHODS

Materials

White noodles made from Palm (Arenga pinnata) Flour that purchased from Malang, East Java, Indonesia. The zeolite used in this research was Zeolite 3A provided by Zeochem, Switzerland, natural zeolite, and silica gel from Indrasari (Chemical Store in Semarang, Central Java, Indonesia).

Sample Preparation

White noodles making refers to a method by Hartati and Putro (2017) with modification [13]. The first step is to make cooked starch with gelatinization. Mix 20% palm flour from the base with water in the ratio of 1:4 w/v. Heat the mixture while stirring 125 rpm to the temperature 65 ˚C. Keep the temperature at range 65 ˚C – 75 ˚C for 2 minutes (until the starch gelatinized). Then, mix the 80% palm flour and xanthan gum 1% of it with cooked starch. Shaping the dough using noodles maker then cook it in the water at 100 ˚C for 30 seconds. Drain and cool in the water at 4 ˚C for 15 seconds.

Determination of Moisture Content

The moisture content was determined by drying white noodles in the oven at temperature 110 ˚C until a constant weight was obtained. The moisture content of white noodles is 70.18 % (wet weight basis).

Drying Process

The drying process uses a tray dryer. The noodles were spread on a stainless steel tray (18 cm x 10 cm x 1 cm) and then dried in a tray dryer with air dehumidified by silica gel, natural zeolite, and synthetic zeolite (50 ˚C and ambient temperature). The air rate is 1.42 m/s and evaluate every 15 minutes for 150 minutes of operation.

Drying Rate

The data obtained experimentally for the various adsorbents (natural zeolite, synthetic zeolite, and silica gel) was plotted drying rate versus moisture content. Drying rate was calculated to estimate the drying efficiency using the following equation:

$$N = -\frac{Ms}{A}\frac{dX}{dt} \quad (1)$$

where N is the rate of water evaporation (expressed in kg m^{-2} h^{-1}), A is the evaporation area and Ms is the mass of bone dry solid and X is moisture content.

Thermal Efficiency

The thermal efficiency was roughly estimated based on the air temperature entering and exiting the dryer, as expressed in Equation 2.

$$\eta = \frac{Tid - Tod}{Tid - Tamb} x100\% \quad (2)$$

Here, η was the thermal efficiency, T_{id}, T_{od} was the air temperature entering and exiting the dryer (ºC), respectively, and T_{amb} was the ambient temperature (ºC).

RESULT

Effect of Drying using desiccant

Drying steps on white noodles carried out at a temperature of 50 °C, 60 °C, and ambient temperature with drying time for 150 minutes and airflow rate 1.42 m/s. In this research, the weight of white noodles was observed during the drying process at the different adsorbents (silica gel, natural zeolite, and synthetic zeolite). Drying is the process of transferring heat and mass between the surface of the product and the drying media to produce the product to a safe storage level[14]. During the noodles drying process, initially, the moisture content reduced faster from the edges [15]. The drying without air dehumidification at temperature 50 °C and 60 °C was shown in Figure 1. The picture represents that white noodles drying at temperature 50 °C cannot meet the moisture content standard (maximum 14.5% wb), it may be due to the slow diffusion process [16]. While at temperature 60 °C can meet the standard with a drying time of 75 minutes and 12.65% moisture content wet base (<14.5% wb). The higher the temperature, the greater the heat energy carried, and the greater the difference between heating media and food. It will encourage more speed in the process of transferring or evaporation of water [17]. The drying at temperature 50 °C with different adsorbents was shown in Figure 2. Drying sohun at temperature 50 °C using silica gel, natural zeolite, and synthetic zeolite can reduce moisture content compared to without the use of adsorbents. However, the use of silica and natural zeolite not able to reduce the sohun moisture content to 14.5 %. While the use of synthetic zeolite can dry up to 13.7% within 90 minutes. The use of adsorbents in the drying process can reduce relative humidity. This low relative humidity will cause a greater transfer of heat and mass from the material to the air [17]. The drying at ambient temperature using different adsorbents was shown in Figure 3. From the figure, we can see that drying at ambient temperature for 150 minutes using silica gel, natural zeolite, or synthetic zeolite cannot dry the sohun up to 14.5%. However, the best performance was shown by synthetic zeolite which can dry up to 28% wb.

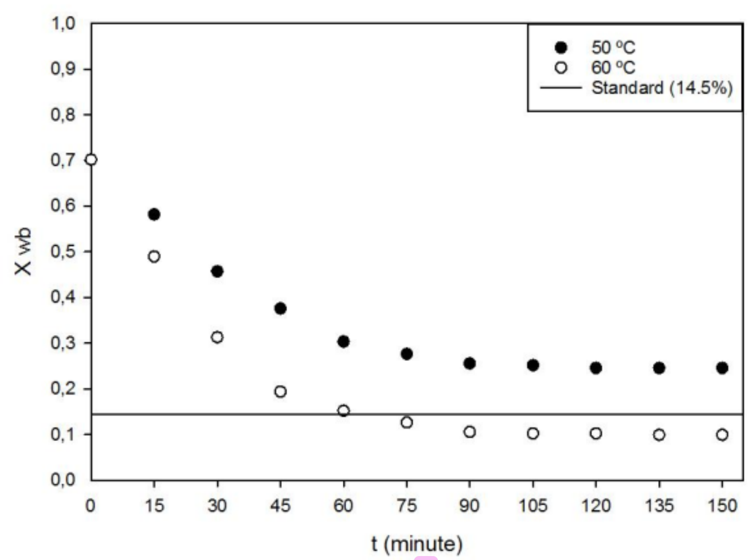

Figure. 1. Moisture content (wb) of white noodles as a function of time at various temperature

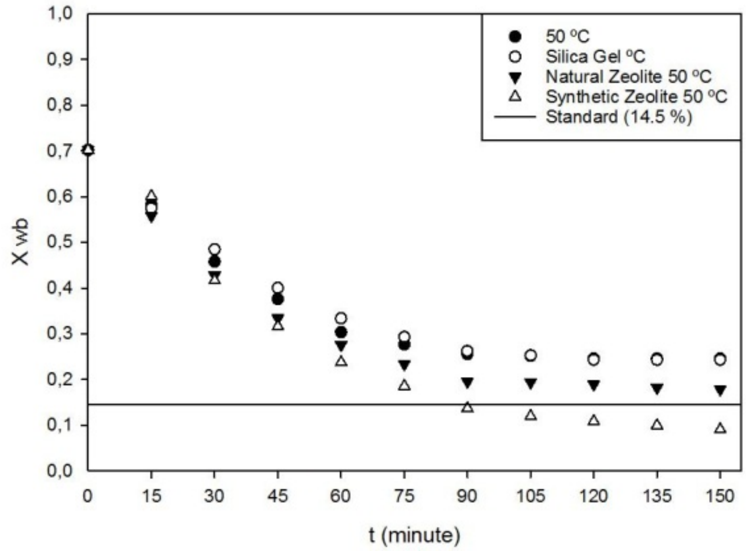

Figure. 2. Moisture content (wb) of white noodles as a function of time at temperature 50 °C, various adsorbents

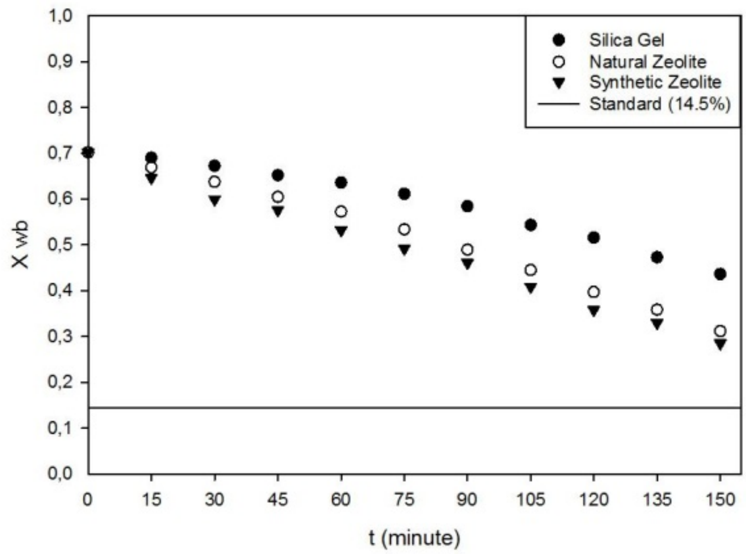

Figure. 3. Moisture content (wb) of white noodles as a function of time at ambient temperature, various adsorbents

Figure 4 and Figure 5 show the graph of drying rate in drying without air dehumidification (50 ºC and 60 ºC) and using air dehumidification, respectively. At this graph, we can see that the different adsorbents will show the differences mass of drying sohun. This result indicates that the drying process occurs, the process of heat and mass transfer between air and the moisture content in sohun. A very significant decrease in the weight of vermicelli indicates heat and mass transfer. This process consists of three stages: preheating or adjusting the temperature of the dried material, constant rate period, and falling rate period.

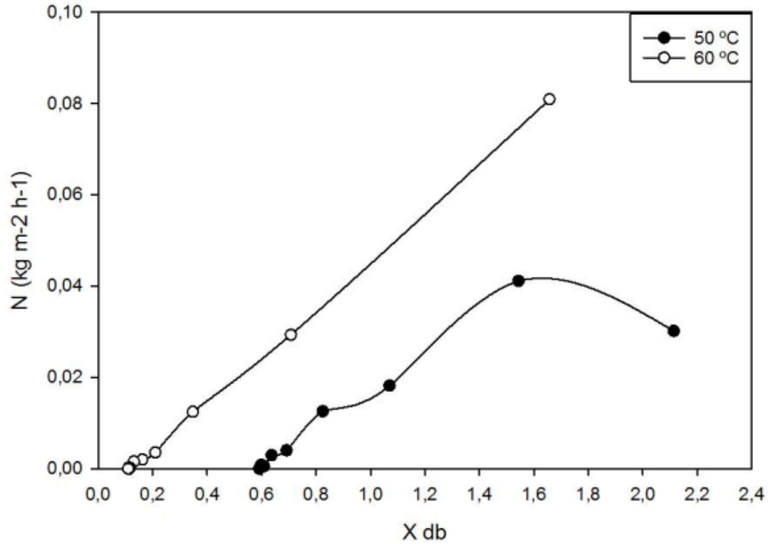

Figure. 4. The drying rate of white noodles as a function of moisture content (dB) at various temperature

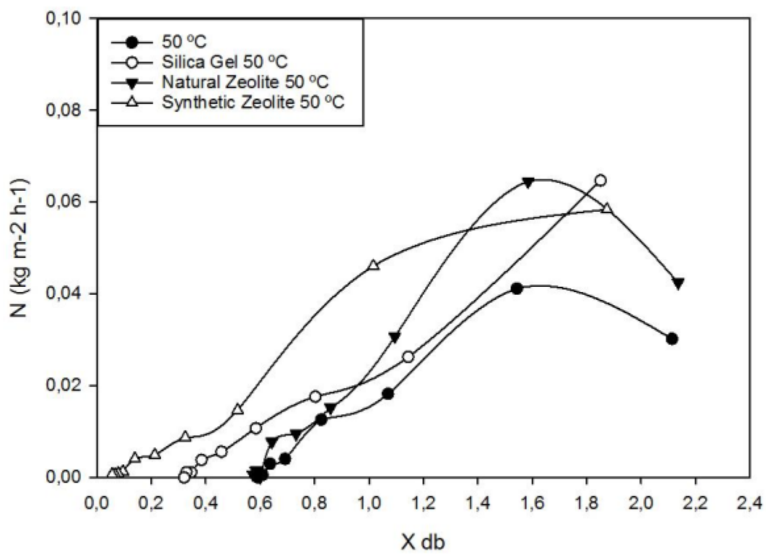

Figure. 5. The drying rate of white noodles as a function of moisture content (dB) at temperature 50 °C, various adsorbents

Product color is a crucial parameter that needs to be maintained during sohun drying. The air temperature was usually set high to increase the drying rate in the main drying stage according to the three-stage drying method[18]. But, the color can be changed from wet sohun to dried sohun can make the color change to browning by high temperature. The drying with adsorbents can prevent the color of white noodles browning. The browning indicates that the component in white noodles ruins and remove the ingredients. Drying at higher temperatures resulted in a greater color change. Therefore a reduction in drying temperature and use of adsorbents can be applied to minimize browning.

The Average Thermal Efficiency

Smaller thermal efficiency indicates that less water can be evaporated or more heat is required for evaporating bounding moisture. A comparison of the average thermal efficiency of drying white noodles at 60 ºC without adsorbents and 50 ºC using synthetic zeolites was shown in Figure 6. This figure represents that the low-temperature drying performance of 50 ºC can equal the drying at 60 ºC if synthetic adsorbent zeolites were added.

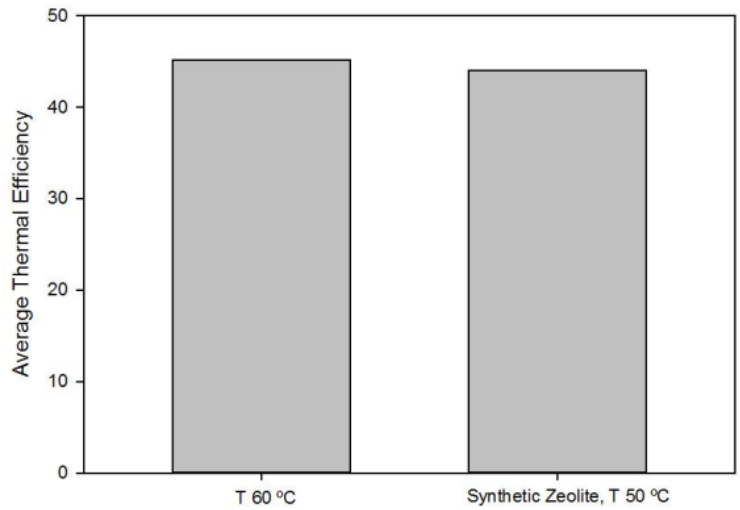

Figure. 6. The average thermal efficiency between sohun drying at 60 ºC and 50 ºC, synthetic zeolite

CONCLUSION

White noodles drying with adsorbents at a tray dryer has been conducted. Results indicated that higher air temperature faster drying. With adsorbents, the performance of the dryer can be improved where the synthetic zeolite was the most superior compare to the others. Drying sohun at low temperature at 50 ºC using synthetic zeolite result 13.7% moisture content within 90 minutes. The low-temperature drying with air dehumidification can prevent the color of white noodles browning. The low-temperature drying performance of 50 ºC can equal the drying at 60 ºC if synthetic adsorbent zeolites were added.

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