The drying rate of mushroom on tray dryer and effect of mushroom powder on organoleptic properties of Batagor

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Abstract. Oyster mushrooms and straw mushrooms are currently great demand in the food industry. Mushrooms have the characteristics that are easily damaged and decomposed. The effort of preserving mushrooms is by drying using hot air at a certain temperature and flow rate. The purpose of this study was to determine the drying rate of oyster mushrooms and straw mushrooms in variations temperature and flow rate of hot air. In this study, the drying of mushrooms was carried out with a tray dryer that has a stacking rack with dimensions of 30 cm x 25 cm. The temperature variations used were 30, 40, 50ºC and the dryer air flow rate was 1, 2, 3 m/s. The dried mushroom with a moisture content of less than 10% is mashed to a powder then added to the food (Batagor) for an organoleptic test. The best drying result is obtained at temperature 50ºC and flow rate of 3 m/s with a drying rate of 1.52 kg water/m².h. Organoleptic test on Batagor produces the most preferred flavour by using type mushroom of Volvariella volvacea, and for aroma and texture preferably with Pleurotus ostreatus.

1. Introduction
Oyster mushroom (Pleurotus ostreatus) and straw mushroom (Volvariella volvacea) are edible fungi that are easily obtained and cultivated. Mushrooms are foods that contain protein, vitamins, and minerals. Protein content in oyster mushrooms is 20-25%, fiber 37-48%, fat 4-5%, carbohydrates 37-48%, minerals 37-48% and moisture content 86-87%. Oyster mushrooms also contain 19 types of amino acids such as cysteine, glutamic acid, aspartic acid, and lysine. Vitamin C and folic acid are also found in oyster mushrooms [1]. The high potassium to sodium ratio makes this fungus ideal for treating hypertension and heart disease. Straw mushroom (Volvariella volvacea) have been tested and added to Cantonese sausages [2]. With the addition of edible mushroom powder, it can enhance the flavor and nutrition to Cantonese sausages. Mushrooms are cultivated to be used as food ingredients and can be used as medicine. Mushrooms can be used to reduce cholesterol levels, high blood pressure, obesity, inflammation, and cancer [3]. From the research results of oyster mushroom (Pleurotus ostreatus) which has heteropoly saccharide characteristics can be used to maintain health including antidiabetic activity [4], anti-hyperlipidemia [5] and anti-tumor [6].

Mushrooms have a short shelf life, are quickly damaged after post-harvest because the mushroom has a high moisture content. To extend the shelf life of mushroom can be done by drying, canning, and pickling [7]. Dry mushrooms are usually used as an ingredient in various foods such as instant soup, snacks etc. Drying can maintain taste, color, and aroma.
Drying is the most inexpensive method for storing mushrooms, if stored in an airtight condition, the fungus can be stored for more than 1 year [8]. Various conditions for drying mushroom operations will affect the quality of the mushroom powder produced. These conditions are drying flow rate and drying air temperature. Various ways of drying can be done to make mushroom powder. Drying using tray dryer is an inexpensive and effective tool in drying mushrooms because mushrooms are low density. To dry the mushroom from 7.5% moisture to 2% the time required for the type of cabinet/tray will be faster than the fluidized bed or microwave oven. But it is slower than using vacuum drying. However, the tray dryer has the advantage of being easy to operate rather than vacuum drying.

The purpose of this study was to determine the drying rate of drying mushrooms and investigate the effect of adding mushroom powder on texture, color and sensory properties on snack Batagor (tofu with meatballs frying), as an alternative to improve the quality and nutrition of Batagor. Batagor is a snack made from tofu and meatballs, which are fried with a mixture of flour dough.

2. Material and method

2.1 Experimental procedures

The Oyster mushrooms and straw mushrooms were got from Bandung, West Java, Indonesia. Early preparation was done by washing the mushrooms and cut to a size of 4 mm. Mushrooms were arranged on the top of the tray and put into the tray dryer. The dryer used in this study is presented in Figure 1. The mushrooms were dried at various temperature (30°C, 40°C, 50°C) and air flow rate (1m/s, 2m/s, 3 m/s). During the drying process, temperature, weight, and humidity were observed. The drying was terminated when the sample had reached a constant weight. Furthermore, dried mushrooms were mashed and used as additional ingredients in batagor.

![Figure 1. Tray dryer](image)

2.2 Data Analysis

Moisture content was defined as

\[ X_t = \frac{(W - W_s)}{W_s} \]  
\[ X = X_t - X^* \]  

For drying rate, could be determine as

\[ R = -\frac{L_s}{A} \frac{dX}{dt} \]

for

\[ X_t = \text{moisture content at the time (kg water/kg dry solid)} \]
\[ W = \text{weight of the wet solid (kg)} \]
\[ W_s = \text{weight of the dry solid (kg)} \]
X = moisture content (kg free water/kg dry solid)
X* = equilibrium moisture content (kg equilibrium moisture/kg dry solid)
R = drying rate (kg water/h.m²)
Ls = weight of dry solid used (kg)
A = surface area for drying (m²)

2.3 Organoleptic test

Organoleptic tests conducted in this study used three samples with code A (sample without mushroom powder); B (sample with oyster mushroom powder); C (sample with straw mushroom powder). The parameters tested by panelists include savory flavors, aroma, color, and texture. The assessment conducted by the panelists is by observing the sample and filling out the questionnaire with a numerical assessment in each parameter. Organoleptic test on batagor samples with mushroom-based flavorings was carried out on 20 random panelists aged 18 – 45 years.

The organoleptic test method used in this study is the preference test. The quality determining factor in this method is the feeling of liking or dislike of the panelists for the product given. The level of the panelist’s preference is expressed on a hedonic scale that distinguishes some product offered.

3. Result and discussion

3.1 Effect of temperature on drying time

The drying operating conditions determine the results of the products got. The operating conditions are temperature and drying air flow rate. The temperature used in the food dryer ranges from 30 - 60°C [9]. If the temperatures used under 30°C will require a longer drying time compared to the use of a higher temperature. Whereas if drying is carried out at temperatures above 60°C it will damage the micronutrients in the material. The higher drying temperature results in more starch or carbohydrates being converted into sugar. When carbohydrates are heated, the sugar in the carbohydrates will turn brown [10].

Effect of drying temperature of Oyster mushrooms is presented in Figure 2. At a Temperature of 50°C drying time is faster than 30°C which is half the time required for drying at 30°C. The phenomenon also occurs in drying straw mushroom (Figure 2 (b)) which shows that the shortest time required is 390 minutes. Drying time is faster because of the higher temperature. The higher the heat energy carried out by air, the greater the amount of mass of liquid evaporated from the surface of dried material.

![Figure 2](image-url). Effect temperature at air flow rate of 1.5 m/s (a) oyster mushrooms (b) straw mushroom
3.2 Effect of air flowrate on drying time
As the drying air flow rate increases, it will also increase the diffusion of hot air into each sample. So that the water content in the sample can be reduced faster and shorten the drying time. In Figure 3, the fastest drying time is achieved at the highest air flow rate of 3 m/s for both oyster mushrooms and straw mushrooms. At the end of the drying process, the moisture content of solid materials with varying flow rates experience almost the same value. This happens because the relative humidity the drying air used has the same value. The relative humidity is obtained from the use of the same drying air temperature of 40°C.

![Figure 3. Effect air flow rate at 40°C (a) oyster mushrooms (b) straw mushroom](image)

3.3 Effect of temperature on drying rate
The effect of temperature on the relationship between moisture content in solids and drying rate is shown in Figure 4. At the beginning of the drying process, the water contained in the solids is still large enough so that the drying rate is faster because a lot of water is evaporated. However, after some time, drying reaches a constant condition so the existing water vapor is surface water vapor. This constant period is visible at 50°C. After that, the curve has decreased which proves that the evaporated water is bound to water vapor resulting in a decrease in the drying rate.

![Figure 4. Effect temperature on drying rate at 3 m/s (a) oyster mushrooms (b) straw mushroom](image)
Increasing temperatures results in increased drying rate so that the water content in the material decreases. This is due to the diffusivity of water on the surface and inside the solid increases with increasing temperature. This phenomenon occurs as shown in Figure 4, where for the type of mushroom, drying at a temperature of 50°C gives a higher drying rate than the temperature of 30°C and 40°C which is 1.52 kg of water/h.m².

3.4 Effect of air flow rate on drying rate
The air flow rate affects the drying rate of the mushrooms. Figure 5 shows the fluctuating drying rate of mushrooms because the air flow is not evenly distributed throughout the surface of mushrooms. Effect of air flow rate on drying straw mushrooms has the opposite phenomenon of drying oyster mushrooms. The highest drying rate is obtained from the air flow rate of 2 m/s. Tray dryer has disadvantages, dried mushrooms in the bottom tray get heat and a larger air flow compared to the upper tray.

3.5 Organoleptic test
Organoleptic test results are presented in Table 1. The results of the assessment of savory flavors in a various sample given, sample C obtained the highest score of 4.7. For aroma and texture, sample B obtained the best value compared to sample A and C. For the best color assessment is given to sample A, which gets a perfect score (very preferred).

| Sample | savory taste | aroma | color | texture |
|--------|--------------|-------|-------|---------|
| A      | 4.65         | 4.30  | 5.00  | 4.65    |
| B      | 4.50         | 4.50  | 4.50  | 4.85    |
| C      | 4.70         | 4.45  | 3.70  | 4.30    |
Figure 6. Batagor with a variety of mushroom powder: (A) Original Batagor without mushroom powder, (B) Batagor with oyster mushroom powder, (C) Batagor with straw mushroom powder

The color of the sample is influenced by several factors, such as frying time, the temperature of cooking oil, and the raw material color. Sample with straw mushrooms is browner than other varieties. This is because the straw mushroom in the initial conditions has been brown and cannot be removed before processing into flavoring powder. Based on the result of organoleptic tests, it can be concluded that the use of straw mushroom powder as an alternative to MSG is very possible to use. It is proven to get a higher taste for savory sample compared to other variations.

4. Conclusion
Based on this study, the most effective temperature for drying mushrooms is 50°C. The air flow rate of 3 m/s during drying of oyster mushrooms provides a drying rate of 1.52 kg of water/h.m². The organoleptic results tested using mushrooms powder on food (Batagor) give results: straw mushrooms are preferred for savory flavours, while oyster mushrooms for aroma and texture.

5. References
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