Physicochemical properties of white oyster mushroom
(*Pleurotus ostreatus*) flavouring powder

N L Rahmah¹, Sukardi¹, W Wulantiasari¹ and N Wijayanti²
¹Department of Agro-industrial Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia
²Department of Agricultural Product Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

E-mail: nur_laila@ub.ac.id

Abstract. White oyster mushroom – WOM- (*Pleurotus ostreatus*) was only has a shelf life of 2-3 days so it needs further processing to extend its shelf life. WOM contains 41 mg of glutamic acid/g dried mushrooms. It makes WOM have a savory taste or umami. The drying process of WOM broth could affect the physicochemical properties of WOM flavouring powder. The purpose of this study was to determine the effect of temperature and drying time on the physicochemical properties of WOM flavouring powder and to know the best treatment. This study used a factorial randomized block design with two factors, namely temperature (60, 70, and 80°C) and drying time (8, 10, and 12 hours). Replication was done 3 times. Data analyzed using variance analysis (α = 0.05). The drying temperature significantly affected the yield, solubility, and water content parameters but did not significantly affect the glutamate acid level while the drying time significantly affected all parameters. The best treatment of WOM flavouring powder was obtained with a drying temperature of 80°C for 8 hours with physicochemical properties are 21.30% of yield, 82.58% of solubility, 7.75% of moisture content and 621.54 ppm of glutamic acid content.

1. Introduction

White oyster mushroom (WOM) (*Pleurotus ostreatus*) is a type of wood fungus that contains glutamic acid reaching 41 mg/g of dried mushrooms [1]. This content makes WOM have a savory taste or umami. The taste and aroma can be obtained from a broth of oyster mushroom. WOM production according to the Central Bureau of Statistics in 2017 [2] reached 37,020 tons where East Java became one of the most oyster mushroom producing regions. It produced more than 25% of national mushroom production. The problem is that oyster mushrooms have a short shelf life that is only 2-3 days after harvesting due to high water content, which is around 86.6% [3]. Therefore, it is needed for food processing technology to extend the shelf life of WOM, one of which is flavored white oyster mushroom powder.

Drying process is an important step in making WOM flavouring powder. Drying is a process of decreasing water content to a certain extent so that it can slow down the rate of material damage due to biological and chemical activities before the material is processed [4]. The drying process can be influenced by several factors including the temperature and the time or duration of drying. Drying can affect the physical and chemical properties of a material. Based on this, it is necessary to know the temperature and time of drying according to the material to avoid the damage. Therefore this research...
studied to determine the effect of temperature and drying time on physicochemical properties of WOM flavouring powder and to know the best temperature and drying time.

2. Materials and method

2.1. Instruments and materials

The tools used in this research and testing are analytical balance (Sartorius ENTRIS 224-1S), digital balance (Sartorius ENTRIS 5201-1S), hotplate magnetic stirrer (SCIENTIFICA VELP), oven (MEMMERT UN 55), spectrophotometer UV-VIS (Thermo Scientific GENESYS 10 UV), cabinet dryer, blender, mortar, sieve of 20 mesh, thermometer, baking sheet, knife, glassware, filter fabric, desiccator and petri dish.

The materials used were white oyster mushrooms (got from a traditional market in Malang), garlic, salt, granulated sugar, pepper, water, aluminum foil and dextrin as fillers. The materials used for testing include tissue, filter paper, ninhydrin reagent (MERCK), aquadest, and ethanol pa (99%) (Smartlab), glutamic acid standard (L-Glutamic acid) (MERCK).

2.2. Method

2.2.1. Experimental design. The research method used was experimental laboratories, with the experimental design used namely Randomized Block Design (RBD) arranged in factorial with 2 factors and 3 replications. The first factor is the drying temperature which consists of 3 levels are 60, 70 and 80°C. The second factor is the drying time which consists of 3 levels are 8, 10 and 12 hours. In this study, 9 treatment combinations were repeated 3 times, there were a total of 27 trials.

2.2.2. Production of WOM flavouring powder. Production of WOM flavouring powder begins with WOM were weighed as much as 500 grams and then washed. Then reduce the size of 0.5-1 cm, boiled with 1000 ml of water (comparison with mushroom 1:2) at a temperature of 90 ± 3°C for 30 minutes and filtered. After that, the resulting filtrate added with salt 9.99% (b/b), garlic 1.5% (b/b), sugar 2% (b/b), pepper 0.01% (b/b), boiled again at a temperature of 90 ± 3°C for 2 minutes then filtered. 100 ml of resulting filtrate added with 18.72% (b/b) dextrin and then dried by oven at 60, 70, and 80°C with different drying times are 8, 10 and 12 hours then size reduction and sieving with 20 mesh size.

2.2.3. WOM flavouring powder yield. The WOM flavouring powder yield testing [13] was done by weighing the starting material and the final material. The yield is obtained by comparing the final material obtained with the starting material used and multiplied by 100%.

2.2.4. Solubility test. Solubility test [13] was done by filter paper was dried in an oven at 105°C for 10 minutes, then it was cooled in a desiccator for 30 minutes, weighing the empty weight. The sample weighed 1 gram and put in 100 ml water with a temperature of ± 25°C, stirred on a hotplate stirrer at the same speed for 5 minutes. The stirred sample was filtered with filter paper (known the weight). The filter paper was dried in an oven at 105°C for 3 hours, then cooled in a desiccator for 30 minutes, weighed to constant weight. Solubility calculation can be calculated with the ratio of weight after the oven with the initial weight multiplied by 100%.

2.2.5. Moisture content. Moisture content [14] was done by petri dish was dried in an oven at 105°C for 24 hours, then cooled in a desiccator for 30 minutes and weighed the empty weight. The sample was weighed 1-2 grams inserted into the petri dish (known weight). It was dried in an oven at 105°C for 5 hours then cooled in a desiccator for 30 minutes and weighed to a constant weight. Water content is calculated by the ratio of weight after the oven with the initial weight multiplied by 100%.

2.2.6. Glutamic acid content. The measurement of glutamic acid content [5] was started by making standard glutamic acid curves with a concentration of 0, 200, 400, 600, 800 and 1000 ppm. The sample
was taken 1 ml and added with 1 ml of 0.1% ninhydrin which was dissolved in ethanol solvent. The mixture heated to the waterbath for 5 minutes was then cooled at room temperature and measured by a spectrophotometer at a wavelength of 570 nm. Calculation of glutamic acid content refers to the standard glutamic acid curve.

2.2.7. The best treatment. The best treatment used multiple attribute techniques [15]. The parameters used included WOM flavouring powder yield, solubility, moisture content, and glutamic acid content. To determine the values/scores in the WOM flavouring powder for each parameter, yield parameters, solubility, and glutamic acid content must be the highest, but moisture content must be the lowest according to the result of this research. The best treatment is obtained from the lowest total value. The total value was the sum of the values L1, L2, and L∞.

2.3. Statistical analysis
Data analysis used SPSS version 23 program with Analysis of Variant (ANOVA) method to determine the effect or difference of each treatment. Then proceed with the LSD (Smallest Significant Difference) or DMRT (Duncan Multiple Range Test). The confidence level used is 95% (α = 0.05).

3. Results and discussion
3.1. WOM flavouring powder yield
Based on the analysis of variance (ANOVA), it showed the interaction between the temperature factor and drying time and both had a significant effect (α = 0.05) on the WOM flavouring powder yield. The graph of WOM flavouring powder yield can be seen in figure 1.

3.2. Solubility test
Based on the results of variance analysis (ANOVA), the temperature factor and drying time and the interaction of both had a significant effect (α = 0.05) on the WOM flavouring powder solubility. Graph of WOM flavouring powder solubility can be seen in figure 2.
Based on figure 2, it shows that the mean ranges of WOM flavouring powder solubility from 69.02 to 93.19%. Based on these results that the higher temperature and drying time increased solubility produced. This is because at low temperatures and drying times it will produce high water content. The high water content will produce particles that are larger in size and can form a lump. It formed a strong bond between particles, so that solvent molecules are difficult to separate them. According to Sutardi [7], the flavoured with high water content can also cause the material to be difficult to be dispersed or spread in water solvents because the material will tend to be more sticky and will not form the pores so that the material difficult absorb much of water. Powder products with high water content are also thought to occur caking and can reduce the solubility of the material. Caking is an event where the constituent particles unit and form a larger size [16]. Powder with a high water content has a low solubility due to the formation of lumps which cause the breakdown time of particles by the solvent is longer, so that the total dissolved solids filtered on filter paper is increasing.

3.3. Moisture content

Based on the results of the analysis of variance (ANOVA), there was no interaction between the temperature factor and the drying time on the moisture content of WOM flavouring powder, but the temperature and drying times had a significant effect. Graphs of moisture WOM flavouring powder can be seen in figure 3.

Figure 3 shows that the mean ranges of WOM flavouring powder moisture content from 6.37 to 11.84%. Based on these results, the higher temperature and drying time decreased the moisture content of flavored WOM powder. The drying process on the WOM flavouring powder experienced two displacements, namely energy transfer from the environment to evaporate the water contained on the surface of WOM flavouring powder and the transfer of water mass contained in the WOM flavouring powder to the surface due to the evaporation process [8]. The higher the drying temperature, the faster
the water evaporated. The longer drying time, the more evaporated water so that the water content found in the material decreases. This is consistent with the research conducted by Daza et al. [9] which states that the higher the temperature of drying air and the longer drying process, the greater the ability of the material to release water from its surface so that the resulting water content gets lower.

3.4. Glutamic acid content

Based on the results of the analysis of variance (ANOVA), the drying temperature and interaction factors of the two factors were not significantly different on the WOM flavouring powder glutamic acid content but the drying time factor was significantly different. Graph of WOM flavouring powder glutamic acid content can be seen in figure 4.

![Graph of WOM flavouring powder glutamic acid content](image)

**Figure 4.** WOM flavouring powder glutamic acid content graph.

Figure 4 shows the mean ranges of WOM flavouring powder glutamic acid content from 612.38-785.71 ppm. Increased glutamic acid content at 8-10 hours drying time due to the water content in the flavor of the white oyster mushroom powder decreased and more evaporation occurred. Decreasing water content due to the water evaporation makes the percentage of other ingredients in the material increase. This is in accordance with the statement of Sobri et al. [10] that the higher drying temperature used in food, the lower the percentage of moisture content contained in it so that the percentage of protein content increased and the percentage of amino acids namely glutamic acid increased too. Drying for 12 hours caused glutamic acid content in WOM flavouring powder decreased. This is due to the Maillard reaction is the reaction that occurs between reducing sugars with free amine groups of amino acids or proteins because of excessive heat [11]. The Maillard reaction causes loss of amino acids, especially glutamic acid and causes the product to turn brownish in color. The maillard reaction did not require high temperatures, but the reaction rate will increase sharply with increasing temperature and drying time [12].

3.5. The best treatment

The best treatment is determined according to table 1. In this research, the best treatment of WOM flavouring powder was with a treatment temperature of 80°C and drying time of 8 hours (rank 1) which result a yield of 21.30%, solubility of 82.58%, moisture content of 7.75% and glutamic acid content of 621.54 ppm.
Table 1. Determination of best treatment.

| Parameters | L1     | L2     | L∞      | Total | Ranks |
|------------|--------|--------|---------|-------|-------|
|            | 0.9419 | 0.0203 | 0.1156  | 1.0778| 8     |
|            | 0.9556 | 0.0140 | 0.1010  | 1.0706| 7     |
|            | 0.9361 | 0.0193 | 0.0900  | 1.0453| 4     |
|            | 0.9495 | 0.0130 | 0.0840  | 1.0464| 5     |
|            | 0.9578 | 0.0098 | 0.0704  | 1.0381| 2     |
|            | 0.9447 | 0.0147 | 0.0975  | 1.0569| 6     |
|            | 0.9633 | 0.0060 | 0.0522  | 1.0215| 1     |
|            | 0.9694 | 0.0059 | 0.0650  | 1.0403| 3     |
|            | 0.9587 | 0.0151 | 0.1100  | 1.0839| 9     |

4. Conclusions
The results showed that the drying temperature factor had a significant effect on the parameters of yield, solubility, moisture content but not on glutamic acid content. The drying time factor significantly affected the parameters of yield, solubility, water content, and glutamic acid content. The interaction between the treatment of drying temperature and drying time significantly affected the parameters of yield and solubility but did not significantly affect the parameters of water content and glutamic acid content. The best treatment of WOM flavouring powder obtained with a drying temperature of 80°C for 8 hours with physicochemical properties are 21.30% of yield, 82.58% of solubility, 7.75% of moisture content and 621.54 ppm of glutamic acid content.

References
[1] Zhang Y, Chandrasekar V, Zhongli P and Wei W 2013 Recent developments on umami ingredients of edible mushrooms Trends Food Sci. Technol. 33 78–92
[2] Central Bureau of Statistics 2017 Statistics of Indonesian Seasonal Vegetable and Fruit Plants (Jakarta, Indonesia: Central Bureau of Statistics) (in Indonesian)
[3] Asgar A, Zain S, Widyasanti A and Wulan A 2013 The process of drying oyster mushrooms (Pleurotus sp.) using a vacuum drying machine J. Hort. 23 379–89 (in Indonesian)
[4] Aviara N A, Lovelyn N O, Oluwakemi E F and Joseph C I 2014 Energy and exergy analysis of native cassava starch drying in a tray dryer Energy 73 809–17
[5] Lawal A K, Oso B A, Sanni A I and Olatunji O O 2011 L-Glutamic acid production by Bacillus spp. isolated from vegetable protein African Journal of Biotechnology 10 5337–45
[6] Sitohang A and Bernatan S 2017 The effect dextrin concentrations and duration of drying times on quality passion fruit instant IOSR Journal of Enviromental Science, Toxicology and Food Technology 11 5–11
[7] Sutardi, Suwedo H and Constansia R N M 2010 The effect of dextrin and Arab gum on the chemical and physical properties of sweet corn juice (Zea mays saccharata) Jurnal Teknologi dan Industri Pangan 21 102–07 (in Indonesian)
[8] Kha T C, Minh H N and Paul D R 2010 Effect of spray drying conditions on the physicochemical and antioxidant properties of the gac (Momordica cochinensis) fruit aril powder J. Food Eng. 98 385–92
[9] Daza L D, Alice F, Carmen S F T, Juliana N R R, Daniel G and Maria I G 2016 Effect of spray drying condition on the physical properties of cagaita (Eugenia dysenterica DC.) Fruit Extracts Food and Bioproducts Processing 97 20–9
[10] Sobri A, Herpandi and Susi L 2017 Test of the effect of drying temperature on chemical and sensory characteristics of cork fish head powder broth (Channa striata) Jurnal Teknologi Hasil Perikanan 6 97–106 (in Indonesian)
[11] Prasetyo D Y B, Yudhomenggolo S D and Fronthea S 2015 The effect of temperature differences and fuming time on the quality of milkfish (*Chanos chanos Forsk*) pull out the smoke thorns *Jurnal Aplikasi Teknologi Pangan* **4** 94–8 (in Indonesian)

[12] Purwanto R O and Bambang D A 2010 Effect of glucose syrup composition and variations in drying temperature on physico-chemical and sensory properties of seaweed dodol (*Eucheuma spinosum*) *Jurnal Bioproses Komoditas Tropis* **1** 1–12 (in Indonesian)

[13] Sudarmadji S B, Haryono and Suhardi 1997 Analysis of Food Material and agricultural (Yogyakarta, Indonesia: Liberty)

[14] Association of Official Analytical Chemists 1995 Official Method of Analysis of The Association of The Official Analytical Chemist. AOAC. Wangshinton D C, USA.

[15] Zeleny M 1982 Multiple Criteria Decision Making (New York: Mc Graw-Hill Co)

[16] Marta H, Tensiska and Lia R 2017 Characterization of Maltodextrin from Corn Starch (*Zea mays*) using Acid Hydrolysis Method at Varios Concentrations Karakterisasi Maltodekstrin dari Pati Jagung (*Zea mays*) Menggunakan Metode Hidrolisis Asam pada Berbagai Konsentrasi *Chimica et Natura Acta* **51** 13–20