The formulation of white oyster mushroom (*Pleurotus ostreatus* (Jacq.) P. Kumm) as natural flavoring and the quality test in temperature and drying time variations

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Abstract. The determination of the drying temperature and time depends to the characteristic of the mushrooms. The use of low temperatures causes the mushrooms to not fully ripen, if the temperature is too high the protein contained in the mushrooms can be denatured and drying too long will change the color of the mushrooms to brown and change its taste. Research on the processing of oyster mushrooms as a raw material for natural flavoring, it is carried out to determine the quality flavoring produced through a descriptive test of the test parameters, color, aroma, taste and texture by variations the temperature 60°C and 70°C in drying time 6, 7 and 8 hours. The results of descriptive test of the sixth color of the flavoring have an intensity of attractive colors are light brown; Descriptive taste test F1, F2 and F5 have the intensity of the taste is rather pleasant, the umami is weak while F3, F4 and F6 have taste is quite good, umami tastes; Descriptive test of the six flavoring textures has a good intensity and; Descriptive test of the sixth aroma of flavoring has a slightly fragrant aroma intensity, the aroma of the material is not too smelly. The conclusion of the research is that temperature and drying time do not affect quality of color, aroma and texture. However, they affect the taste where the temperature 60°C for 8 hours and a temperature of 70°C within 7 and 8 hours have enough delicious taste with tasteful umami.

1. Introduction

Flavoring is an additive in food that has no taste, but the use of flavoring can increase the natural taste of umami in food [1]. These additives in addition to enriching the taste, can also maintain the freshness of the product and maintain the original taste for a long period of time in storage. The increasing interest in the discovery of natural umami formulations occurs because the taste is the main characteristic of food and has a huge impact on consumer choice so that extraction and utilization of flavorings from natural sources can be a viable solution to consumer negative attitudes towards additives. As a major source of natural umami components, edible mushrooms attract attention [2]. Mushrooms have long been used as food or flavoring because of their unique taste, aroma to taste as well as the components that add to their function for food including delicious properties, nutritional value, physiological effects, and cultural characteristics. [3].

In Indonesia, the white oyster mushroom (*Pleurotus ostreatus*) is one type of oyster mushroom that is often cultivated by farmers, including in Aceh Besar [4]. At the time of harvesting white oyster mushrooms, there are a large hood and a small hood in 1 mushroom. It is impossible to conclude and recommend the appropriate stage of harvest maturity to obtain mushrooms with maximum umami content based on the size of the hood [5]. Different sizes of the same mushroom species will give different results on the content of glutamic acid and aspartic acid. This is influenced by a number of factors, namely the stage of development, the part of the fungus, the quality of the fungus, and the location of harvest. From these results, it can be concluded that the umami content of edible mushrooms changes with the level of maturity. So, it is necessary to analyze the amino acids on various sizes of white oyster mushroom caps in Aceh to determine the harvest time. An important...
function of this fungus can be to add flavor to food or products over its nutritional properties [6]. The formulation of white oyster mushroom as the main component of natural flavoring is influenced by variations in temperature and drying time. This can not only reduce the moisture in the mushrooms and prolong storage time but also change the color, aroma, texture, and taste [7].

Determination of temperature and drying time must pay attention to the characteristics of the mushroom. The use of low temperatures causes the mushrooms to not ripen perfectly, if the temperature is too high the protein contained in the mushrooms can be denatured, and drying for too long will change the color of the mushrooms to brown and change the taste [8]. Mushrooms can be dried at a temperature of 45°C-95°C [9] and the optimum drying time is until the mushrooms are dry and can be mashed [10]. This shows that in the production process of flavoring, it is necessary to vary the combination of temperature and drying time to produce quality flavoring. Therefore, the white oyster mushroom was formulated as a flavoring by varying the drying temperature (60°C and 70°C) and drying time (6, 7, and 8 hours). The quality of the mushroom flavoring product was assessed by the panelists with a descriptive test, where it is expected that natural flavor enhancers made from white oyster mushrooms can be used as an alternative flavor enhancer.

2. Materials and Methods

2.1. Mushrooms Samples

White oyster mushrooms were taken directly by purposive sampling technique at the place of cultivation, namely Lamcheu village, Kuta Baro district, Aceh Besar regency. For the analysis of glutamic acid, 2 white oyster mushrooms were taken from the same hump with significant differences in size, namely large and size small-medium size. For the formulation, oyster mushrooms have to be good and fresh and the shape of the mushroom cap is blooming.

2.2. Drying white oyster mushrooms

A total of 10 kg of fresh white oyster mushrooms were washed with running water to remove the adhering dirt, then the oyster mushrooms were dried and aired for 3-4 hours and then separated into large oyster mushrooms and small mushrooms. Then the mushrooms are cut and dried for 14 days. Several oyster mushroom simplicia was dried in an oven at 60°C for 6 hours and then weighed. Simplicia that has been dried and the immersion is calculated. Then it is mashed with a blender and tested for water content and ash content. Furthermore, all simplicia was divided into 6 pans and coded F=Formula based on temperature and drying time. The first (F3), second (F2), and third (F1) pans were placed for 8, 7 and 6 hours, respectively, into the oven at 60°C. The fourth (F6), fifth (F5), and sixth (F4) pans were put for 8, 7, and 6 hours, respectively, into the oven at 70°C. Then, each simplicia was mashed using a blender and sieved using a 60-mesh sieve to obtain a uniform fine powder.

| Table 1. Oyster mushroom simplicia drying temperature and time. |
|----------------|----------------|----------------|
| **Powder**     | **Time (Hour)**| **Formula**    |
| Oyster Mushroom| **Temperature**|                |
|                | (°C)           | 6              |
| 60°C           | 1 F1           |
| 70°C           | 2 F2           |
| 8              | 3 F3           |
| 6              | 4 F4           |
| 7              | 5 F5           |
| 8              | 6 F6           |

2.3. Making flavors from Oyster mushroom powder

Oyster mushroom powder is formulated to be a flavor enhancer with addition of spices consisting of white pepper powder, onion powder, garlic powder. then prepared a container for mixing mushroom powder. Then 60.14% oyster mushroom powder is mixed with 1.11% shallot, 20.21% garlic, 6.18%
white pepper powder, 8.65% salt, and 1.24% sugar in the container then added roasted tapioca powder as much as 2.47%. The formula was stirred and then homogenized again with a blender, then sieved with a 60 mesh and packed in a container.

**Table 2.** Composition of natural flavouring based on Oyster mushroom powder.

| Ingredients                              | Amount (%) |
|------------------------------------------|------------|
| White oyster mushroom powder            | 60.14      |
| Tapioca flour                           | 2.47       |
| White pepper (Piper nigrum)              | 6.18       |
| Shallots (Allium cepa)                   | 1.11       |
| Garlic (Allium sativum)                  | 20.21      |
| Salt                                     | 8.65       |
| Sugar                                    | 1.24       |

Source: Rizani Modification, (2020)

2.4. **Test the characteristics of white oyster mushroom powder and flavoring**

Characteristics were carried out on white oyster mushroom powder and the resulting flavouring.

2.4.1. **Determination of Water Content [11]**. White oyster mushroom powder weighed as much as 2 g in a cup of known weight. The cup containing the sample was put in an oven and dried at 105°C for 3 hours. Then the cup is cooled in a desiccator until the constant weight. The water content is calculated using the following formula:

$$\text{Water Content (}\%\text{)} = \frac{W_1 - W_2}{W_1} \times 100\%$$  \hfill (1)

Where,

- $W_1$ = Weight of sample before drying
- $W_2$ = Weight of sample after drying

2.4.2. **Determination of Ash Content**. Porcelain cup weighed and heated then 1 g sample was added. Then the sample was heated using a furnace at a temperature of 600°C for 3 hours to obtain white ash. The ash was cooled in a desiccator for 30 minutes to constant weight. Then the ash content is calculated using the following formula:

$$\text{Ash content (}\%\text{)} = \frac{W_2 - W_{\text{cup}}}{W_1} \times 100\%$$ \hfill (2)

Where,

- $W_1$ = Weight sample before annealing
- $W_2$ = sample weight after annealing
- Cup = weight of empty cup

2.5. **Oyster Mushroom Amino Acid Analysis**

A total of 60 mg of white oyster mushroom powder added 4 ml of 6N hydrochloric acid heated for 24 hours at 110°C then cooled to room temperature. Then neutralized (pH 7) with 6N NaOH, and added aquabides to 10 ml, and then filtered using Whatman filter paper 0.2 m. A total of 50 µl of filtrate plus 300 µl of o-phthalaldehyde (OPA) solution was stirred for 5 minutes and then 10 l was put in a high performance liquid chromatography injector Thermo brand, LiChrospher 100 RP-18 (5µm) column, Mobile phase A= CH3OH: 50mM, sodium acetate: THF ( 2:96:2 ) pH 6.8; B = 65% CH3OH, Flow
rate 1.5 ml/min, Gradient Eluent Time 0.1; 15; 30; 40; 45 stops, Pump (A)% 100; 0; 0; 0; -, Pump (B)% 0, 35, 100, 100, Thermo Detector Ultimate 3000 Rs Fluorescence Detector.

2.6. Flavor organoleptic test
The organoleptic test selected in this study was a descriptive test. This test was carried out by panelists to determine the quality of the sample on texture, color, taste, and aroma at different temperatures and drying times. Each panelist was given 6 different types of flavoring samples, namely F1, F2, F3, and F4, F5, F6. Panelists tested the texture, color, aroma, and taste of the samples by tasting the samples and writing down the panelists' responses to the descriptive test questionnaire provided in the appendix.

3. Results and discussion
3.1. Oyster Mushroom Simplicia
Each part of the mushroom was chopped and carried out in 2 stages of drying, namely aerated for 14 days and then re-dried in the oven for 6 hours at a temperature of 600°C. This is because fresh white oyster mushrooms have a high moisture content of 92.65% [12] so a combination of drying must be carried out, wherein research [13] mushrooms that are directly dried in the oven will cause the mushroom to stick to the oven pan. Drying is a process of separating most of the water from the material in the form of evaporation as a result of heat absorption [14]. Drying using an oven aims to evaporate the water that is still bound in the Simplicia. The dry weight of simplicia was obtained, namely 62 grams of large oyster mushrooms, 78 grams of small oyster mushrooms, and 665 grams of other white oyster mushrooms, the total weight of simplicia was 805 grams. The percentage of oyster mushroom marinade is 8.05%.

3.2. Oyster Mushroom Simplicia characteristics
Characteristics carried out include water content and total ash content. The results of these characteristics can be seen in Table 3.

| Simplicia          | Parameters             |
|--------------------|------------------------|
|                    | Moisture Content (% ± SD) | Ash Content (% ± SD) |
| Large Hood Oyster  | 1.043 ± 0.00738        | 6.23±0.010            |
| Small Hood Oyster  | 1.97±0.472             | 5.09±0.017            |

3.2.1. White oyster mushroom water content. The difference in moisture content of the two mushrooms can be influenced by harvest time, ripening period, and environmental conditions such as humidity and temperature at planting time. Both mushrooms have a low water content which is included in the simplicia requirements according to BPOM RI (2014) which is less than 10% . With low water content, the shelf life of simplicia is also longer because microbial growth and enzyme activity that can damage the quality of simplicia can be inhibited.

3.2.2. Characteristics of Oyster Mushroom Total Ash Content. The principle of determining the total ash content of dry weight of oyster mushrooms is a combustion reaction, where a reaction occurs with O₂ so that all organic compounds will turn into CO₂ and H₂O leaving inorganic and mineral compounds that aim to determine the minerals contained [15]. The average percentage of total ash content of large oyster mushrooms obtained was 6.23% and the total ash content of small oyster mushrooms obtained was 5.09%. In contrast to the study of Mau et al., [16] large-sized P. eryngii obtained 5.76% and small-sized P. eryngii obtained 7.21%. Meanwhile, research by Kalac [17]
showed that the body of white oyster mushrooms produced a higher ash content of 12.5%. Maftoun et al., [18] stated that oyster mushrooms contain various kinds of minerals, including the body which is characterized by the highest mineral content. The majority of minerals contained are K, P, Na, Ca, Mg and other minor components including Cu, Zn, Fe, Mo, Cd. The mineral content in mushrooms is influenced by the species, level of maturity, the part of the mushroom, and the composition of the substrate. High ash content indicates high mineral content in white oyster mushrooms.

3.3. Amino Acid Analysis

Based on the results of the HPLC chromatogram, there were 15 types of amino acids identified. This is due to the deamination of asparagine during hydrolysis with HCL into aspartate. And glutamine is deaminated into glutamate. The advantage of deamination is that it increases aspartate and glutamate levels. Asparagine and glutamine are commonly found in enzymatic protein hydrolysis. Tryptophan and cysteine are amino acids that are degraded by HCl solution. The hydrolysis method for the analysis of tryptophan and cysteine does not use acid but uses a basa. White Oyster Mushrooms do not contain Proline.

| No | Amino acid          | Big Oyster Mushroom Concentration (mg/g) | Small Oyster Mushroom Concentration (mg/g) |
|----|---------------------|-----------------------------------------|-------------------------------------------|
| 1  | Aspartate           | 23.56                                   | 23.27                                     |
| 2  | Glutamate           | 40.95                                   | 42.47                                     |
| 3  | Serine              | 12.33                                   | 12.55                                     |
| 4  | Histidine           | 6.79                                    | 7.23                                      |
| 5  | Glycine             | 10.31                                   | 10.17                                     |
| 6  | Threonine           | 14.54                                   | 14.24                                     |
| 7  | Arginine            | 18.42                                   | 18.94                                     |
| 8  | Alanine             | 14.31                                   | 13.74                                     |
| 9  | Tyrosine            | 11.32                                   | 11.40                                     |
| 10 | Methionine          | 1.44                                    | 1.28                                      |
| 11 | Valine              | 10.94                                   | 10.82                                     |
| 12 | Phenylalanine       | 11.02                                   | 10.89                                     |
| 13 | Ileucine            | 9.32                                    | 8.92                                      |
| 14 | Leucine             | 15.86                                   | 14.18                                     |
| 15 | Lysine              | 17.97                                   | 18.27                                     |

3.4. Flavoring

Simplicia as much as 665 grams which have been dried at a temperature of 60°C and 70°C during a drying time of 6, 7, 8 hours will experience changes in umami taste because it is influenced by the processing and maturity. Drying as a processing process does not only reduce moisture activity in raw materials so that it can inhibit microbial growth and unwanted reactions and extend shelf life but also change the texture and improve taste. Simplicia that has gone through the drying process is mashed using a blender and sieved with a 60 mesh to achieve a uniform fine powder [19].

White oyster mushroom flavoring is formulated with the addition of several natural additives, namely onion powder, garlic powder, white pepper, tapioca flour, salt, and sugar that have been remashed using a blender. the use of spices such as shallots, garlic, and white pepper as additional ingredients in this study can produce a distinctive taste and aroma. The use of tapioca flour in the formulation of flavoring can increase the adhesion of the flavoring to the food that is added with mushroom flavoring. Garlic contains allicin compounds, and red onions contain alliin compounds which play a role in producing a savory taste and fragrant aroma in cooking [20]. While white pepper
acts as an ingredient that gives a fairly sharp aroma and spicy taste because of Chavicine compounds which are similar to Capsaicin in chilies. Salt can give a salty taste so it is commonly used as a seasoning in cooking. In addition, salt functions as a preservative and is not toxic. The ability of salt as a preservative is due to its ability to act as a selective inhibitor of certain polluting microorganisms and can affect the water activity of a product so that it can control microbial growth. Then sugar gives sweetness to flavoring and has preservative properties that can bind water so that it does not become available for the growth of microorganisms [21]. Furthermore, each Simplicia of variations in temperature and drying time of white oyster mushrooms was mashed with a blender and added these additional ingredients, and blended again to achieve a homogeneously mixed flour and then sifted with a 60-mesh sieve to get a smoother flavoring flour.

3.5. Flavoring Characteristics

Characteristics carried out include water content and total ash content of the resulting flavoring.

| Flavor Formulation | Moisture Content (%±SD) | Ash Content (%±SD) |
|---------------------|-------------------------|--------------------|
| F1 (60°C, 6 hours)  | 1.018±0.015             | 13.73 ± 0.15       |
| F2 (60°C, 7 hours)  | 1.012 ± 0.009           | 13.25 ± 0.07       |
| F3 (60°C, 8 hours)  | 1.015 ± 0.002           | 12.83±0.00         |
| F4 (70°C, 6 hours)  | 1.026 ± 0.002           | 10.25 ± 1.59       |
| F5 (70°C, 7 hours)  | 1.007±0.012             | 11.97±1.74         |
| F6 (70°C, 8 hours)  | 1.023 ± 0.013           | 12.41±0.66         |

3.6. White oyster mushroom flavoring water content

The water content of each variation of temperature and drying time of flavoring flour is lower than the water content of mushroom simplicia. This difference is due to the determination of the water content, the mushrooms are aerated and re-dried at a temperature of 60°C for 6 hours, while the simplicia prepared for flavoring is heated at a higher temperature variation and the drying time is longer so that the simplicia contains less water than the flavoring but belongs to the quality requirements of simplicia moisture content according to BPOM RI (2014), namely mushroom simplicia powder at variations in drying temperatures of 60°C and 70°C at 6, 7, 8 hours which has been formulated according to the quality requirements of seasoning flour water content, namely (SNI 01-4476-1998) with an average moisture content of more than 1%.

This is also influenced by the addition of spices. This is because spices can attract moisture content from the surrounding environment during the seasoning storage process. The value of water content in this flavoring is quite low, so it is suspected that flour will have a longer shelf life due to microbial growth and enzyme activity that can damage the quality of flour and can be inhibited. Because the water content is too high in flour products, the flour will clump during storage and be easily damaged. From table 4.2, it can be seen that the higher the temperature and the drying time, the higher the water content except at F5, which is 70°C temperature, and 7 hours of drying time which has the lowest water content. In contrast to the research of Lisa et al., (2015) where the higher the temperature and the drying time, the lower the water content, this is due to continuous evaporation of water.

3.7. Total ash content white oyster mushroom flavor

The total ash content of each white oyster mushroom flavoring produced was 10.52%-13.73% higher than the total ash content of the previous white oyster mushroom Simplicia powder, namely 6.23% and 5.09%, respectively. The ash content is related to the mineral content in the flavoring, the increase in the total ash content of the white oyster mushroom after being processed into flavoring is influenced by the additional ingredients in the processing of the mushroom flavoring. One of the additives that can affect the increase in the percentage of ash content for flavoring is salt. Because salt is a food
ingredient that gives a salty taste to food and contains various types of minerals. The dominant types of minerals contained in salt are Na, Cl, and I. So, from some additional ingredients used, the addition of salt affects the percentage of minerals in the total ash content of flavoring. In general, it can be seen that the treatment applied to the white oyster mushroom flavoring process is not directly proportional to the ash content produced, namely the higher the temperature and the drying time, the higher the total ash content because the water content in white oyster mushrooms has decreased higher, so that the material left on the mushroom will increase, one of which is minerals.

3.8. Description test

The descriptive test is a sensory method that covers all product parameters or can be limited by 25 semi-trained panelists. This study uses panelists on certain aspects, namely aroma, taste, color, and texture. This test is expected to help identify the variables of additional ingredients or processes related to certain sensory characteristics of flavoring, namely variations in temperature and drying time of white oyster mushrooms as the basis of natural flavoring formulations. The descriptive test assessed the intensity of the product with a scoring system that decreased on aroma, taste, color, and increased scoring on texture. The results of the descriptive test of natural flavoring based on white oyster mushrooms with temperature variations of 60°C and 70°C at 6, 7, 8 hours.

Based on the results of the descriptive test, it was shown that the six flavorings tested had various variations in the assessment of each test parameter.

![Figure 1. Graphics of descriptive test results for flavouring.](image)

In the descriptive color test of each flavoring sample, the white oyster mushroom flavoring sample tested has an attractive color intensity, namely light brown which is one of the attractions of a product, based on the score of each sample so that it is included in the category 4 score. 60°C and drying time of 8 hours with results > 3.8 but not significantly different from other flavorings. This is following the research of Widyastuti et al., (2015), where the flavoring of white oyster mushrooms is preferred in terms of color because it is similar to commercial flavoring products.

Food taste is a very important parameter to determine the level of acceptance of food products. The results of the Descriptive Taste test showed that the flavorings F1, F2, and F5 had a slightly pleasant taste intensity, the umami was weak based on the score of each sample was <2.4 so, it was categorized in a score of 2. While the white oyster mushroom flavoring samples were F3, F4 and F6 have a fairly good taste intensity, the umami taste based on the P-value of each sample is >2.5 and the best taste is owned by the F3 variant, which is quite tasty has umami taste to it. The distinctive taste of oyster
mushroom flavoring is not only influenced by one component but is influenced by certain components that have a distinctive smell and taste. It is thought that the taste of food is only produced after the taste is combined with the smell. The taste that appears in the flavoring also comes from the additional ingredients contained in the flavoring such as shallots with the volatile compound alliin, garlic which contains the compound allisin which plays a role in producing fragrant compounds in a dish, and powdered white pepper that causes a spicy taste by the compound.

The texture is one of the material properties that can be felt through tasting or putting pressure on the product. The results of the descriptive test on the texture of the white oyster mushroom flavoring F1, F2, F3, F4, F5, and F6 were tested to have a smooth texture intensity based on the score value of each sample is >1.5 As stated by Lisa et al., (2015) drying affects the texture where the level of hardness of the material will produce larger particles during the grinding process so that the amount of material that passes during the sieving process is also greater. Based on the descriptive texture test graph, the higher the temperature and drying time, the smoother the texture where F6 as a formulation for drying mushrooms at a temperature of 70°C at a drying time of 8 hours has the highest value compared to other flavorings.

The quality of a food product is determined by the aroma released or generated which can stimulate the sense of smell so that the desire to consume the product arises. Mushrooms have a characteristic odor caused by naturally occurring volatile aromatic compounds. The volatile compounds responsible for the unique mushroom aroma are 3-octanone, 1-octen-3-one, 3-octanol, 1-octen-3-ol, benzaldehyde, 1-octanol, and 2-octen-1-ol. When the drying temperature increased, the aroma also increased. In contrast to this study, the highest aroma was found in F1 with a temperature of 60°C and a drying time of 8 hours. The higher the drying temperature and time, the lower the aroma in the ingredients, because the water content in the food will dissolve the distinctive taste if the temperature and drying time are too high [22, 23]. Descriptive tests on the aroma of the F1, F2, F3, F4, F5, and F6 flavors that were tested had different aroma intensities but based on the score the value of each sample was >2.5 so that it is categorized in somewhat fragrant, the aroma of the material is not too smelly. It can be seen in the graph that the difference in aroma at a temperature of 60°C is higher than 70°C. This is influenced by additives that not only affect the taste but also the aroma, namely the volatile aromatic compounds allicin in garlic, allisin in shallots, and pipeline in powdered white pepper.

4. Conclusions
The formulation of white oyster mushrooms with powdered additives such as onion, garlic, pepper, sugar, and salt have the opportunity to be developed into a natural flavoring base. The total levels of glutamic acid and aspartic acid as pleasant-tasting amino acids in small oyster mushrooms are 66.24 mg/g, higher than large oyster mushrooms, which are 64.51 mg/g. Flavorings (F3, F4, F6) at a drying temperature of 60°C for 8 hours and a temperature of 70°C for 7 and 8 hours produced the best quality, which has a fairly good taste with umami taste while the drying temperature is 60°C, 70°C and a drying time of 6, 7, 8 hours did not affect the quality of color, aroma, and texture of the flavoring, where the six flavorings had different values but in the same range.

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