

PASTEURIZATION OF COCONUT WATER AND RICE WASHING WATER AS A SUPPLEMENT FOR EXTENDING THE LIFE OF OYSTER MUSHROOM CULTIVATION MEDIA

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ABSTRACT

*In the cultivation of oyster mushrooms, it often occurs that the growing media in the baglog is not able to support the growth of oyster mushrooms optimally. This is partly due to the limited availability of nutrients from the supplements given at the beginning of the preparation of the growing media. The addition of supplements in the middle of the cultivation period is possible, but it is prone to contamination by saprophytic fungi and bacteria. This study aims to obtain information on the potential of coconut water and rice washing water as nutritional supplements in oyster mushroom (*Pluerotus ostreatus*) cultivation and to obtain information on the temperature range and length of the supplement pasteurization process to extend the life of the growing media in the baglog. This research was conducted from May to October 2020 using an in-depth literature review method. The results of the study show that rice washing water and coconut water can be used as supplement materials in oyster mushroom cultivation to increase the length of the growing media usage period for oyster mushroom cultivation. By taking into account the characteristics of fungal and bacterial pollutants and the pasteurization approach of milk, it is necessary to test the effect of pasteurization of rice washing water and coconut water at a temperature of 80-85°C with an incubation period of 10-20 minutes on the length of the production period of the growing medium that these two types of supplements have added.*

Key words: *Oyster mushroom (*Pluerotus ostreatus*), coconut water, rice washing water*

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INTRODUCTION

The government and all stakeholders continue to intensify efforts to improve community nutrition. The use of oyster mushrooms as a portion of healthy food is growing. However, obstacles are often faced, namely the limited production period of the planting media baglog. For this reason, the use of certain chemicals that are additives is often carried out by manufacturers. This is actually less effective in the long term and has the potential to cause food contamination, namely the mushroom fruiting bodies contain chemicals that are less hygienic.

Oyster Mushrooms *Pleurotus* sp. is one of the consumption mushrooms which is rich in nutrients so that it becomes one of the important food sources (Hidayah *et al.*, 2017); This mushroom is also used as a health food and contains biotherapeutic molecules (Maftoun *et al.*, 2017).

Oyster mushrooms grow on a baglog that has been filled with media and nutrients that can support fungal growth. The planting media

used for oyster mushroom cultivation, in general, can use organic agricultural waste materials such as sawdust, plant stems, and twigs, straw, bagasse, coconut husk, dried banana leaves, even rice washing water, and various other organic materials (Suparti *et al.*, 2016).

In the cultivation of white oyster mushrooms, it is often found that the growth media of oyster mushrooms are not able to reach the potential support period for oyster mushroom growth, which is up to 4-6 months. In fact, it is often found in production practice that each baglog with a capacity of one kg can only be productive for about two months. Many factors affect baglog age and are difficult to control, for example, the presence of saprophytic microbes which reduce the ability of the media to support the growth of oyster mushrooms for longer. In this condition, it means that the media has decreased its nutritional content for oyster mushrooms, especially compounds that are supplements.

One of the efforts to increase the carrying capacity of the longer-growing media is to insert supplements regularly as long as the lignin compounds and other energy sources are still able to support the optimal life of oyster mushrooms. Some of the materials that are potential and widely available in the agricultural environment and in the environment of the community are rice water and coconut water. These two kinds of materials are actually household and food industry waste.

Rice washing water produced in each household is still not widely used. It contains nutrients including carbohydrates in the form of starch by 89-90%, protein, cellulose, hemicellulose, sugar, and B vitamins which are abundant in the pericarps and aleurone which are also eroded. Coconut water is a source of natural hormones auxin and cytokinins, which are hormones to stimulate plant growth. The main substances contained in coconut water include potassium, calcium, and magnesium, sodium, chloride, and phosphate (Maula *et al.*, 2018).

This in-depth study of the two types of waste materials is expected to answer the challenge in the form of extending the productive life of the baglog by using natural materials that are wasted in the household. The use of coconut water and rice water also increases the added value of household kitchen waste and related industries. After formulating and tested through this research, these two materials are expected to be a solution in helping producers to increase productivity in their oyster mushroom cultivation.

This review aims to obtain information on the potential of rice washing water and coconut water as a nutritional supplement to increase the production life of the growing medium in the baglog in oyster mushroom (*P. ostreatus*) cultivation and to obtain information on the temperature range and duration of the supplement pasteurization process to extend the production life of the growing medium.

METHODS

The method used is the narrative review writing method in which scientific articles are identified by a systematic search method from

an electronic database, especially through Google scholar and NCBI (<https://www.ncbi.nlm.nih.gov/>). The search for reference sources was carried out with a focus on finding information related to the effect of nutritional ingredients of cherry water and coconut water on the productivity of oyster mushrooms. Some of the keywords are white oyster mushroom (*Pleurotus ostreatus*), rice washing water, and coconut water which are used as references in gathering information. Papers collected from the search results are then studied in-depth to validate various relevant reference sources.

RESULTS AND DISCUSSION

Characteristics of Oyster Mushrooms and the Mediawhere they grow

Oyster mushroom fungus that grows a lot on wood media, either logs or sawdust. Oyster mushrooms are well known in the community with their soft morphological characteristics, circular or semicircular hoods, fruit color is white, gray, brown, pink, or yellow (Guzman, 2000; Achmad *et al.*, 2011). Taxonomically, the oyster mushroom *P. ostreatus* is classified into classes: Basidiomycota, order: Agaricales, and genus: Pleurotus (NCBI, 2021; Uniprot, 2021) Oyster mushrooms live from a source of nutrition that comes from wood fiber. Therefore, this fungus is cultivated with a growing medium in the form of wood chips which are placed in a container known as a baglog. The main ingredient of baglog is sawdust. This material contains lignin and nutrients that are needed for the growth of oyster mushrooms (Zulfarina, 2019).

The type of wood and its metabolites contained in the fiber and wood particles will determine the content and availability of nutrients that are needed for optimal oyster mushroom growth. Therefore, choosing good sawdust as a growing medium for oyster mushrooms is very important where cellulose is available. The high cellulose concentrations and lignin needed for the life of oyster mushrooms in order to be able to body and produce fruiting bodies optimally (Anggriani, 2017).

Plant Fiber Chemicals For Oyster Mushroom Nutrition

The chemical content needed for the growth of oyster mushrooms is carbohydrates, lignin, and fiber, while the inhibiting factors are sap and extractive substances including natural preservatives found in wood (Hadrawi, 2014). The content of cellulose and hemicellulose will be broken down into glucose and water, as well as other products that will be absorbed for the metabolic needs of fungal cells.

Lignin is a complex aromatic polymer that strengthens cellulose and hemicellulose in plant cell walls (Li *et al.*, 2018) which is formed by heterogeneous components of the phenylpropanoid group, while cellulose as an organic polysaccharide polymer consists of chains of hundreds or thousands of β -glucose 1-4 which cross-linked with D-glucose units (Li *et al.*, 2019). On the other hand, hemicellulose is an organic polysaccharide heteropolymer and usually appears with cellulose in plant cell walls and has an amorphous structure that is less resistant to hydrolysis (Liu *et al.*, 2018). Lignin is a macromolecular component with a higher proportion of hardwood than softwood, namely 26–32% and 20–25% of dry weight, respectively (Mikela *et al.*, 2018). Most of the lignocellulosic components are present in plant or wood materials and are usually difficult to degrade for most microorganisms, except for a few types of fungi which are capable of producing specific oxidoreductase enzymes that can degrade these molecules (Zhang *et al.* 2020) including those of this oyster mushroom. This weathering fungus will degrade and mineralize lignin by using its consortium of ligninolytic enzymes (Asemoloye *et al.*, 2021), so that it can convert lignin to H_2O and CO_2 (Sigoillot *et al.*, 2012; Spina *et al.*, 2020). Lignin is more resistant to microbial damage, so it will slow down the

wood weathering process. High levels of lignin in wood fiber will inhibit the growth of fungal mycelium, meanwhile, if the cellulose content is increasing, the growth rate of mushroom mycelium will increase (Aini and Kuswytasari, 2013).

In order to support the growth of fungi in order to grow optimally, baglog media are given additional supplements or external ingredients that contain active nutrients needed by oyster mushrooms, such as rice washing water and coconut water. Additional nutrients are only needed in small amounts, but their availability is needed to support the growth and production of oyster mushrooms (Pribady *et al.*, 2018). The addition of supplements to baglog plays a role in adding or completing the nutritional components needed for the growth of oyster mushrooms so that their development becomes more optimal. According to Yulynawati (2019), nutrients or nutrients are chemical compounds used for metabolism or organism physiology; These nutrients are usually categorized into nutrients that provide energy and are used for the body or cell structure.

Microbes that destroy media and nutrition of oyster mushrooms

The microbes that damage the growing media for fungi are mostly fungi and bacteria in addition to various types of pest animals such as sciarid fungus flies, phorids, fungal mites, red pepper mites, small fungal mites, and porous (Christita and Suryawan, 2018). Several types of fungi and bacteria that are often found as contaminants that can reduce production by 30-50% are *Trichoderma*, *Penicillium*, *Aspergillus flavus*, *Rhizopus*, and *Bacillus subtilis* with colonic characteristics shown in Figure 1 (Sietalab, 2019).



Figure 1. Microbial contaminants in oyster mushroom cultivation

Pasterusisasi To Increase the Endurance of Nutritional Supplements

Pasteurization is a process of killing some pathogenic microbes in oyster mushroom baglog with temperatures below 100 °C and under normal pressure. According to Djuwendah & Septiarini (2016), pasteurization aims to kill pathogenic microorganisms in the baglog. The success of a pasteurization process is the fulfillment of sufficient heat energy to inactivate the microorganisms that cause damage to the product (Sukasih *et al.*, 2009). Pasteurization is carried out on rice washing water and coconut water so that the ingredients are sterile. Supplements that are treated with the pasteurization process are useful for extending the shelf-life of the supplement so that it can be used for a long period of time. The shelf life of a product is the length of time in which a portion of food can be stored under certain storage conditions and its freshness can be maintained by testing the product under certain storage conditions or by predicting microbial growth in the product under certain storage conditions Budiyo (2009).

Treatment of temperature and heating time in pasteurization

During the pasteurization process, the supplement will not lose its nutritional content but only eliminate harmful pathogenic microbes. The temperature and heating time are not quite right, so it will not kill microorganisms or only cause damage to cells. (Nursari *et al.*, 2016) also added that in food processing, cells that are damaged due to sublethal heating may be able to recover back into normal cells and reproduce during storage in a good medium. Most of the bacteria in their vegetative form will die at a temperature of 82-94°C, but many bacterial spores are still resistant to boiling water temperatures of 100°C for 30 minutes. Several studies have reported that heating milk is carried out to 85-90°C for 10-15 minutes or 80-85°C for 15-20 minutes, then cooled to 48°C, then inoculated the culture (starter) as much as 2-3% and incubated at 45°C until the acidity reaches 0.85-0.90% lactic acid (Resnawati, 2020). Research by Sukasih *et al.* (2009) obtained the

best treatment results for coconut milk at a temperature of 75°C for 31.2 minutes.

From the review results, several sources prove that in general the provision of nutrients in the form of leri water and coconut water has no significant effect on the development of oyster mushrooms. It is known that the elements contained in leri water and coconut water are low so that the effect is not significant on all observed variables (harvest time, number of fruiting bodies, maximum width of fruit caps, and total body weight of fruit (Suprpto *et al.*, 2017). Based on the research of Suprpto *et al.* (2017) it is known that without giving water, the total body weight of mushrooms weighing 258.61 g, giving 20 ml/liter produces a weight of 266.01 g; giving 40 ml/liter produces a weight of 271.3 g, meanwhile, giving 60 ml/liter of leri water yields a total weight of 288.08 g. The higher the concentration of rice water is given, the resulting growth and production increases.

Giving rice washing water by giving 250 ml/baglog has the fastest mycelium growth time, which is 43.22 days (Fajri and Elfin, 2019). Kalsum *et al.* (2011) showed that giving 40 ml/1000 g of rice washing water with a combination of two-day time intervals obtained the best production results. This is possible because temperature, humidity, and incubation place as well as the quality of mushroom seeds affect the growth and production of optimal mycelium biomass. The physical conditions of the optimum incubation room atmosphere for oyster mushrooms are a temperature of 24-29°C and relative humidity of 90-100% (Obire, 2013). The concentration of 80% of rice washing water is thought to be able to increase the content of the auxin hormone which functions to stimulate cell growth and elongation and is able to increase the content of the hormone cytokinin which plays a role in cell division (Laksono *et al.*, 2018).

Coconut water contains a complete chemical and nutritional composition including citric acid, nicotinic acid, pantothenic acid, folic acid, niacin, riboflavin, thiamin, and contains organic hormones such as auxin, gibberellin, and cytokinins which can stimulate cell division and extension (Hidayati, 2011).

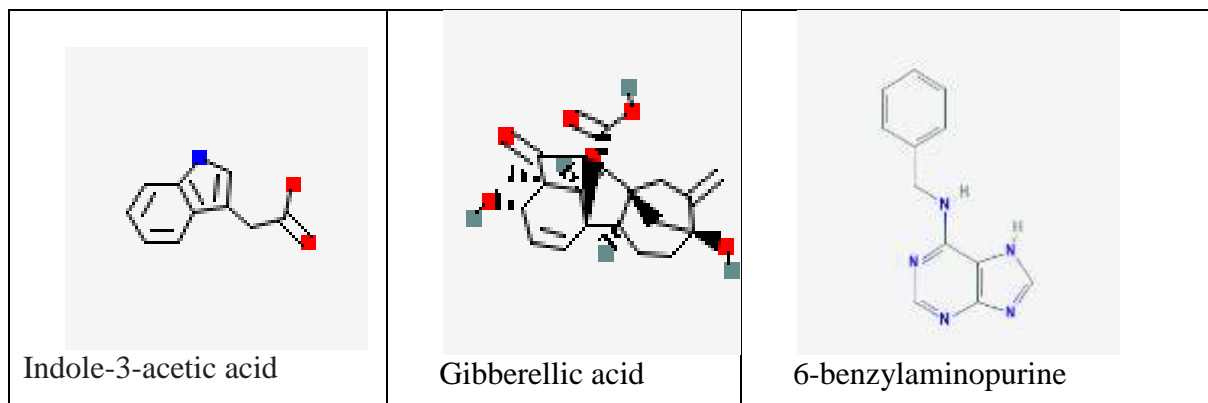


Figure 2. Molecular structure of three important growth regulators for plants (NIH, 2021^{a-c})

This growth regulator compound has several molecular derivatives (Figure 2) which are very necessary for the growth and production of body biomass of oyster mushrooms

Coconut water also contains sugar and also micro-minerals which are useful as a source of nutrition for oyster mushrooms. Yulynawati's research (2019) explains that the best composition for adding coconut water is 50% and coconut water is 100%. The research of Nisa *et al.* (2019) proved that the provision of 300 ml coconut water gave the best results as indicated by a faster harvest age; meanwhile, the length of the stalk, the area of the hood, the number of covers per clump and the fresh weight per baglog were higher. The growth of white oyster mushrooms can take place optimally if the essential nutrients needed are available and can meet their growth and development needs.

Both types of households and food industry waste contain various vitamins which are important for cell metabolism. Thiamin, riboflavin, niacin, pentatonic acid, and pyridoxine which are known as vitamin B-complexes are available in coconut water in concentrations of 0.03-0.57 mg/100 g (Yong *et al.*, 2009), a large amount to support growth and production of oyster mushroom.

Sterilization of media packaged in baglog and supplements formulated therein by using hot steam has the potential to damage several types of vitamins and growth-regulating compounds, although some compounds such as 6-Benzylaminopurine and cytokinin derivatives have high melting points reaching an average of 233.0°C (NIH, 2021^b).

Therefore, pasteurization is expected to prevent damage to supplements.

Supplements that have been pasteurized and given into the growing medium in the baglog periodically will increase the number of supplements so that they are always available for the living needs of mushrooms. However, baglog age cannot be guaranteed to run normally if the presence of microbial contaminants cannot be prevented or as much as possible its existence in the growing media. *Trichoderma*, *Aspergillus*, and *Penicillium* fungi will shorten the life of the baglog because the medium organic matter is quickly broken down by the three kinds of fungi (Obire, 2013).

Future Perspectives

Mushrooms are food ingredients that have high nutritional value, with an average oyster mushroom protein content of 3.5-4% of the wet weight and the fat content of oyster mushrooms at least 72% of the total fatty acids are unsaturated fatty acids, this makes mushrooms oysters as a portion of healthy food (Fajri and Elfin, 2019). The potential of oyster mushrooms is very good so that many of the residents have started to cultivate these white oyster mushrooms in addition that, the demand for oyster mushrooms for both the domestic and foreign markets is still not fulfilled (Maula *et al.*, 2018).

The development of science and knowledge regarding the use of household waste materials is expected to be of greater benefit to the community, especially mushroom farmers in increasing the productivity of their mushroom cultivation. The addition of rice washing water

and coconut water waste is expected to increase the production period of oyster mushrooms grown in baglogs, so that mushroom farmers can use this to increase the productivity of their agricultural products. However, further research needs to be done to determine the effect of pasteurization of rice washing water and coconut water with more varied heating times in order to find a more appropriate heating time to extend the life of the baglog media. In each study that evaluates the adequacy of nutrients to optimize the production capacity of oyster mushrooms, it can be seen from the growth of their mycelium (Muthua and Shanmugasundaram, 2015). In addition, controlling several factors such as the C/N ratio, pH, temperature, and air composition in the medium composition is very important (Bellettini *et al.*, 2016) because it will affect the effectiveness of supplementation.

CONCLUSION

Coconut water and rice washing water can be used as a supplement in the cultivation of oyster mushrooms (*Pleurotus ostreatus*) to increase the length of the growing media usage period by oyster mushroom mycelium. Potential application of pasteurized leri and coconut water waste using the approach of pasteurizing milk with a temperature of 80-85°C for 10-20 minutes has the potential to increase the age of the baglog as a growing medium for oyster mushrooms. It is necessary to examine the effect of pasteurization of rice washing water and coconut water as a supplement more carefully with a wider range of temperatures and heating times on the viability of oyster mushrooms which is represented by the growth of fungal mycelium and the production of fruit bodies

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