

INNOVATIVE BRAN MIXER FOR OYSTER MUSHROOM CULTIVATION

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Abstract

Innovation in modern agriculture continues to focus on developing technologies that enhance efficiency and productivity, including in oyster mushroom cultivation. Oyster mushrooms are a high-value commodity that is highly sensitive to environmental conditions, particularly during the preparation of the growing medium. A homogeneous and contamination-free growing medium is a critical factor determining the success of mushroom growth. One of the main challenges faced by farmers is the mixing process of bran and other growing medium materials, which requires high precision to avoid contamination and maintain the quality of the mixture. As a solution, an automatic bran mixer has been developed to address the limitations of manual processes that are time- and labor-intensive. This tool allows for the mixing of large quantities of materials with optimal homogeneity while minimizing contamination risks through a closed system. The use of this tool not only increases production efficiency by up to 30% compared to conventional methods but also supports improved hygiene standards in oyster mushroom cultivation. This innovation is expected to provide significant benefits to small and medium-scale farmers, both in terms of yield improvement and production sustainability.

Keywords: Bran mixer, Growing medium, Innovation, Inoculation, Production efficiency, Oyster mushroom, Sterilization.

INTRODUCTION

The cultivation of oyster mushrooms (*Pleurotus sp.*) represents a rapidly growing sector within agribusiness. This growth is driven by the high market value of oyster mushrooms, both as a nutrient-rich food source and as a commodity for export. Over the past few years, domestic and international demand for oyster mushrooms has significantly increased, reflecting rising public awareness of their health benefits (Yadi Heryadi *et al.*, 2021). Oyster mushrooms are known to be rich in protein, fiber, vitamins, and minerals, making them a preferred choice among consumers who prioritize healthy and sustainable eating habits.

Despite the substantial market interest, oyster mushroom production faces several technical challenges, particularly in substrate preparation. The substrate serves as the primary nutrient source for mushroom growth, and its quality is crucial to the success of the cultivation process. A substrate that is homogeneous, sterile, and free from contamination is essential to ensure optimal growth conditions for the mushrooms. Inconsistent mixing can hinder fungal propagation, result in uneven growth, and increase the risk of contamination by pathogenic fungi or other harmful microorganisms (Nugraha & Hasan, n.d.).

One of the main obstacles in substrate preparation is the mixing process, which involves combining materials such as bran, water, and sawdust. For small-scale oyster mushroom farmers, this process is often performed manually. Manual mixing is labor-intensive and time-consuming, leading to higher production costs. Furthermore, manual methods expose the substrate to the open environment, making it more susceptible to contamination. Under such conditions, the risk of introducing wild fungal spores or bacterial contaminants is significantly heightened, which can adversely affect the yield.

The development of technologies aimed at improving substrate homogeneity and sterilization is crucial for enhancing the productivity and efficiency of oyster mushroom cultivation. Innovations such as automatic mixing machines with closed systems can help farmers overcome the limitations of manual methods. These technologies not only enable consistent mixing of materials on a larger scale but also reduce the risk of contamination, thereby ensuring higher-quality yields in both quantity and quality.

LITERATURE REVIEW

1. Nutritional Theory and Growth of Oyster Mushrooms

Oyster mushrooms (*Pleurotus* sp.) are among the most widely cultivated mushrooms globally due to their adaptability to various climates and high nutritional value. These mushrooms require a growing medium as the primary source of carbon, nitrogen, and micronutrients to support their growth. An ideal growing medium must have a balanced carbon-to-nitrogen (C:N) ratio, optimal moisture content (approximately 60–65%), and be free from contamination (Sánchez, 2010).

Lignocellulosic waste, such as sawdust, rice bran, and corn cobs, has been proven to be an effective substrate for oyster mushroom cultivation due to its high nutritional content. Research by Sánchez (2010) demonstrated that hardwood sawdust supplemented with rice bran increased yields by 20–30% compared to media without rice bran supplementation. Moreover, micronutrients such as phosphorus and potassium found in rice bran also contribute to the optimal growth of mushroom mycelium.

2. Homogeneity and Sterilization of Growing Media

The uniformity of the growing medium is a key factor in ensuring an even distribution of nutrients, which is essential for optimal oyster mushroom growth. Inhomogeneity in the preparation of growing media can lead to uneven nutrient distribution, potentially reducing yields. Additionally, non-sterile growing media pose a higher risk of contamination by pathogenic microorganisms such as bacteria, wild fungi, or competitor spores (Suwannarach *et al.*, 2022).

Sterilizing growing media through heat-based methods such as autoclaving or steam pasteurization is a critical step to minimize the risk of contamination. Modern technologies have enabled the development of closed sterilization systems that enhance efficiency while reducing energy consumption. A study by Singh *et al.* (2018) found that closed sterilization systems could eliminate 98% of pathogenic microorganisms without compromising the nutritional structure of the growing media (Singh *et al.*, 2018).

3. Technology in Growing Media Mixing Processes

Manual mixing of growing media often poses challenges in mushroom cultivation, particularly for small-scale farmers. This method is not only labor-intensive and time-consuming but also increases the risk of contamination due to exposure to open environments. Automatic mixing machines offer a solution to these challenges.

Modern mixing machines are equipped with closed mechanisms that ensure uniform blending of materials such as sawdust, bran, and water. Additionally, this technology enables large-scale mixing in a shorter timeframe. Devi (2020) reported that automatic mixing machines could improve time efficiency by up to 40% and enhance the homogeneity of the growing media by 30% compared to manual methods (Devi *et al.*, 2020).

4. Sustainable Agribusiness Paradigm

Oyster mushroom cultivation holds significant potential for supporting the sustainable agribusiness paradigm. The substrates used in this cultivation are predominantly derived from agro-industrial waste, such as rice husks, corn cobs, or sawdust, which ecologically help reduce waste and improve environmental conditions.

Technologies like automatic mixing machines with closed systems align with sustainability principles by reducing reliance on manual labor, improving energy efficiency, and minimizing the risk of contaminated waste. Thus, oyster mushroom cultivation is not only economically beneficial but also supports sustainable development goals (SDGs).

RESEARCH METHOD

In this study, the research method employed is field observation, involving direct observation and active participation in the oyster mushroom cultivation process. These observations were conducted to identify and analyze key issues faced by oyster mushroom farmers. The research was carried out in Je'ne Taesa Village, Maros Regency, South Sulawesi Province, with direct interviews conducted with a local oyster mushroom farmer. The primary objective of this research is to provide a comprehensive understanding of the impact of modern technology implementation in supporting oyster mushroom cultivation.

Observations were conducted using two techniques. The first technique involved detailed documentation of the growing media mixing process, including the duration of the task, the level of mixture homogeneity, and the potential for contamination. The second technique entailed in-depth interviews with small-scale oyster mushroom farmers to gather information on technical challenges, production costs, and perceptions of adopting new technologies.

The research was structured into several phases. The first phase was direct observation, which involved participation in the growing media preparation process alongside farmers, including the mixing of materials such as sawdust, rice bran, and water. The time required for manually preparing the growing media was meticulously recorded. Subsequently, the prepared growing media underwent a sterilization process, followed by the inoculation of oyster mushroom spores. Throughout these processes, observations were made to record and analyze the primary challenges faced by farmers during the growing media preparation cycle.

RESULTS AND DISCUSSION

1. Field Observation

During field observations conducted by the team, several challenges faced by oyster mushroom farmers were identified, particularly in the process of preparing the growing media mixture. The growing media consists of a blend of sawdust, rice bran, calcium, and pure water with the following composition:

- Sawdust (from sawmill waste): 16 kg
- Rice bran: 3 kg
- Calcium: 1 kg
- Water (pure, without any additives): 40%

Farmers perform the entire process of mixing the growing media and packaging it independently, without additional labor or employees. This limitation arises from farmers' insufficient

income to cover additional labor costs. As a result, the production process is time-consuming, posing a significant barrier to improving production efficiency for oyster mushrooms.



Figure 1. Field observation

This issue highlights the need for technological innovations or assistance to simplify the production process, particularly in the media mixing stage. Initiatives such as adopting automatic mixing machines can serve as a potential solution to reduce farmers' workload and expedite production without compromising the quality of the growing media.

2. Problem Identification



(a)



(b)

Figure 2. Mushroom farmer mixing planting media (a); Planting oyster mushrooms in the growing media (b)

The observations revealed that oyster mushroom farmers face significant challenges in the production of growing media. The entire process is still carried out conventionally, leading to uneven media mixing, susceptibility to bacterial contamination, and lengthy preparation times. Consequently, the quality of the growing media is suboptimal, directly affecting mushroom yield. These issues underscore the necessity of tools to enhance farmers' efficiency, reduce contamination risks, and produce uniform media mixtures.

3. Concept Proposal

Based on the identified challenges, the team proposed designing a growing media mixer as a solution. This tool is expected to help oyster mushroom farmers perform mixing processes more

quickly and efficiently while producing homogeneous growing media. The mixer aims to improve productivity and harvest quality while reducing manual labor for farmers. Additionally, the idea supports the sustainability of mushroom farming by utilizing simple, easy-to-adopt technology.

4. Tool Design and Testing

After internal team discussions and consultations with oyster mushroom farmers, the tool was designed using AutoDesk Inventor software. A simple prototype of the mixer was created using readily available materials from local markets, such as used drums, recycled motors (dynamo), and L-shaped steel frames. The design was tailored to meet the needs of small-scale farmers, prioritizing cost efficiency and ease of use.

The prototype underwent testing to ensure it could produce homogeneous and sterile growing media mixtures. Various parameters were measured during testing, including mixing time,

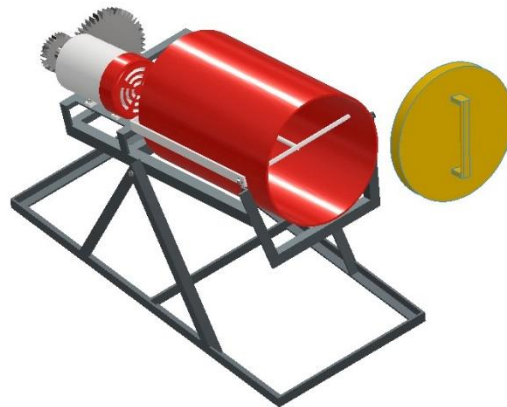


Figure 3. Proposed design ideas

the homogeneity of the results, and the tool's impact on contamination risks. The goal was for the tool to not only simplify farmers' tasks but also improve the quality of the growing media, ultimately contributing to the overall productivity of oyster mushroom cultivation.



Figure 4. Documentation of the simple prototype handover to oyster mushroom farmers (a); Documentation of the prototype and design presentation to oyster mushroom farmers (b)

CONCLUSION

This study successfully identified key challenges faced by oyster mushroom farmers, particularly in the manual preparation of growing media. The conventional process is not only time-consuming but also produces inconsistent media mixtures, making them prone to bacterial contamination and leading to lower productivity and harvest quality.

As a solution, the team proposed and developed a prototype of a growing media mixer with a simple design using locally sourced materials, such as used drums, recycled motors, and steel frames. This technology is expected to accelerate the media mixing process, produce more uniform mixtures, and reduce contamination risks.

The testing results demonstrated that the designed tool outperformed manual methods in terms of both time efficiency and media quality. By implementing this tool, farmers are expected to enhance productivity, reduce workload, and support the sustainability of oyster mushroom farming. This innovation reflects the importance of appropriate technology in assisting small-scale farmers to address production challenges more efficiently.

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