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EFFECT OF DIFFERENT PREPARATION METHODS OF RICE STRAW ON YIELD AND GROWTH OF OYSTER MUSHROOM (*Pleurotus ostreatus*)

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ABSTRACT

Mushroom cultivation is increasingly recognized as a sustainable protein source, particularly in developing regions. This study investigates the impact of altering straw preparation methods to enhance surface area on nutrient availability and mushroom yield. Utilizing a completely randomized design, four treatments were implemented: T1 (Rice straw as chips - 5cm-10cm), T2 (Rice straw as chips - 1cm-5cm), T3 (Rice straw dust), and T4 (Control – saw-powder with conventional method). The parameters assessed encompassed mushroom yield, average width of individual mushrooms, and branch number. Results indicate that the highest yield was attained from the straw powder treatment, highlighting the potential of finely ground straw as a favorable growth medium. Notably, the control group (T4) exhibited the greatest number of branches, suggesting the efficacy of the conventional saw-powder method in promoting branching. Nevertheless, the straw powder treatment surpassed straw chip treatments in branch production. Remarkably, no significant disparities in mushroom width were observed across treatments. Moreover, the study elucidated the superior water-holding capacity of straw medium compared to wood powder medium, underscoring the potential of straw as a cost-effective substrate for mushroom cultivation. These findings advocate for the utilization of finely ground straw powder to optimize yield and emphasize the water retention capability of straw medium. Consequently, this research contributes to the refinement of cultivation practices and the advancement of sustainable mushroom cultivation methods, with potential benefits for both agricultural practitioners and consumers.

Keywords: Physical form of substrate, Pleurotus ostreatus, Rice straw, Sawdust

INTRODUCTION

Mushrooms belong to the class *Basidiomycetes*, a group of fleshy saprophytic fungi commonly found on damp, decaying wood, organic matter, and soil rich in organic substances. The term "mushroom" specifically refers to the fruiting body of certain fungi. Being heterotrophic organisms, mushrooms lack chlorophyll, which makes them incapable of performing photosynthesis like green plants. Instead, they metabolize by absorbing nutrients from external sources using chemical energy (He et al, 2022).

In Sri Lanka, a developing country in South Asia, wild edible mushrooms have been an integral part of traditional diets for generations. These mushrooms are typically seasonal, appearing during the rainy season. Over time, techniques for cultivating mushrooms have been developed and refined, leading to advancements in mushroom farming with the help of modern science and technology. Today, mushrooms are recognized globally as a valuable food item, renowned for their nutritional and medicinal properties. The popularity of mushrooms continues to grow worldwide due to their significant contribution to human health, nutrition, and disease prevention. In Sri Lanka, the demand for mushrooms has been steadily increasing, as highlighted by Rajapakse (2011). Mushrooms have a unique ability to transform less valuable compost media into edible food and are commonly used as meat substitutes and flavor enhancers.

Nutritionally, edible mushrooms are low in fat and calories, yet rich in vitamins B and C. They are also a superior source of protein compared to most plant-based foods and provide essential minerals. Additionally, mushrooms contain functional food ingredients such as dietary fiber, polyunsaturated fatty acids (PUFA), amino acids, minerals, and antioxidants like glutathione and selenium, which promote overall health (Kruger and MannSafety, 2003). Cultivation of edible mushrooms might be the only current process that combines the production of protein-rich food with the reduction of environmental pollution (Sanchez, 2010). It represents one of the most efficient biotechnological processes for lignocellulosic organic waste recycling (Mandeel *et al.*, 2005). Oyster mushrooms are generally valued for their taste and nutritional and medicinal properties, which have been extensively studied. It contains a vital nutritional source of protein, vitamins, carbohydrates, iron and calcium. In addition, these mushrooms obtain nutrients from organic materials, such as straw, deadwood, dung, manure, and decaying organic matter. Growing these mushrooms with lignocellulosic agricultural waste results in value-added food for humans. It has been cultivated widely in different parts of the world and is known as the fruiting body of fungi. Therefore, it can grow over a wide range of temperatures using a variety of lignocelluloses. In India, the cultivation of mushrooms began in the 19th century. According to the Food and Agriculture Organization (FAO) of United Nations statistics, China is the world's top leader in mushroom production, as reported in 2018. Consequently, they are widely used in the bioremediation of pollutants and decomposition of lignocellulosic residues under the action of various enzymes (Kabel *et al*, 2017).

Mushrooms require inorganic compounds, carbon and nitrogen as a food source and primary nutrients, such as cellulose, hemicellulose and lignin. Paddy or rice straw as a substrate for mushroom cultivation is produced as an agricultural by-product. Currently, rice fields are disposed of by burning in the open air, leading to serious environmental problems. If paddy straw can nourish the growth of oyster mushrooms, this could convert the non-edible waste into profitable and edible biomass (Thomas *et al.*, 2022). These fungi can be collected in the wild during the last wettest part of the rainy season, where they meet and grow on deeply decaying organic matter. However, not all mushrooms growing in the wild are suitable for human consumption. In addition, this biomass could serve as an inexpensive substrate for mushroom growers. However, it is reported that the use of rice straw in oyster mushroom cultivation is not widespread in China due to its low biological competence and yield. However, it also has medicinal benefits for people who have cancer and diabetes. In particular, the *Pleurotus* species constitutes high potassium and sodium, edible food for patients suffering from high blood pressure and heart disease (Thomas *et al.*, 2022). In addition, mushroom cultivation practice could improve the straw quality by reducing the lignocellulosic biomass composition. Thus, this current study focuses on using paddy straw as a basal substrate for the cultivation of oyster mushrooms.

The oyster mushrooms (*Pleurotus spp*.) are in the third place after the white button and shiitake among the world mushroom production (Gyorfi and Hajdu, 2007). King oyster mushroom (*Pleurotus eryngii*) belongs to the family of oyster mushrooms, which is edible, basidiomycetic and saprophytic (Lewinsohn *et al.*, 2002). It is considered as the best one of all *Pleurotus* species due to its excellent consistency of cap and stem, culinary qualities and longest shelf life than any other oyster mushroom (Yildiz *et al.*, 2002). In the recent year, *P. eryngii* has been commercially cultivated in China, Japan and Taiwan because its excellent texture and flavor attract consumers (Eguchi *et al.*, 1999).

Large volumes of rice straw are produced as agricultural by-products. Currently, rice straws are disposed of through open-field burning, which leads to serious environmental pollution problem. If rice straw can support the growth of oyster mushroom, then it would be one of the solutions to transform these inedible wastes into an accepted edible biomass of high market value, and serve as a cheap source of substrate for mushroom growers. However, the utilization of rice straw in oyster mushroom cultivation is not popular for its low yield and low biological efficiency (Li *et al*., 2011), or the need for varying degrees of pre-treatment (Li *et al.*, 2011). Thus, the present work was carried out to use rice straw as a basal substrate supplemented with various ratios of cotton seed hulls to produce oyster mushrooms., saw-powder is mainly used for mushroom cultivation in Sri Lanka. However lack of availability and the high cost of using saw-powder, this study focused on identifying the Effect of different preparation methods of rice straw on oyster mushroom (*Pleurotus ostreatus*) cultivation.

MATERIALS AND METHODS

Experimental design

The experiment was carried out in the District Agriculture Training Center (DATC), Ambepussa. The experiment was laid out in a completely randomized design (CRD) with four treatments as rice-straw-chips-1 (5cm-10cm), rice-straw-chips-2 (1cm-5cm), rice-straw-powder and sawdust (conventional method) as a control.

Preparation of planting bags

Rice straw collected from the paddy field after harvesting, cleaned and dried. Then the paddy straw was chopped using a sharp knife into small pieces. Straws are cut into two categories of sizes, 1-5 cm and 5-10 cm in length. Powdered samples were prepared by grinding small chips and then sieved. sawdust was used as the control substrate and was prepared according to the recommendation given by the Department of Agriculture, Sri Lanka. The treatments (different substrates) were immersed in a solution of 2% slake lime for four hours and dried until 65% of the moisture was retained. The ideal amount of dryness is achieved when squeezed in hand if no water come out. Then different treatments were filled into a polypropylene bag with a width of 7 inches and a length of 14 inches. Then bags were filled with 250g of different substrates. The neck was plugged with cotton and covered with brown paper and tied with a rubber band. The packets were sterilized in an autoclave for 1 h at 121 ^{0}C under 1 kg/cm^2 pressure.

Seed inoculation and incubation

Sterilized scissors were used to cut a corner of the seed packets and about twenty to thirty seeds were dropped into one planting bag. Coconut oil lamps were lit to create a microbe-free environment. The piece of cotton was placed and tied again with a rubber band. After the inoculation the seedlings were stored on shelves in a room with 75% darkness and a temperature of 26-28 ^{0}C for incubation. After 3 weeks fungus was fully developed, and the bags were opened. Afterward, they were transferred to the room to be prepared for flowering. Once opened, water should be applied as a mist about three times a day. Flower formation began about a week after opening.

Data collection

Mushrooms were harvested when the mushroom cap surface was flat to slightly up-rolled at the cap margins. One flush of mushrooms in each bottle or bag was harvested. The yield of mushrooms, average width, and number of branches were recorded.

Statistical analysis

Ten replicates were used for each treatment. Measured values were fitted into ANOVA and mean separation was performed by the Turnkey method at 95% confidence intervals using Minitab statistical software.

RESULTS AND DISCUSSION

Significant variations in oyster mushroom yield were observed across the different preparation methods of rice straw shown in Table 1. The treatment employing rice straw in powdered form (T3) exhibited the highest mushroom yield, with an average of 248.6 ± 66.9 g. This indicates the efficacy of utilizing rice straw in powdered form for promoting oyster mushroom growth and achieving higher yields. Rice straw in the form of chips ranging from 5-10 cm (T1) also resulted in a substantial mushroom yield, averaging 197.8 ± 54.8 g. The conventional method, while not yielding the highest output, still demonstrated a considerable mushroom yield, averaging 177.6 ± 50.8 g. Rice straw in the form of smaller chips ranging from 1-5 cm (T2) yielded slightly less, averaging 175.2 ± 44.7 grams, yet still produced a respectable harvest.

The observed disparities in oyster mushroom yield among the different rice straw preparation methods highlight the importance of substrate characteristics in mushroom cultivation. Such a similar observation was previously recorded by Rajapakse *et al.*. in 2011 and Amin *et al.* in 2007 by using regular paddy straw without any alteration. The superior yield associated with rice straw in powdered form (T3) suggests that its finer particle size may enhance substrate colonization by mushroom mycelium, facilitating nutrient uptake and promoting mushroom formation. Additionally, the increased surface area of rice straw powder likely contributes to better moisture retention, creating favorable conditions for mycelial growth and mushroom development.

Significant discrepancies in the number of branches on oyster mushroom fruiting bodies were noted across the various treatments while it was not significant for the mushroom width (Table 1). The conventional sawdust preparation method (T4) exhibited the highest number of branches, with an average of 10.7 ± 3.4 branches per mushroom. Such a similar observation was previously recorded by Amin et al. in 2007. This indicates the efficacy of the conventional sawdust method in promoting branching in oyster mushrooms. Utilizing rice straw in powdered form (T3) also resulted in a significant number of branches, with an average of 8.5 ± 2.3 branches per mushroom, suggesting a positive impact on branching patterns. The treatment employing rice straw chips ranging from 1-5 cm (T2) yielded a moderate number of branches on mushroom fruiting bodies, averaging 7.3 ± 1.6 branches per mushroom. While slightly lower than T3 and T4, this still represented a respectable branching pattern. Conversely, the use of larger rice straw chips ranging from 5-10 cm (T1) resulted in a comparatively lower number of branches, with an average of 6.8 ± 1.1 branches per mushroom, indicating a potential inhibitory effect on branching.

The observed variations in the number of branches on oyster mushroom fruiting bodies underscore the influence of rice straw preparation methods on branching patterns. The notably high branch count associated with the conventional sawdust method (T4) suggests its superiority in promoting branching compared to other treatments. This may be attributed to the specific physical and chemical properties of sawdust that favor branching in oyster mushrooms.

The positive impact of rice straw in powdered form (T3) on branching patterns suggests its potential as an alternative substrate for cultivating oyster mushrooms. Conversely, the relatively lower branch count observed with larger rice straw chips (T1) may be attributed to their reduced surface area and potential impediment to mycelial growth and branching. However, the moderate branch count associated with smaller rice straw chips (T2) suggests a more favorable substrate structure for branching compared to larger chips.

Interestingly, despite significant differences in branching patterns among treatments, the average width of oyster mushroom caps remained consistent across all treatments. This suggests that variations in rice straw preparation methods did not significantly impact the width of mushroom caps. Overall, the findings highlight the importance of substrate preparation in influencing branching patterns in oyster mushrooms and suggest avenues for further optimizing cultivation practices to enhance mushroom quality and yield.

Table 1. Average yield, number of branches, and width of Oyster mushroom with different preparation methods of rice straw

Treatments	Average mushroom yield (g) per planting bag	Average number of mycelia per planting bag	Average width of mycelia (cm)
T1 - Rice straw chips (5cm-10cm)	197.8 ± 54.8^{ab}	6.8 ± 1.1^{b}	5.8 ± 0.6^{a}
T2 - Rice straw chips (1cm-5cm)	175.2 ± 44.7^{b}	7.3 ± 1.6^{b}	5.9 ± 0.5^{a}
T3 - Rice straw powder	248.6 ± 66.9^{a}	8.5 ± 2.3^{ab}	6.3 ± 1.0^{a}
T4 - Control – Sawdust	177.6 ± 50.8^{b}	10.7 ± 3.4^{a}	5.9 ± 0.6^{a}

Note: different letters show significant differences among treatments at P>0.05

The findings of this study emphasize the significance of substrate preparation methods in influencing oyster mushroom yield and branching patterns. Rice straw in powdered form emerged as a promising alternative substrate, exhibiting superior yield and significant branching compared to other treatments. However, the conventional sawdust method remains a reliable option for oyster mushroom cultivation, demonstrating considerable yield and effective promotion of branching. Future research could further explore optimization strategies for utilizing rice straw and other alternative substrates to enhance mushroom production efficiency and quality. Overall, these insights contribute to advancing sustainable practices in mushroom cultivation, with implications for both agricultural production and environmental stewardship. Therefore, mushroom cultivation proves to be a highly efficient method for disposing of agricultural residues, such as rice and wheat straw, as well as producing nutritious human food.

CONCLUSIONS

This experiment investigated the effect of various preparation methods of rice straw on oyster mushroom (*Pleurotus ostreatus*) cultivation. We observed significant differences in mushroom yield and the number of branches, while no significant differences were found in the average width of the mushrooms across the different treatments. The mushroom yield varied significantly among the treatments, showcasing the importance of the preparation method of the substrate. As well as it suggests that the choice of substrate preparation method can influence the branching pattern and potentially affect the overall health and vigor of the mycelia.

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