

**EFFECT OF HEAPING AND BAGGING METHODS OF SUBSTRATE ON THE PERFORMANCE OF OYSTER MUSHROOM IN UNIVERSITY OF UYO AGRICULTURAL EDUCATION SKILL ACQUISITION FARM**

By

**Utibeabasi Wilson Joshua  
Fidela Enoldem Udoh Ph.D.**

And

**Patrick Enang  
Department of Agriculture Education  
University of Uyo, Uyo**

**ABSTRACT**

*The study investigated the effect of heaping and bagging methods of substrate on the performance of oyster mushrooms in university of Uyo Agricultural Education Skill Acquisition Farm. The study compared the effects of heaping and bagging methods of substrate on the growth performance of oyster mushroom based on: weight and height. The study adopted an experimental research design. The population of the study consisted of 100 substrate bagging method and 100 substrate heaping method. The sample size of 25 substrate bagging and 25 substrate heaping methods were randomly selected. To assess the weight and height, weighing scale and graduated meter rule were used to measure the effect. The instrument was subjected to a validity test. Mean was used for answering of the research questions and independent t-test for testing the null hypotheses at 0.05 level of significance. The results revealed that there is significant effect of bagging and heaping methods of substrate on growth performance of Oyster Mushroom based on Weight and Height. It was recommended among others that Farmers and mushroom growers should adopt bagging methods of substrate as part of their cultivation practices, since they have been proven to significantly improve the weight of oyster mushrooms, thereby ensuring better yield and profitability.*

**Keywords; Oyster Mushroom, Heaping, Bagging, Substrate, Performance, Weight and Height**

**INTRODUCTION**

Mushroom cultivation has become an increasingly popular agricultural practice due to its minimal land requirements and high economic potential. Mushrooms more grow on organic rather than soil, making it suitable for production even in areas with limited arable land. The process of mushroom production begins with selecting a substrate, which can include agricultural byproducts like straw, sawdust, or coffee grounds. The substrate is then sterilized to prevent contamination and inoculated with mushroom spores or mycelium for colonization. As the mycelium colonizes the substrate, it breaks down complex organic compounds, creating the ideal conditions for mushrooms to form. The simplicity of mushroom cultivation appeals to both small-scale and commercial growers, providing an efficient way to convert agricultural waste into a valuable product.

The production of oyster mushrooms in Nigeria has grown significantly over the past two decades, largely due to its adaptability, ease of cultivation, and nutritional value. Oyster mushrooms are one of the most widely cultivated mushrooms in the country because they require minimal resources and grow well on agricultural waste such as sawdust, rice husks, and corn cobs. This versatility makes them particularly appealing to small-scale farmers who can produce mushrooms without the need for extensive capital or specialized equipment (Osemwegie and Okhuoya, 2018). The ease of growing oyster mushrooms has made them a popular choice, especially in urban and peri-urban areas where land space and resources are limited.

Despite the low investment costs, challenges such as inadequate infrastructure, lack of technical expertise, and limited access to high-quality spawn have restricted the growth of large-scale oyster mushroom farms in Nigeria (Akinyele and Adetuyi, 2020). Some efforts have been made to expand the production scale through training programs and government initiatives, aimed at enhancing mushroom farming skills and providing access to resources. Universities and agricultural extension services have played a key role in educating farmers on modern mushroom cultivation techniques. These

efforts have seen some success, particularly in states where mushroom farming is increasingly recognized as a sustainable and lucrative agricultural practice.

In recent years, a few commercial operations have emerged, targeting both local markets and potential export opportunities. However, Nigeria's oyster mushroom production still has untapped potential, and scaling up will require significant investment in infrastructure, improved spawn quality, and marketing strategies to reach larger markets. As awareness of oyster mushrooms' nutritional and economic benefits grows, and as demand from health-conscious consumers increases, there is a strong case for expanding production on a larger scale to meet domestic needs and potentially explore export options. Such expansion could not only support local economies but also contribute to national food security and sustainable agricultural practices (Osemwegie and Okhuoya, 2018).

The cultivation of Oyster mushroom can be done using different methods of substrate. Among these methods, heaping and bagging cultivation methods are common, with each exerting significant influences on the performance of oyster mushroom. According to Osemwegie and Okhuoya (2018), the heaping method involves stacking substrate materials, such as sawdust or agricultural waste, in heaps, while the bagging method entails placing the substrate in plastic bags, allowing for better control of environmental conditions. The author further reported that the choice between these methods can lead to distinct differences in yield, growth rate, and quality of the mushrooms produced. On the other hand, Akinyele and Adetuyi, (2020) noted that the heaping method is simpler and requires less initial investment, it can lead to inconsistent growth performance and lower yields. The exposure of the substrate to varying environmental conditions may result in uneven moisture distribution and higher susceptibility to pests and diseases (Akinyele and Adetuyi, 2020). Studies on mushroom have been replicated by different researchers, but these studies have not established the differential effect of heaping and bagging methods of substrate on the performance of oyster mushrooms. This study therefore attempts to examine the effect of heaping and bagging methods of substrate on the performance of oyster mushrooms in Agricultural Education Skill Acquisition Farm, University of Uyo, Uyo.

### **Statement of the Problem**

Generally, mushroom cultivation technology is very vital in the tackle against shortage of food, diminishing quality of human health and none accessible to food or unemployment which human beings still face, and will continue to face, due to the continued increase of the world population, natural resource degradation and impacts from climate change. Despite the versatile benefits in mushroom production, such as potency to improve farmers' economic wellbeing, vocational, nutritional and health benefits, the mushroom industry in Nigeria lacks the necessary technology know-how and the adoption of innovative mushroom farming practices. Also, Nigeria has been blessed with favorable climate, comparatively abundant land and labor as well as reasonably good water resources, yet the production and utilization of mushrooms in Nigeria has not been fully utilized. Consequently, the country has not benefited from mushrooms as the rest of the world. Moreover, the lack of skills, technology and awareness has been a great challenge. With this rational, the present study is initiated to investigate the effect of heaping and bagging methods of substrate on the performance of oyster mushrooms in Agricultural Education Skill Acquisition Farm University of Uyo, Uyo

### **Purpose of the Study**

The purpose of the study is to investigate the heaping and bagging methods of substrates on the performance of oyster mushrooms in University of Uyo Agricultural Education Skill Acquisition Farm. Specifically, the study sought to;

- i) compare the effects of heaping and bagging methods of substrates on the growth performance of oyster mushroom based on weight.
- ii) compare the effects of heaping and bagging method of substrates of oyster and mushroom based on height.

### **Research Questions**

The following research questions were formulated to guide the study

- i) What is the effect of heaping and bagging methods of substrate on the growth performance of oyster mushroom based on weight?

- ii) What is the effect of heaping and bagging method of substrate of oyster mushroom based on height?

### Research Hypotheses

The following null hypotheses were formulated for the study and tested at .05 level of significance.

- i) There is no significant effect of heaping and bagging methods of substrate on the growth performance of oyster mushroom based on weight.  
ii) There is no significant effect of heaping and bagging method of substrate of oyster mushroom based on height.

### Literature Review

#### Heaping Method

The heaping method involves piling substrate materials, such as straw, sawdust, or agricultural residues, into heaps. This method is often used in large-scale outdoor cultivation due to its simplicity and cost-effectiveness. The substrate heap is inoculated with mushroom spawn and left to undergo colonization and fruiting. One of the significant advantages of the heaping method is its ability to retain moisture, which is crucial for mushroom growth. Unlike bagging methods, where mushrooms are cultivated in confined spaces, heaping enables a larger surface area for exposure to the air, enhancing water retention and humidity levels around the substrate (Udo and Ukpong, 2020). This natural moisture balance creates an environment conducive to the growth of mushrooms without requiring additional moisture sources or costly humidifying equipment. Consequently, farmers can maintain ideal conditions for mushroom production even in regions with limited water resources.

Additionally, the heaping method provides better aeration for the mushroom mycelium. Good air circulation is vital in mushroom cultivation, as it reduces the buildup of carbon dioxide and ensures a continuous oxygen supply (Idoko and Obi, 2019). In heaping, the substrate is loosely piled, allowing fresh air to circulate freely through the substrate layers.

#### Bagging Method

The bagging technique, which was first utilized in Japan in the 20th century for pears and grapes, is now widely applied in Asian countries (Japan, China, Korea), Australia and the USA, protecting fruits from the surrounding environment (mainly from light and pathogens, then stresses related to temperature, water/humidity, and air movement) with a sort of shield—a physical barrier around the fruit (Sharma *et al.*, 2014). Bagging consists essentially of enclosing a young fruit in a food bag by capping the bag with a ribbon or a clamp on the fruit stalk. Isolating the fruit from the external environment protects it during development from mechanical or biotic damage, especially in regions where fruits are prone to attacks by fungi, bacteria, insects and even birds (Sharma *et al.*, 2014). The purpose is to obtain fruits without external imperfections, and with desired shape and color depending on the regional or national consumer preferences for the specific fruit. The expected color changes in comparison to non-bagged fruits can therefore correspond either to a reduction or an increase in color or even a greater homogeneity of the colour itself (Ali *et al.*, 2021).

Ali *et al.*, (2021) reported that bagging technique is used specifically to enhance fruit appearance and quality, especially in Asia. Initially, newspaper bags were used to wrap fruits to prevent damage from pests and diseases in Korea, but around 1985, artificially manufactured bags were introduced and since then several different types of bags/bagging material have been introduced. A bag around a fruit controls sunlight, temperature, humidity, evaporation and mechanical damage. Bagging may also regulate harvesting time and it can control pest attacks, especially fruit flies, minimizing residues of pesticides which is particularly important during the rainy-season. Thus, bagging is an excellent method to yield fruits with a very low input or residues of pesticide (Sharma *et al.*, 2020). Fruit quality-size, Brix degree, acidity, was similar between bagged and control fruits, and that bagging protects against various pests and diseases but has minimal effects on organic peach quality (Campbell

*et al.*, 2019). Bagging can determine numerous changes in the physiology of the fruit and in the preservation of its characteristics, and particular attention has been paid to tropical fruits (Ali *et al.*, 2021).

Upamanya *et al.*, (2021) conducted a study on the effect of four different methods of bag opening on yield, benefit cost ratio (BCR) and biological efficiency of oyster mushrooms. The four opening methods were opening top and bottom part of the polythene bag (as treatment 1); retaining polythene bag for the entire cultivation period (as treatment 2); opening top part of the polythene (as treatment 3) and complete removal of the polythene bag (as treatment 4). The results indicated that treatment-2 exhibited significantly the highest yield followed by treatment-3 and treatment-1 and lastly treatment-4. The BCR was also found to be the highest in treatment-2 followed by treatment-3, treatment-1 and treatment-4. The results also revealed that retaining the polythene bag during the entire cultivation period was found to be the best method of cultivation with regard to biological efficiency. Opening the top part of the polythene bag after the spawn run showed the biological efficiency of 76.83% which was followed by the treatment with opening the polythene bag from the top and bottom part of the bag (73.44%). The lowest biological efficiency (55.56%) was observed in the treatment in which the entire polythene bag was removed after a spawn run in darkroom. The findings revealed that retaining the polythene bag during the entire cultivation period can enhance better economic return.

Nurudeen *et al.*, (2013) investigated yield and proximate composition of oyster mushroom (*pleurotus sajor - caju*) cultivated on different agricultural wastes. The sawdust of *Triplochiton scleroxylon*, coconut-husk and corn-cob were used as substrates for mushroom cultivation. Each treatment was replicated five times. Each of the sample consisted of 400g weight of substrate per bag. The produce of the mushroom, mycelia growth, diameter of the pileus, length of stipe, mushroom height as well as proximate analysis of the mushroom were analyzed. The result showed that protein content (%) were found to be higher in coconut-husk followed by corn-cob and sawdust with values of 40.10%, 30.12% and 29.61% respectively. The results also indicated that the mean yield (g) produced from corn-cob substrates were found to be higher followed by yield produced from sawdust and coconut husk with their yield values of  $108.74 \pm 7.87$ ,  $60.76 \pm 4.62$  and  $56.66 \pm 3.48$  respectively. The results also showed that biological efficiency (%) obtained is an indication that the *P.sajor caju* utilizes the given substrates effectively. The highest Biological Efficiency B.E was found in corn-cob followed by sawdust and coconut husk with value of 85.40, 67.50 and 65.25% respectively. The length of stipe, diameter of pileus and mushroom height showed that the mushroom produced from all the substrates used were of good sizeable stage and were found to be marketable despite the differences in nutritional composition of mushroom samples.

Hoa *et al.*, (2015) conducted to compare the effects of different agro-wastes on the growth, yield, and nutritional composition of oyster mushrooms (*Pleurotus ostreatus*) (PO) and *Pleurotus cystidiosus* (PC). Seven substrate formulas including sawdust (SD), corncob (CC), sugarcane bagasse (SB) alone and in combination of 80 : 20, 50 : 50 ratio between SD and CC, SD and SB were investigated. The findings revealed that different substrate formulas significantly influenced the fruiting body characteristics, yield, biological efficiency (BE), nutritional composition, and mineral content of two oyster mushroom species, PO and PC. An increase in the proportion of CC and SB in the substrate formulas resulted in a reduced carbon-to-nitrogen ratio (C/N) ratio and enhanced the mineral content of the substrates, particularly calcium (Ca), phosphorus (P), and magnesium (Mg). Higher levels of CC and SB in the substrates also improved the mushrooms' fruiting bodies. Substrate formulas containing 100% CC and 100% SB were identified as the most suitable for cultivating oyster mushrooms PO and PC. These formulas produced the highest values for yield and BE, (Ca, K, and Mg), while also resulting in shorter stipe lengths. However, the 100% CC formula exhibited the longest time to the first harvest for both mushroom species (46.02 days for PO and 64.24 days for PC).

### **Research Design**

The study adopted an experimental research design. According to Amajuoyi and Joseph (2016) experimental research design seeks to establish, cause and effect relationship among variables (dependent and independent). This design is considered suitable for the study because it allowed the researcher to experiment, observed and report the effect of bagging and heaping methods of mushroom substrate on the variables understudied. The population of the study consisted 100 mushroom substrate bagging method and 100 mushroom substrate heaping method. The sample size of 25 substrate bagging method and 25 substrate heaping methods were randomly selected for the study To determine the comparative growth performance of effect of bagging and heaping methods of mushroom substrate on the weight, height, stape girth, cap size in diameter and harvesting period of oyster mushroom. These instruments weighing scale and graduated meter rule were used to measure the growth performance effect. The instruments for measuring the variables (studied) weight, height, stape girth, cap size in diameter and harvest period) were validated by pre-testing the instruments to ensure its suitability, functionality and standard before using for the study.

### **Experimental Procedures**

The experimental procedures for the comparison of heaping and bagging method of substrate on the growth performance of Oyster mushroom in Agricultural Education skill acquisition farm are reported under the sub-heading: materials requirement, substrate preparation, inoculation, incubation, fruiting induction, growth monitoring and yield measurement.

#### **Treatment I – Heaping method**

10kg of substrate was place to form a heap, the heaps were compressed to make it tight. The total number of the heaps were 1kg heaps making it 100kg, the heaps were covered to maintain humidity that endured air exchange.

#### **Treatment II – Bagging Method**

In the bagging method the substrate were filled in the mushroom nylon, it was measured 1kg per nylon; a total of 100 nylon was used which gives 100kg. A p.v.c. of 3cm pipe was placed at the opening of the nylon to maintain humidity and air-exchange in order to make the substrate breathable. **Inoculation:** inoculation refers to the process of introducing mushroom spawn (the vegetative mycelium of the mushroom) into a prepared and sterilized substrate so that the mycelium can begin to colonize and grow. It is one of the most important steps in mushroom cultivation because it determines how well and how quickly the mushroom culture establishes itself in the substrate.

#### **Steps of Performing Inoculation**

- (1) Methylated spirit was used to dis-infect all the tools and materials used in the inoculation process to prevent micro-organism bacterial affecting the substrate.
- (2) Hand gloves and cotton-wool was used to clean the spoon, plate immediately after each inoculation.
- d) **Incubation Period:** the Incubation Period refers to the stage after inoculation during which the mycelium grows, spreads, and fully colonizes the substrate before fruiting begins. It is a critical phase that determines the success, speed, and quality of mushroom development.
  - i) After inoculation, the heaps/bags were placed in a dark, warm environment at a temperature of 25-28°C for mycelium colonization.
  - ii) The sterilized substrate was monitored for colonization progress. It took 21-30 days based on the environmental conditions and spawn quality.
  - iii) The sterilized substrate was checked for complete colonization substrate in both methods. The sterilized substrate was whitish in colour and covered with mycelium. Mycelium is the root-like vegetative part of the fungus. It is made up of a network of tiny white filaments called hyphae that spread through the organic material (substrate).
- D) **Fruiting Induction**



- i) After full colonization, the temperature of the environment was lower to 18 – 22°C and increased humidity to around 85 – 90%
  - ii) The heaps and bags were placed in a fruiting room (controlled chamber) with indirect light (12 hours light/dark cycle).
  - iii) The bags were opened to allow mushroom fruiting bodies to form.
  - iv) Optimal conditions such as temperature, humidity, CO2 levels were maintained for fruiting.
- E) Growth Monitoring and Yield Measurement**
- i) **Growth Observations:** The growth of mycelium during colonization was tracked. The growth of mycelium during colonization was tracked through routine visual observation and documentation. Each substrate bag was inspected at regular intervals to assess the spread, density, and uniformity of the white mycelial network. Also, the development of primordial (mushroom pins) was monitored.  
 It took 2 – 3days for fruiting bodies to emerge  
 The average size, number and weight of the mushroom was measured.
  - ii) **Yield Measurement:** The harvest of the mushroom was done by cutting the base of the fruiting bodies. The harvesting period lasted for four months.
- F) Data Collection**
- 1. **Growth and yield parameters**
    - i. The colonization time for the sterilized substrate was 30 days.
    - ii. The fruiting time for the sterilized substrate was 4 months.
    - iii. The weights were measured using weighting balance and calibrated measuring tape.

**Method of Data Analysis**

Data collected from the study were analyzed using mean for answering of the research questions and independent t-test for testing the null hypotheses at .05 level of significance.

**RESULTS**

What is the effect of heaping and bagging methods of substrate on the growth performance of Oyster Mushroom based on Weight?

**Table 1: Mean difference between bagging and heaping methods of substrate on Growth Performance of Oyster Mushroom based on Weight**

<b>Variables</b>	<b>Mean of Final weight</b>	<b>Mean of initial weight</b>	<b>Mean of Weight gain</b>
Bagging Method	3.28	0.72	2.56
Heaping Method	2.47	0.60	1.87
Total	5.75	1.52	4.23

**Field Experiment,2025**

Data presented in Table 1 indicated that the oyster mushroom placed in bagging method of substrate showed weight gain of (2.56), while heaping method of substrate had 1.87 weight gain. The weight gain of bagging method rises from 0.72 initial weight to 3.28. While the weight gain of heaping method recorded 1.87 weight gain which rises from the initial weight gain of 0.60 to 2.47 weight again. Therefore, the study establishes that bagging methods of substrate of Oyster Mushroom promotes growth Performance based on weight.

**Research Question 2:** What is the effect of bagging and heaping methods of substrate on the growth Performance of Oyster Mushroom based on Height?

**Table 2: Mean of bagging and heaping methods of substrate on Growth Performance of Oyster Mushroom based on Height**

Variables	Mean of final Height	Mean of Initial Height	Mean of Height gain
Bagging Method	3.33	0.60	2.73
Heaping Method	2.34	0.40	1.94
Total	5.67	1.00	4.67

Source: Field Experiment, 2025

Data presented in Table 2 indicated that the height of oyster mushroom placed in bagging method of substrate showed height gain of 2.73, while heaping method of substrate had 1.94 height gain. The height gain of bagging method rises from 0.60 initial height to 3.33 at the end of the experiment. while the height gain of heaping method indicated the height gain from 0.40 initial height to 2.34g at the end of the experiment. Therefore, the study establishes that bagging methods of substrate of Oyster Mushroom promotes growth Performance based on height.

**Testing of null hypotheses**

The five postulated null hypotheses were tested at .05 level of Significance.

**Null Hypothesis 1:** There is no significant effect of heaping and bagging methods of substrate on growth performance of Oyster Mushroom based on Weight gain.

**Table 3: Independent t- test Analysis on effect of bagging and heaping methods of substrate on Growth Performance of Oyster Mushroom based on Weight Gain**

Variables	N	X	Sd	Df	t-cal.	t-tab	Decision
Bagging Method	25	3.28	0.23	48	13.2	2.00	*Significant
Heaping Method	25	2.47	0.16				

Source: Field Experiment, 2025

From Table 3, shows that the calculated t-value of 13.2 with the tabulated t-value of 2.00 at 48 degrees of freedom. This implies that since the t-calculated of 13.2 is greater than the t-tabulated of 2.00 at 0.05 level of significance, the null hypothesis which stated that there is no significant effect of heaping and bagging methods of substrate on growth performance of Oyster Mushroom based on Weight gain is rejected. Therefore, there is a significant effect of heaping and bagging methods of substrate on growth performance of Oyster Mushroom based on Weight gain.

**Null Hypothesis 2**

There is no significant effect of heaping and bagging methods of substrate on Growth Performance of Oyster Mushroom based on Height

**Table 4: Independent t- test Analysis on effect of bagging and heaping methods on substrate on Growth Performance of Oyster Mushroom based on Height Gain**

Variables	N	X	Sd	df	t-cal.	t-tab	Decision
Bagging Method	25	3.33	0.29	48	5.85	2.00	*Significant
Heaping Method	25	2.47	0.16				

Source: Field Experiment, 2025

The result in Table 4 shows that the calculated t-value of 5.85 with the tabulated t-value of 2.00 at 48 degrees of freedom. This implies that, since the t-calculated of 5.85 is greater than the tabulated t-value of 2.00 at 0.05 level of significance, the null hypothesis which stated that there is no significant effect of heaping and bagging methods of substrate on growth performance of Oyster Mushroom based

on Height is rejected. Therefore, there is a significant effect of heaping and bagging methods of substrate on growth performance of Oyster Mushroom based on Height.

### **Discussion of the findings**

Findings from Table 1, research questions 1 revealed that the weight gain of bagging method rises from 0.72 initial weight to 3.28 at the end of the experiment. while the weight gain of bagging method shows the weight gain from 0.60 initial weight to 2.47g at the end of the experiment. Therefore, the study establishes the fact that bagging methods of substrate of Oyster Mushroom promotes growth Performance based on weight. Also, on Table 3, null hypothesis 1, revealed a significant effect of heaping and bagging methods of substrate on growth performance of Oyster mushroom based on weight. This finding is in line with Yang *et al.*, (2019), observation that bagging is a very effective technique to modify the fruit microclimate, resulting in less fruit drop and reduced organic acid content in fruits. The microenvironment inside the bag also showed a positive effect on the structure of apple peels and reduced the cracking in longan and date palm and fruit sunburn and cracking in pomegranate. Also, Chaiwong, *et al.*, (2019). opined that bagging can increases fruit sugars and organic acid contents, two significant determinants of fruit organoleptic quality although the response to bagging weight is according to the fruits considered.

Data presented in Table 2 research question 2, indicated that the oyster mushroom placed in bagging method of substrate showed height gain of 2.73, while heaping method of substrate had 1.94 height gain. The height gain of heaping method rises from 0.60 initial height to 3.33 at the end of the experiment. while the height gain of bagging method indicated the weight gain from 0.40 initial height to 2.34 at the end of the experiment. The study therefore establishes that bagging methods of substrate of Oyster Mushroom promotes growth Performance based on height. Also, in Table 4 null hypothesis 2, revealed that the calculated t-value is 5.85 while the tabulated value is 2.00 at 48 degrees of freedom. Therefore, there was significant effect of heaping and bagging methods of substrate on growth performance of Oyster Mushroom based on height. This finding is in line with Ali *et al.*, (2021) who opined that bagging technique is used specifically to enhance fruit appearance, height and quality, in many countries. Also, Umoetuk (2018) stated that since artificially manufactured bags were introduced and several countries have different types of bags/bagging material which have been utilized to Improve mushroom height.

### **CONCLUSION**

Based on the findings of the study, it was concluded that bagging methods of substrate contribute to the Growth Performance of Oyster Mushroom based on Weight and Height, help to maintain a consistent moisture level, which is crucial for mushroom growth. The enclosed environment can help to limit the spread of diseases and pests. Bags can be easier to handle and move than other methods. Complete removal of the bag or creating openings in the bag after spawn run can improve air circulation and potentially increase yield.

### **RECOMMENDATIONS**

The following recommendations were made based on the results of the study.

- i) Farmers and mushroom growers should adopt bagging method of substrate as part of their cultivation practices, since it has been proven significantly to improve the weight of oyster mushrooms, thereby ensuring better yield and profitability.
- ii) Agricultural extension officers and mushroom research institutes should train farmers on proper bagging techniques, as these methods enhance mushroom height, which is an important indicator of healthy growth and market quality.

---

**REFERENCES**

- Akinyele, B. J., and Adetuyi, F. C. (2020). Factors affecting mushroom cultivation in tropical climates. *International Journal of Agricultural Science and Research*, 15(3), 45-52.
- Ali, M. M., Hashmi, M. S., Baig, K. S., and Raza, M. A. (2021). Fruit bagging: A tool for quality improvement in horticultural crops. *Journal of Horticultural Science and Biotechnology*, 96(3), 265-276.
- Campbell, J., Robinson, T., and Lang, G. (2019). Effects of preharvest fruit bagging on peach quality and pest management. *HortScience*, 54(5), 845-851.
- Hoang, H. T., Wang, C. L., and Wang, C. H. (2015). The effects of different substrates on the growth, yield, and nutritional composition of two oyster mushrooms (*Pleurotus ostreatus* and *Pleurotus cystidiosus*). *Mycobiology*, 43(4), 423-434.
- Idoko, O., and Obi, J. U. (2019). Influence of aeration and substrate structure on oyster mushroom production. *Nigerian Journal of Mycology*, 11(2), 45-54.
- Nurudeen, A. A., Lawal, O. S., and Azeez, A. O. (2013). Yield and proximate composition of oyster mushroom (*Pleurotus sajor-caju*) cultivated on different agricultural wastes. *Journal of Agricultural Research and Development*, 12(1), 45-53.
- Osemwegie, O. O., and Okhuoya, J. A. (2018). Mushroom production in Nigeria: Challenges and prospects. *Nigerian Journal of Mycology*, 9(2): 78-89
- Sharma, R. R., Reddy, S. V. R., and Jhalegar, M. J. (2014). Pre-harvest fruit bagging: A useful approach for plant protection and quality improvement. *Journal of Horticultural Sciences*, 9(2), 101-113.
- Sharma, R. R., Singh, D., and Reddy, S. V. R. (2020). Fruit bagging: A sustainable approach for quality improvement and pest management. *Indian Journal of Horticulture*, 77(1), 1-12.
- Udo, I. E., and Ukpong, S. J. (2020). Evaluation of traditional substrate management techniques in mushroom cultivation in southern Nigeria. *Journal of Sustainable Agriculture and Environment*, 8(1), 22-30.
- Upamanya, M., Chhetri, R., and Rai, S. (2021). Effect of different bag opening methods on yield, biological efficiency and economics of oyster mushroom (*Pleurotus ostreatus*). *International Journal of Tropical Agriculture*, 39(2), 135-141.