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Effect of Different Substrates on Yield and Biological Efficiency of *Pleurotus florida* and *Hypsizygus ulmarius*

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A B S T R A C T

Oyster mushroom cultivation provides an efficient means of converting agricultural residues into nutritious food and value-added products. The present investigation evaluated the effect of different substrates on yield and biological efficiency of *Pleurotus florida* and *Hypsizygus ulmarius*. The experiment was conducted in the Department of Microbiology, University of Agricultural Sciences, Raichur, using eight substrate treatments with three replications in a completely randomized design. Paddy straw, cocopeat, maize cob powder and mushpellets were evaluated alone and in combination with 5 per cent mulberry silkworm pupa powder. Each treatment contained 2.5 kg substrate per bag. Yield was recorded over three successive flushes and biological efficiency was calculated from total fresh mushroom yield in relation to dry substrate weight. Substrate treatments significantly influenced total yield and biological efficiency in both species. In *P. florida*, Mushpellets supplemented with 5 per cent mulberry silkworm pupa powder (T_8) recorded the highest total yield of 636.70 g bag^{-1} and biological efficiency of 115.76 per cent. In *H. ulmarius*, T_8 recorded the highest total yield of 654.06 g bag^{-1} and biological efficiency of 118.92 per cent. Mushpellets alone (T_7) ranked second for productivity in both species, whereas cocopeat-based treatments recorded the lowest yields and biological efficiencies. The results indicate that nutrient supplementation of Mushpellets with 5 per cent mulberry silkworm pupa powder can improve substrate productivity and offers a promising option for oyster mushroom cultivation.

Keywords

Biological efficiency, *Hypsizygus ulmarius*, mushpellets, *Pleurotus florida*, substrate, oyster mushroom, yield

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Introduction

Mushrooms are nutritionally valuable edible fungi and are increasingly cultivated as high-value biological converters of agricultural residues. Oyster mushrooms are particularly suitable for cultivation because they can utilize a broad range of lignocellulosic materials and can be produced with relatively simple technology. The use of crop residues as mushroom substrates provides an opportunity to convert low-value biomass into nutritious food while reducing problems associated with residue disposal.

Yield and biological efficiency of oyster mushrooms are strongly influenced by the physical and chemical characteristics of the substrate. Moisture-holding capacity, aeration, nutrient availability, lignocellulosic composition and carbon-to-nitrogen balance affect substrate utilization and fruit body production. Earlier studies have shown considerable differences in oyster mushroom yield and biological efficiency when different agricultural residues are used as substrates (Mandeel *et al.,* 2005; Hoa *et al.,* 2015; Girmay *et al.,* 2016). Rice straw has also been reported as an effective substrate for oyster mushroom production (Zhang *et al.,* 2002).

Nutrient supplementation can improve substrate productivity by increasing the availability of nutrients needed for fungal biomass production. Mulberry silkworm pupa powder is a potentially useful organic supplement in sericulture-producing regions, while Mushpellets provide a processed substrate material with relatively uniform physical characteristics.

Studies on Hypsizygus ulmarius have also demonstrated substantial differences in yield and biological efficiency among substrates (Aditya *et al.,* 2022).

Therefore, the present investigation was undertaken to evaluate paddy straw, cocopeat, maize cob powder and Mushpellets, alone and in combination with 5 per cent mulberry silkworm pupa powder, for yield and biological efficiency of *Pleurotus florida* and *Hypsizygus ulmarius.*

Material and Methods

The experiment was conducted in the Department of Microbiology, University of Agricultural Sciences, Raichur, Karnataka. Paddy straw and maize cob were collected from farmers' fields in Raichur. Cocopeat was obtained from the Department of Horticulture, University of Agricultural Sciences, Raichur, while mulberry silkworm pupa powder was procured from the College of Sericulture, Chintamani, Karnataka. Mushpellets were obtained from Adam Mushroom Farm, Kerala. Pure spawn cultures of *Pleurotus florida* and *Hypsizygus ulmarius* were obtained from the Mushroom Laboratory, Indian Institute of Horticultural Research, Bengaluru.

Eight substrate treatments with three replications were evaluated in a completely randomized design. Paddy straw, cocopeat, maize cob powder and Mushpellets were used alone and in combination with 5 per cent mulberry silkworm pupa powder. Each treatment contained 2.5 kg substrate per bag and 5 per cent mulberry silkworm pupa powder was used per 2.5 kg substrate in supplemented treatments.

Paddy straw was chopped into approximately 3–4 inch pieces, soaked in clean water for 4–6 hours and pasteurized by boiling for about 45 minutes. Prepared substrates were filled into cultivation bags and inoculated with the respective spawn. Yield was recorded separately for the first, second and third flushes and expressed as g bag^{-1}. Total yield was obtained by summing the three flushes. Biological efficiency was calculated as fresh mushroom yield divided by dry weight of substrate multiplied by 100. Treatment means were compared using the statistical procedure adopted in the original experiment with DMRT at the 5 per cent level.

Results and Discussion

Yield of *Pleurotus florida*. Significant differences were observed among the substrate treatments for yield in all three flushes and for total yield. During the first flush, T_8 recorded the highest yield (313.00 g bag^{-1}), statistically on par with T_7 (308.86 g bag^{-1}), followed by T_1 (287.50 g bag^{-1}) and T_2 (263.50 g bag^{-1}). The lowest first-flush yield was recorded in T_3 (137.63 g bag^{-1}), followed by T_4 (143.00 g bag^{-1}). Across successive flushes, T_8 continued to produce the highest yields, resulting in the highest total yield of 636.70 g bag^{-1}, followed by T_7 at 589.55 g bag^{-1}. T_1 and T_2 recorded 536.80 and 506.70 g bag^{-1}, respectively, while T_5 and T_6 produced 408.76 and 428.02 g bag^{-1}. T_3 and T_4 recorded the lowest total yields of 261.82 and 269.52 g bag^{-1}, respectively.

Yield of *Hypsizygus ulmarius*. T_8 produced the highest first-flush yield of 358.90 g bag^{-1} and also recorded the highest yields in the second and third flushes (200.60 and 94.56 g bag^{-1}, respectively), resulting in the maximum total yield of 654.06 g bag^{-1}. T_7 ranked second with 587.33 g bag^{-1}.

Among paddy straw treatments, T_2 recorded 527.96 g bag^{-1} and T_1 recorded 506.09 g bag^{-1}. T_5 and T_6 recorded 404.16 and 425.00 g bag^{-1}, respectively, whereas T_3 and T_4 recorded 286.93 and 294.56 g bag^{-1}.

The higher yield under T_8 may be associated with the favourable physical properties of Mushpellets together with the additional nutrients supplied by mulberry silkworm pupa powder. The combination appears to have supported efficient conversion of substrate biomass into fruit bodies over successive flushes. Paddy straw also supported comparatively high productivity, consistent with its established suitability as an oyster mushroom substrate.

Table.A Eight substrate treatments with three replications

Treatment	Substrate
T_1	Paddy straw
T_2	Paddy straw + 5 per cent mulberry silkworm pupa powder
T_3	Cocopeat
T_4	Cocopeat + 5 per cent mulberry silkworm pupa powder
T_5	Maize cob powder
T_6	Maize cob powder + 5 per cent mulberry silkworm pupa powder
T_7	Mushpellets
T_8	Mushpellets + 5 per cent mulberry silkworm pupa powder

Table.1 Total yield and biological efficiency of *Pleurotus florida* and *Hypsizygus ulmarius* under different substrate treatments

Treatments	*P. florida* yield (g bag^{-1})	Biological efficiency (%)	*H. ulmarius yield* (g bag^{-1})	Biological efficiency (%)
T_1	536.80^{b}	97.60^{b}	506.09^{e}	91.11^{c}
T_2	506.70^{b}	92.13^{b}	527.96^{d}	95.99^{c}
T_3	261.82^{c}	30.80^{f}	286.93^{a}	33.76^{f}
T_4	269.52^{c}	31.71^{f}	294.56^{h}	34.65^{f}
T_5	408.76^{d}	50.31^{e}	404.16^{g}	49.72^{e}
T_6	428.02^{d}	52.68^{e}	425.00^{f}	52.27^{e}
T_7	589.55^{a}	107.19^{a}	587.33^{c}	106.79^{b}
T_8	636.70^{a}	115.76^{a}	654.06^{b}	118.92^{a}

Note: Each value represents the mean of three replications. Means followed by the same superscript letter are not significantly different, whereas means with different superscript letters differ significantly according to DMRT.

Figure.1 Different substrates used for oyster mushroom cultivation.

Figure.2 General view of *P. florida* mushrooms under different substrate treatments.

T_1 – Paddy straw

T_2 – Paddy straw + 5 % Mulberry silkworm pupa powder

T_3 – Cocopeat

T_4 – Cocopeat + 5 % Mulberry silkworm pupa powder

T_5 – Maize cob powder

T_6 – Maize cob powder + 5 % Mulberry silkworm pupa powder

T_7 – Mushpellets

T_8 – Mushpellets + 5 % Mulberry silkworm pupa powder

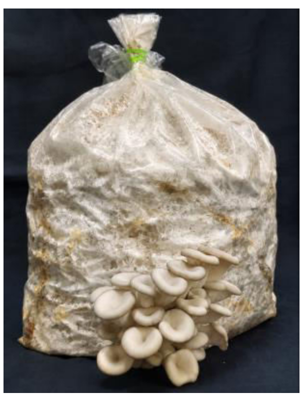
Figure.3 General view of *H. ulmarius* mushrooms under different substrate treatments.

T_1 – Paddy straw

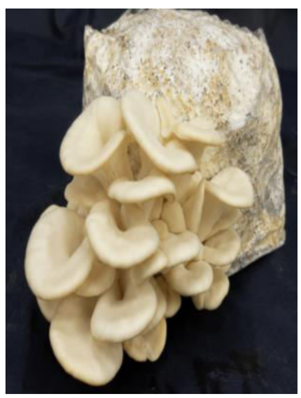
T_2 – Paddy straw + 5 % Mulberry silkworm pupa powder

T_3 – Cocopeat

T_4 – Cocopeat + 5 % Mulberry silkworm pupa powder



T_5 – Maize cob powder



T_6 – Maize cob powder + 5 % Mulberry silkworm pupa powder

T_7 – Mushpellets

T_8 – Mushpellets + 5 % Mulberry silkworm pupa powder

Similar substrate-dependent variation in yield has been reported for oyster mushrooms (Zhang *et al.,* 2002; Hoa *et al.,* 2015; Girmay *et al.,* 2016).

Biological efficiency. Biological efficiency closely followed total yield. In *P. florida*, T_8 recorded the highest biological efficiency of 115.76 per cent, followed by T_7 (107.19 per cent). T_1 and T_2 recorded 97.60 and 92.13 per cent, respectively, while T_5 and T_6 recorded 50.31 and 52.68 per cent. T_3 recorded the lowest value (30.80 per cent).

In H. ulmarius, T_8 recorded the highest biological efficiency of 118.92 per cent, followed by T_7 (106.79 per cent). T_2 and T_1 recorded 95.99 and 91.11 per cent, respectively, while T_5 and T_6 recorded 49.72 and 52.27 per cent. T_3 and T_4 recorded 33.76 and 34.65 per cent. The superior biological efficiency of T_8 indicates more effective conversion of substrate biomass into mushroom fruit bodies. The combined effect of the physical structure of Mushpellets and the nutrient contribution of mulberry silkworm pupa powder may have improved substrate utilization and sustained fruit body production across successive flushes. Similar effects of substrate type and nutrient status on biological efficiency have been reported by Mandeel *et al.,* (2005), Hoa *et al.,* (2015), Girmay *et al.,* (2016) and Aditya *et al.,* (2022).

In conclusion, the study demonstrated that substrate type markedly affected yield and biological efficiency of

Pleurotus florida and *Hypsizygus ulmarius*. Mushpellets supplemented with 5 per cent mulberry silkworm pupa powder (T_8) was the most productive treatment, recording 636.70 g bag^{-1} yield and 115.76 per cent biological efficiency in *P. florida* and 654.06 g bag^{-1} yield and 118.92 per cent biological efficiency in *H. ulmarius*. Mushpellets alone ranked second, while paddy straw also produced comparatively high yields. Cocopeat-based treatments were the least productive. Thus, supplemented mushpellets can be considered a promising substrate combination for improving oyster mushroom yield and biological efficiency.

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Authors Contribution

Karna K B: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Statistical analysis, Writing – original draft, Writing – review and editing. Pampangouda: Conceptualization, Methodology, Supervision, Validation, Writing – review and editing. Yallappa M: Investigation, Data curation, Validation, Writing – review and editing. Anupama C: Investigation, Data curation, Validation, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial or personal interests that could have influenced the work reported in this manuscript.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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