



ECONOMIC PERFORMANCE OF *PLEUROTUS FLORIDA* AND *HYPsizYGUS ULMARIUS* UNDER DIFFERENT SUBSTRATE TREATMENTS

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ABSTRACT

Mushroom cultivation provides an opportunity for converting agricultural residues into a value-added food product and generating additional income from small-scale agricultural enterprises. The present study evaluated the yield and economic performance of *Pleurotus florida* and *Hypsizygus ulmarius* cultivated on different substrate treatments. Eight treatments comprising paddy straw, cocopeat, maize cob powder and mushroom pellets, either alone or supplemented with 5 per cent mulberry silkworm pupa powder, were evaluated using 2.5 kg substrate bags. The experiment was conducted in a completely randomized design with three replications. Yield was recorded for three successive flushes. Production cost, gross return, net return and benefit-cost ratio were estimated for the substrate treatments. In *P. florida*, the highest total yield was recorded in T8 (mush pellets + 5% mulberry silkworm pupa powder), with 636.70 g bag⁻¹. Similarly, *H. ulmarius* recorded the highest total yield in T8, with 654.06 g bag⁻¹. The lowest yields were recorded under cocopeat-based treatments. The treatment-level economic analysis showed that production cost ranged from ₹129 to ₹184 bag⁻¹. T8 recorded the highest gross return (₹387.23 bag⁻¹) and net return (₹203.23 bag⁻¹), whereas T1 (paddy straw) recorded the highest benefit-cost ratio of 2.41. Mushroom pellets alone also showed favourable economic performance, with a net return of ₹194.07 bag⁻¹ and B:C ratio of 2.22. The findings demonstrate that substrate selection influences both mushroom productivity and economic efficiency. Paddy straw provided an economically efficient low-cost option, while mushroom pellet-based substrates supported higher production and higher absolute returns.

KEYWORDS: *Pleurotus florida*, *Hypsizygus ulmarius*, oyster mushroom, substrate, production cost, gross return, net return, benefit-cost ratio.

1. INTRODUCTION

Mushroom cultivation is an important component of agricultural diversification because it permits the conversion of agricultural and agro-industrial residues into a high-value food commodity. Unlike many conventional agricultural enterprises, mushroom production can be undertaken on a relatively small land area and can utilize locally available lignocellulosic materials. Oyster mushrooms are particularly suitable for diversified production systems because of their ability to grow on a wide range of agricultural residues.

The cultivation of oyster mushrooms has received considerable attention because substrate selection directly influences mycelial development, fruit-body formation, yield and biological efficiency. The ability of *Pleurotus* species to utilize lignocellulosic residues is associated with their capacity to degrade structural components of plant biomass through extracellular enzymes. The composition and physical characteristics of the substrate therefore have an important influence on mushroom productivity (Chang and Miles, 2004).

A number of agricultural residues, including paddy straw, maize residues and other plant materials, have been evaluated for oyster mushroom production. Studies have demonstrated substantial differences in yield among substrate materials and substrate combinations (Jiskani *et al.*, 1999; Jain and Vyas, 2002; Hoa *et al.*, 2015). Substrate quality, moisture availability, nutrient balance and physical structure can influence the efficiency with which mushroom mycelium converts substrate biomass into edible fruiting bodies.

Pleurotus florida is an important cultivated oyster mushroom species, while *Hypsizygus ulmarius* is an edible elm oyster mushroom with potential for cultivation on agricultural residues. Previous investigations have reported variation in the growth and yield of *H. ulmarius* according to substrate composition (Sharma *et al.*, 2013; Kumar *et al.*, 2019; Sen *et al.*, 2019).

From an enterprise perspective, biological yield alone is insufficient to determine the suitability of a mushroom substrate. A substrate may provide high yield but also involve high input expenditure. Conversely, a relatively low-cost substrate may generate a favourable return on investment even if its yield is lower. Economic assessment therefore requires simultaneous consideration of production cost, gross return, net return and benefit-cost ratio.

Mushroom cultivation can also contribute to rural entrepreneurship and agricultural residue utilization. Studies from Karnataka have identified technological adoption, knowledge and enterprise-related constraints as important considerations in mushroom



entrepreneurship (Shirur *et al.*, 2016). Identification of productive and economically suitable substrates can therefore support the development of small-scale mushroom enterprises.

The present study was undertaken to evaluate the production and economic performance of *P. florida* and *H. ulmarius* under eight substrate treatments comprising paddy straw, cocopeat, maize cob powder and mushroom pellets, with or without 5 per cent mulberry silkworm pupa powder.

2. MATERIALS AND METHODS

2.1 Experimental location and biological material

The study was conducted in the Department of Microbiology, University of Agricultural Sciences, Raichur, Karnataka. Pure spawn cultures of *P. florida* and *H. ulmarius* were obtained from the mushroom laboratory of the Indian Institute of Horticultural Research (IIHR), Bengaluru. The experimental work consisted of eight substrate treatments with three replications.

2.2 Substrate treatments

Paddy straw, corn cob powder, cocopeat and mushroom pellets were evaluated as substrate materials. In the supplemented treatments, mulberry silkworm pupa powder was incorporated at 5 per cent.

Table 1. Details of substrate treatments

Treatment	Substrate
T1	Paddy straw
T2	Paddy straw + 5% mulberry silkworm pupa powder
T3	Cocopeat
T4	Cocopeat + 5% mulberry silkworm pupa powder
T5	Maize cob powder
T6	Maize cob powder + 5% mulberry silkworm pupa powder
T7	Mushpellets
T8	Mushpellets + 5% mulberry silkworm pupa powder

Each experimental bag contained 2.5 kg substrate. In the supplemented treatments, 5 per cent mulberry silkworm pupa powder was incorporated into the substrate. The experimental design consisted of three replications in a completely randomized design.

2.3 Mushroom cultivation and yield recording

The substrates were prepared and conditioned according to the experimental procedure described in the thesis. Spawn was inoculated into the prepared substrate bags and maintained under suitable cultivation conditions. Observations were recorded for successive flushes. Total yield was calculated from the cumulative yield obtained from the first, second and third flushes and expressed as grams per 2.5 kg substrate bag.

2.4 Economic analysis

Production cost was estimated on a per-bag basis. Variable costs included substrate, pupa powder where applicable, spawn, covering material, labour and miscellaneous expenditure. Fixed costs included depreciation and other fixed components.

The selling price used in the economic analysis was ₹300 kg⁻¹.

The following formulae were used:

Gross return (₹ bag⁻¹) = Yield (g bag⁻¹) × ₹300/1000

Net return (₹ bag⁻¹) = Gross return – Total production cost

Benefit-cost ratio = Gross return ÷ Total production cost

The economic analysis was based on the treatment-level yield dataset presented in the original thesis economic analysis. It should therefore be distinguished from the species-specific yield data reported separately for *P. florida* and *H. ulmarius*.

3. RESULTS AND DISCUSSION

3.1 Production cost

Production cost varied according to substrate type and supplementation. Paddy straw (T1) recorded the lowest total cost of ₹129 bag⁻¹, followed by cocopeat (T3) at ₹149 bag⁻¹ and mushroom pellets (T7) at ₹159 bag⁻¹. The incorporation of 5 per cent mulberry silkworm pupa powder increased production expenditure in each corresponding treatment.

The highest production cost was recorded in T8 (mushpellets + 5% pupa powder), at ₹184 bag⁻¹. The increase was primarily associated with the additional expenditure on pupa powder and the higher base cost of mushroom pellets.



Table 2. Production cost under different substrate treatments

Treatment	Production cost (₹ bag ⁻¹)
T1	129
T2	154
T3	149
T4	174
T5	155
T6	180
T7	159
T8	184

The increase in cost following supplementation emphasizes that additional nutrient inputs need to generate sufficient additional production or revenue to justify their use. This is particularly important for small-scale producers operating with limited working capital.

3.2 Yield performance of *Pleurotus florida*

The total yield of *P. florida* varied substantially among the substrate treatments. T8 recorded the highest total yield of 636.70 g bag⁻¹, followed by T7 with 589.55 g bag⁻¹. Paddy straw (T1) produced 536.80 g bag⁻¹, while paddy straw supplemented with pupa powder (T2) produced 506.70 g bag⁻¹.

The lowest yield was recorded under cocopeat-based treatments. T3 produced 261.82 g bag⁻¹ and T4 produced 269.52 g bag⁻¹.

Table 3. Yield of *Pleurotus florida* under different substrate treatments

Treatment	First flush (g)	Second flush (g)	Third flush (g)	Total yield (g bag ⁻¹)
T1	287.50	172.20	77.10	536.80
T2	263.50	163.10	80.10	506.70
T3	137.63	88.56	35.63	261.82
T4	143.00	87.46	39.06	269.52
T5	246.75	110.17	51.84	408.76
T6	238.46	128.86	60.70	428.02
T7	308.86	191.86	88.83	589.55
T8	313.00	229.56	94.14	636.70

The higher yield under T8 is consistent with the general observation that substrate composition and nutrient availability influence oyster mushroom productivity (Chang and Miles, 2004). Previous studies have similarly reported differences in *P. florida* yield according to substrate composition (Jiskani *et al.*, 1999; Jain and Vyas, 2002; Srinivasan *et al.*, 2005).

The superior performance of T8 in the present study may be associated with the physical and nutritional characteristics of the mushpellet substrate together with the supplementary nutrients supplied by mulberry silkworm pupa powder. However, the additional production cost must be considered before recommending the treatment for commercial cultivation.

3.3 Yield performance of *Hypsizygus ulmarius*

A similar pattern was observed in *H. ulmarius*. The highest total yield was obtained in T8, at 654.06 g bag⁻¹, followed by T7 at 587.33 g bag⁻¹. T2 produced 527.96 g bag⁻¹ and T1 produced 506.09 g bag⁻¹.

Cocopeat-based treatments recorded the lowest production, with 286.93 g bag⁻¹ in T3 and 294.56 g bag⁻¹ in T4.

Table 4. Yield of *Hypsizygus ulmarius* under different substrate treatments

Treatment	First flush (g)	Second flush (g)	Third flush (g)	Total yield (g bag ⁻¹)
T1	268.73	158.80	78.56	506.09
T2	286.50	158.93	82.53	527.96
T3	191.43	69.40	26.10	286.93
T4	186.93	78.23	29.40	294.56
T5	238.30	122.06	43.80	404.16
T6	236.70	134.40	53.90	425.00
T7	341.77	161.03	84.53	587.33
T8	358.90	200.60	94.56	654.06

The results are in agreement with earlier studies showing that substrate composition substantially influences the productivity of *H. ulmarius* (Sharma *et al.*, 2013; Kumar *et al.*, 2019; Sen *et al.*, 2019). The higher productivity under mushpellet-based treatments indicates their potential as an alternative substrate for this species.

3.4 Comparative performance of the two species

The comparative yield data showed that T8 produced the highest yield in both species.

Table 5. Comparative total yield of *P. florida* and *H. ulmarius*

Treatment	<i>P. florida</i> (g bag ⁻¹)	<i>H. ulmarius</i> (g bag ⁻¹)
T1	536.80	506.09
T2	506.70	527.96
T3	261.82	286.93
T4	269.52	294.56
T5	408.76	404.16
T6	428.02	425.00
T7	589.55	587.33
T8	636.70	654.06

H. ulmarius produced higher total yield than *P. florida* under T2, T3, T4 and T8, whereas *P. florida* recorded higher yield under T1, T5, T6 and T7. The highest yield of both species under T8 indicates a consistent response to the mushroom-based supplemented substrate.

3.5 Gross return

The economic analysis showed that gross return varied substantially among the treatments. T8 recorded the highest gross return of ₹387.23 bag⁻¹, followed by T7 at ₹353.07 bag⁻¹ and T1 at ₹311.37 bag⁻¹.

The lowest gross return was obtained under T3, at ₹164.75 bag⁻¹. The pattern broadly followed the treatment-level yield used for the economic calculation.

3.6 Net return

The highest net return was recorded under T8 at ₹203.23 bag⁻¹. T7 recorded a net return of ₹194.07 bag⁻¹, followed by T1 at ₹182.37 bag⁻¹. T2 recorded ₹156.29 bag⁻¹.

The lowest net return was observed in T4, where the return was -₹4.37 bag⁻¹. This indicates that, under the cost and selling-price assumptions used in the study, the gross revenue from T4 was insufficient to cover the total production cost.

The results demonstrate that higher input expenditure does not automatically translate into proportionally higher economic efficiency. Economic performance depends on the balance between additional production and additional input expenditure.

3.7 Benefit-cost ratio

The benefit-cost ratio differed considerably among treatments. T1 recorded the highest B:C ratio of 2.41, followed by T7 at 2.22 and T8 at 2.10.

Table 6. Economic performance of mushroom cultivation under different substrate treatments

Treatment	Total cost (₹ bag ⁻¹)	Yield used for economics (g bag ⁻¹)	Gross return (₹ bag ⁻¹)	Net return (₹ bag ⁻¹)	B:C ratio
T1 – Paddy straw	129	1037.89	311.37	182.37	2.41
T2 – Paddy straw + 5% pupa	154	1034.29	310.29	156.29	2.01
T3 – Cocopeat	149	549.16	164.75	15.75	1.11
T4 – Cocopeat + 5% pupa	174	565.42	169.63	-4.37	0.97
T5 – Maize cob powder	155	812.72	243.82	88.82	1.57
T6 – Maize cob + 5% pupa	180	852.69	255.81	75.81	1.42
T7 – Mushroom pellets	159	1176.89	353.07	194.07	2.22
T8 – Mushroom pellets + 5% pupa	184	1290.76	387.23	203.23	2.10

Note: Economic calculations were made on a 2.5 kg bag basis at a selling price of ₹300 kg⁻¹. The yield column in this table is the treatment-level yield used in the original economic analysis and is distinct from the species-specific yields reported in Tables 3–5. Consequently, the gross return, net return and B:C ratio should not be interpreted as separate species-specific economic returns.

The highest B:C ratio under T1 can be attributed to its comparatively low production cost combined with a relatively high treatment-level yield. Similar economic considerations are important in mushroom enterprises because production costs, input availability and market conditions influence profitability and adoption (Shirur *et al.*, 2016).

3.8 Economic comparison of substrate options

The results reveal two different dimensions of economic performance. T8 generated the highest absolute gross and net returns, whereas T1 generated the highest return relative to the cost of production. T7 also showed favourable economic performance, combining relatively high production with a lower cost than T8.



For growers with limited capital, the lower production cost of paddy straw may be an important consideration. Paddy straw is also a commonly available agricultural residue in rice-producing regions. In contrast, mushroom pellets may be attractive where they are readily available and where the producer places greater emphasis on achieving higher production and absolute net return.

The addition of mulberry silkworm pupa powder increased production cost in all supplemented treatments. Its economic usefulness therefore depends on whether the additional yield compensates for the additional expenditure. In the present experiment, supplementation did not uniformly increase economic efficiency across all substrate types.

The findings support the view that substrate selection should be based on both biological and economic considerations rather than yield alone. Previous studies have likewise demonstrated that substrate composition and nutrient enrichment can alter mushroom productivity and biological efficiency (Hoa *et al.*, 2015; Kumar *et al.*, 2019; Sen *et al.*, 2019).

4. IMPLICATIONS FOR RURAL MUSHROOM ENTERPRISES

Mushroom production can provide an avenue for value addition to agricultural residues and diversification of farm income. The present findings indicate that both paddy straw and mushroom pellet-based substrates have potential, although their economic advantages differ.

Paddy straw had the lowest production cost and highest B:C ratio. This makes it relevant to small-scale producers seeking to minimize initial investment. Mushroom pellets, on the other hand, supported high production in both mushroom species and generated favourable absolute net returns.

The results also demonstrate the importance of local input availability. A substrate that performs well biologically may not be economically attractive if it has to be transported over long distances or purchased at a high price. Consequently, farm-level recommendations should consider local substrate prices, labour costs, mushroom market prices and availability of supplementary materials.

The conversion of agricultural residues into mushroom biomass also provides an opportunity for improved resource utilization. Earlier work has emphasized the potential of agricultural residues and spent mushroom substrates within integrated production systems (Wiafe-Kwagyan, 2014; Zeid *et al.*, 2020).

5. CONCLUSION

The study demonstrated substantial differences in the productivity and economic performance of *P. florida* and *H. ulmarius* under different substrate treatments. Mushroom pellets supplemented with 5 per cent mulberry silkworm pupa powder (T8) recorded the highest species-specific total yield in both *P. florida* (636.70 g bag⁻¹) and *H. ulmarius* (654.06 g bag⁻¹).

The treatment-level economic analysis showed that T8 recorded the highest gross return (₹387.23 bag⁻¹) and net return (₹203.23 bag⁻¹). Paddy straw (T1) recorded the highest B:C ratio of 2.41 because of its comparatively low production cost. Mushroom pellets alone (T7) also recorded a favourable B:C ratio of 2.22 and a net return of ₹194.07 bag⁻¹.

The findings indicate that maximum biological production and maximum return on investment are not necessarily obtained from the same treatment. Therefore, substrate selection should consider yield, input cost, gross return, net return and benefit-cost ratio together. Paddy straw provides a low-cost option with favourable investment efficiency, whereas mushroom pellet-based substrates provide potential for higher production and higher absolute returns.

Further farm-level studies should evaluate species-specific cost structures, labour requirements, transportation, packaging, marketing costs and seasonal variation in mushroom prices before large-scale commercial recommendations are made.

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