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SUSTAINABLE CULTIVATION OF MILKY MUSHROOM (*CALOCYBE INDICA*) USING REGION-SPECIFIC AGRO-WASTE: INSIGHTS FROM RISHIKESH

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ABSTRACT

This review explores the sustainable cultivation of *Calocybeindica* (Milky Mushroom) using region-specific agro-waste, focusing on field studies conducted in the Rishikesh area of Uttarakhand, India. Wheat straw enriched with wheat bran emerged as a highly productive and locally viable substrate. The study evaluates various agricultural residues tailored to local availability, presenting them as eco-friendly and cost-effective alternatives to conventional cultivation inputs. By emphasizing substrate efficiency, local sustainability, and reduced input cost, this review supports the promotion of climate-resilient and economically viable mushroom farming practices in the Rishikesh region.

Keywords:*Calocybeindica*, Milky mushroom, Sustainable cultivation, Agro-waste substrates, Rishikesh, Uttarakhand

INTRODUCTION

Sustainable agriculture and nutritional security are gaining increasing attention, particularly in regions like Uttarakhand where climate resilience and cost-effective farming solutions are crucial. *Calocybeindica* (Milky Mushroom), a tropical edible fungus, has emerged as a promising source of high-quality protein, essential minerals, and vitamins (Sharma et al. 2018). Its adaptability to warm climates and low input requirements make it suitable for cultivation in subtropical areas such as Rishikesh, Uttarakhand (Singh & Chaudhary, 2020). Traditionally, paddy straw has been the primary substrate for *C. indica* cultivation. However, in Rishikesh, wheat straw is more readily available and economically viable. Rising costs, environmental concerns related to crop residue burning, and regional variations in substrate availability have driven the need to identify locally sourced alternatives for mushroom farming (Gupta andJarial 2020; Kumar et al. 2019).

This study focuses exclusively on the cultivation of *C. indica* in Rishikesh using region-specific agro-waste materials. Various combinations of paddy straw, wheat straw, mustard straw & supplementation with wheat bran or rice bran were analyzed under standardized environmental conditions (Rathore et al. 2022). This study aims to evaluate the biological efficiency and yield of *Calocybeindica* using locally sourced materials, thereby promoting a sustainable, low-cost cultivation model tailored to the region. By emphasizing localized agricultural residues, this study offers a practical and replicable framework for mushroom growers in the Rishikesh region and similar agro-climatic zones of Uttarakhand (Verma et al. 2021).

Region of Focus and Methodology

The research was conducted in the rural outskirts of Rishikesh, Dehradun district, Uttarakhand. This area provides favorable subtropical climatic conditions for mushroom cultivation, including moderate to high humidity, warm temperatures, and ready availability of agro-waste.

Substrate Selection and Preparation

The primary substrates selected for mushroom cultivation included wheat straw, paddy straw, and mustard straw, which are abundant agricultural residues in the surrounding areas. For nutritional supplementation, rice bran and wheat bran were incorporated to enhance the yield and growth of the mushrooms. The substrate preparation process began by sun-drying and chopping the raw materials into manageable lengths. The materials were soaked overnight in clean water to enhance their moisture level and soften their texture. To eliminate harmful microbes and pests, the soaked substrates were pasteurized using the hot water method—maintaining a temperature between 65°C to 70°C for approximately one hour. After pasteurization, the substrates were drained, cooled to room temperature, and supplemented with 4% of either wheat bran or rice bran. This enrichment step aimed to provide additional nutrients to support vigorous mycelial growth.

Spawn Preparation and Casing

For spawning, sterilized wheat grains were used as base. These were inoculated with vigorously growing *C. indica* mycelium under aseptic conditions and incubated until complete colonization was achieved, producing healthy grain spawn. Cultivation was conducted using the polybag technique, wherein the prepared substrates were filled into perforated plastic bags and layered with the grain spawn. Each bag was kept in a controlled environment, and once the mycelium had thoroughly colonized the substrate (typically within 15–20 days), the bags were opened and transferred to the fruiting chamber. Casing soil (made of loam soil and well-decomposed farmyard manure) was applied to stimulate fruiting. This layer maintained surface moisture and facilitated gas exchange, supporting fruit body development.

Fruiting and Crop Management

During the fruiting phase, environmental parameters were carefully regulated. The temperature was maintained between 28°C and 30°C, relative humidity was kept at 80% to 90%, and indirect or diffused light was provided to mimic natural forest floor conditions favorable for fruit body formation. Adequate ventilation was provided during fruiting to minimize CO_2 accumulation and promote healthy mushroom development. Pinhead initiation was observed 10–12 days after casing, and mature fungal fruit bodies were harvested within 18–22 days. Harvesting involved gently twisting and pulling mushrooms from the base to avoid damaging the casing layer. This method ensured optimal growth and yield of *C. indica* under region-specific agro-climatic conditions in Rishikesh.

Synthesis of Findings

Table 1: Effect of Substrates on *C. indica* Yield and Efficiency in Rishikesh

Substrate Combination	Yield (g/bed)	Biological Efficiency (%)
Wheat straw + wheat bran	623.6	69.28
Wheat straw + rice bran	528.78	58.75
Paddy straw only	476.0	47.60
Mustard straw	392.5	43.00

The combination of wheat straw and wheat bran produces highest biological efficiency, supporting the idea that regionally abundant substrates can be optimized for superior performance in local conditions. Loam soil casing-mixture further boost fruit body development. These observations align with Sardar et al. (2020), who reported improved yield with enriched substrates. Ramya Krishna et al. (2019) demonstrated that paddy straw alone can be effective, though yields are modest. These findings are in agreement with global studies which identify wheat bran as a superior organic supplement (Alamet al. 2010; Vijaykumar et al. 2014).

DISCUSSION

The sustainable cultivation of *Calocybeindica* using locally available agro-waste substrates in Rishikesh offers both economic and environmental advantages. The study reaffirms that utilizing region-specific agricultural residues such as wheat straw and mustard

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straw, easily accessible in Rishikesh, they offer a cost-effective solution for cultivation and dependence on conventional substrates like paddy straw. These agro-wastes, when supplemented with nutrient-rich additives such as wheat bran or rice bran, provided efficient mycelial colonization and satisfactory biological efficiency. Wheat straw enriched with wheat bran proved particularly effective under the subtropical conditions of Rishikesh, resulting in higher yields, faster pinhead initiation, and superior quality fruiting bodies. This supports previous findings on the nutritional and structural suitability of wheat straw for milky mushroom cultivation in similar climatic zones.

Table-2: Comparative Agricultural Residues Supporting *C. Indica* Cultivation in Various Climatic Zones

Region	Common Agricultural Waste	Potential as Substrate	References
Uttarakhand (Rishikesh)	Wheat straw, mustard straw	High; excellent yield and structural suitability	Present study
Punjab & Haryana	Wheat straw, paddy straw	High; good mycelial growth and yield	Sharma et al. (2020)
Uttar Pradesh (neighbouring plains)	Wheat straw, sugarcane leaves	High; structurally suitable with supplementation	Gupta andJarial(2020)
Odisha & West Bengal	Rice straw, jute waste	Excellent; commonly used and affordable	Patra et al. (2022)

Moreover, reusing agricultural waste contributes to circular farming and environmental sustainability by minimizing stubble burning and landfill pressure. Such practices are especially beneficial for smallholder farmers and self-help groups in Uttarakhand, where low-cost and climate-resilient cultivation techniques are essential for livelihood improvement and food security. However, some challenges were observed. Agro-waste substrates like mustard straw required more attention in terms of pre-treatment to prevent contamination and ensure even colonization. Seasonal fluctuations in substrate moisture content and lignin-cellulose ratio also influenced mushroom growth dynamics. These findings highlight the need for location-specific substrate standardization, including moisture adjustment, pre-soaking time, and supplementation ratio to ensure consistent and reliable results across seasons.

Conclusion

This study concludes that cultivating *Calocybeindica* using locally available agro-waste, particularly wheat straw enriched with wheat bran, is highly effective for the Rishikesh region. The method ensures high yield, economic viability, and environmental sustainability, making it ideal for small-scale farmers. The Rishikesh model offers a replicable framework for similar agro-climatic zones, highlighting the value of region-specific practices. Future efforts should focus on optimizing substrates, adapting to seasonal changes, and training rural cultivators to enhance scalability and support sustainable agriculture in Uttarakhand.

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