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Button (*Agaricus bisporus)* and oyster mushrooms (*Pleurotus ostreatus*): Cultivation and its value addition: A overview

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Abstract
Button and oyster mushrooms (*Agaricus bisporus* and *Pleurotus ostreatus*, respectively) are among the most widely cultivated mushroom species due to their nutritional benefits, versatility, and ease of cultivation. This study examines the cultivation techniques, environmental factors, and substrates involved in growing these mushrooms, highlighting the key factors that influence yield and quality. The paper also explores the significant potential for value addition to these mushrooms, including drying, powdering, processing into snacks, soups, sauces, and the production of medicinal extracts. The nutritional profile of both species, rich in protein, dietary fiber, vitamins (especially B vitamins), minerals, and antioxidants, contributes to their appeal as functional foods and nutraceuticals. Moreover, their low calorie and fat content makes them popular in health-conscious markets. Value-added products such as mushroom powders and capsules for health supplements have seen increasing demand, driven by the growing interest in plant-based, immune-boosting diets. However, the growth of this sector faces challenges related to post-harvest handling, processing technology, and market access. This paper concludes that with technological innovation, improved infrastructure, and enhanced market linkages, the cultivation and value addition of button and oyster mushrooms can become a highly lucrative venture for smallholder farmers, promoting food security and sustainable rural development.

Keywords: Button mushroom, Oyster mushroom, *Agaricus bisporus*, *Pleurotus ostreatus*, mushroom cultivation

1. Introduction
Mushrooms, a type of edible fungus, have gained significant popularity in recent years due to their nutritional, medicinal, and economic value. They are rich in proteins, vitamins, minerals, and antioxidants, making them an important component of a balanced diet, especially for vegetarians. Beyond their health benefits, mushrooms offer a promising avenue for sustainable agricultural practices, particularly for small and marginal farmers [1].
Mushroom cultivation involves growing fungi in controlled environments using substrates like straw, sawdust, or other organic materials. This process requires minimal land and water, making it an eco-friendly and resource-efficient venture. Popular varieties cultivated include button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus spp.*), and shiitake (*Lentinula edodes*) [2].
In addition to primary production, value addition in the mushroom sector has emerged as a vital component for improving profitability and shelf-life. This includes processing mushrooms into dried products, pickles, soups, powders, and nutraceuticals. Value-added mushroom products not only cater to consumer preferences for ready-to-use or longer-lasting foods but also open up new market opportunities locally and globally [3]. Mushroom cultivation and its value addition offer immense potential for income generation, rural development, and entrepreneurship. With increasing consumer demand and support through technology and training, this sector is poised for rapid growth in the coming years. Table 1 presents the details of nutritional value of *Agaricus bisporus* (White Button Mushrooms) and Oyester mushroom (Pleurotus ostreatus) [1, 4-6, 34].

Table 1: Nutritional Value of *Agaricus bisporus* (White Button Mushrooms) and Oyester mushroom (Pleurotus ostreatus) per 100 g

Nutrient	White Button Mushroom (*Agaricus bisporus*)	Oyster Mushroom (*Pleurotus spp.*)
Energy	22 kcal	33 kcal
Water	92.5 g	89.2 g
Protein	3.1 g	3.3 g
Fat	0.3 g	0.4 g
Carbohydrates	3.3 g	6.1 g
Dietary Fiber	1.0 g	2.3 g
Sugars	1.9 g	1.1 g
Calcium (Ca)	3 mg	10 mg
Iron (Fe)	0.5 mg	1.3 mg
Magnesium (Mg)	9 mg	18 mg
Phosphorus (P)	86 mg	120 mg
Potassium (K)	318 mg	420 mg
Sodium (Na)	5 mg	18 mg
Zinc (Zn)	0.5 mg	1.1 mg
Vitamin C	2.1 mg	3.5 mg
Thiamine (B1)	0.1 mg	0.1 mg
Riboflavin (B2)	0.4 mg	0.3 mg
Niacin (B3)	3.6 mg	5.2 mg
Vitamin D	7-10 IU (varies with UV exposure)	18 IU (if sun-exposed)
Folate (B9)	17 µg	38 g

2. Cultivated mushrooms in India

Button, oyster, shitake and milky mushrooms are the most commercially cultivated in India due to their adaptability and market demand. Cultivation methods vary depending on the species (e.g., straw beds, logs, sawdust blocks). Table: 2 present the current scenario of types of cultivated mushrooms in India [1 & 3].

Table 2: Types of Mushrooms Cultivated in India

Mushroom Type	Scientific Name	Description
Button Mushroom	*Agaricus bisporus*	Most widely cultivated; prefers cool climates; commonly used in cooking.
Oyster Mushroom	*Pleurotus spp.*	Grows in tropical/subtropical climates; fast-growing and rich in nutrients.
Milky Mushroom	*Calocybe indica*	Suitable for warm climates; long shelf-life and high yield.
Shiitake Mushroom	*Lentinula edodes*	Popular for medicinal and culinary uses; grown on hardwood logs or blocks.
Paddy Straw Mushroom	*Volvariella volvacea*	Thrives in hot, humid conditions; cultivated using paddy straw beds.
Reishi Mushroom	*Ganoderma lucidum*	Known for medicinal value; grown mainly for nutraceutical products.
Enoki Mushroom	*Flammulina velutipes*	Thin, white mushrooms with a crunchy texture; grown under low-light conditions.
Maitake Mushroom	*Grifola frondosa*	Medicinal mushroom with immune-boosting properties; cultivated on logs.

3. India's total mushroom production

- **Estimated Annual Production:** ~2.5 lakh tonnes (as of recent data)
- **Most Cultivated Type:** Button Mushroom (~75% of total production)
- **Fastest Growing Segment:** Oyster and Milky Mushrooms due to low cost and easy cultivation

Table 3: Present the major mushroom production areas and production in India [33].

Table 3: Major Mushroom Production Areas and Production in India

State/Region	Major Type(s) Grown	Approx. Production Share (%)	Remarks
Punjab	Button Mushroom	~25-30%	Leading producer; favorable climate and infrastructure.
Haryana	Button & Oyster Mushroom	~10-12%	Close to major markets like Delhi; good cold storage.
Himachal Pradesh	Button & Oyster Mushroom	~8-10%	Ideal cool climate for seasonal cultivation.
Uttarakhand	Button, Oyster, and Medicinal	~6-8%	Expanding in hilly areas with government support.
Tamil Nadu	Milky & Oyster Mushroom	~10-12%	Warm climate suitable for year-round milky mushroom.
Kerala	Oyster & Milky Mushroom	~5-7%	Mostly small-scale, home-based units.
Maharashtra	Oyster & Button Mushroom	~5%	Growing urban demand supports cultivation.
Odisha	Paddy Straw & Oyster Mushroom	~4-5%	Promoted among tribal farmers and SHGs.
West Bengal	Paddy Straw & Oyster Mushroom	~4-5%	Traditional cultivation; growing urban markets.
Jammu & Kashmir	Button & Medicinal Mushrooms	~3-4%	Cold regions favor seasonal button mushroom production.

4. Basic requirement for cultivation of mushroom

4. Selection of Mushroom Species

The choice of mushroom species depends on the local climate, market demand, and available resources. Commonly cultivated varieties include *Agaricus bisporus* (Button), *Pleurotus spp.* (Oyster), and *Calocybe indica* (Milky). Each species has specific environmental requirements for optimal growth [8].

4.2. Substrate Material

Mushrooms are saprophytic organisms and grow on organic substrates. Suitable substrates include paddy straw, wheat straw, sawdust, cotton waste, and composted materials. The substrate serves as the primary source of nutrients for the mushroom mycelium [9].

4.3. Spawn (Mushroom Seed)
Spawn is the vegetative seed of mushrooms containing mycelium, used to inoculate the prepared substrate. High-quality spawn, free from contaminants, is essential for successful mycelial colonization and fruiting [9 & 10].

4.4. Environmental Conditions
The microclimate must be carefully controlled for optimal mushroom development. Key parameters include:

- Temperature: Varies by species; Button mushrooms require 16-20°C, while Oyster mushrooms thrive at 20-30°C.
- Humidity: Mushrooms need high humidity (70-90%) for proper fruit body formation.
- Light: Most species require diffused or low light; it influences pinhead formation and development.
- Air Ventilation: Adequate oxygen supply is essential, especially during the fruiting stage, to prevent CO_2 buildup and malformed mushrooms [11& 12].

4.5. Water Supply
Consistent access to clean water is necessary for substrate moistening and maintaining ambient humidity. Overwatering or underwatering can adversely affect yield [12].

4.6. Hygiene and Sanitation
Maintaining a clean and sterile environment minimizes the risk of contamination by molds, bacteria, and pests. Disinfection of tools, substrate, and cultivation space is critical [1].

4.7. Infrastructure and Cultivation Space
Depending on scale, mushrooms can be cultivated in rooms, thatched sheds, polyhouses, or controlled-environment chambers. The structure must protect the crop from temperature extremes, pests, and direct sunlight [6].

4.8. Pasteurization or Sterilization
To eliminate competing microorganisms, substrates must be pasteurized (e.g., hot water treatment) or sterilized, especially in the case of indoor cultivation or bag-based systems [9].

5. Mushroom Spawning
spawning initiates the growth of the fungal mycelium, which later develops into fruiting bodies (mushrooms) [13 & 14].

Step	Details
Substrate Preparation	Organic materials like straw, sawdust, or compost are chopped and pasteurized or sterilized to eliminate contaminants.
Cooling the Substrate	After pasteurization, the substrate is cooled to room temperature (25-30°C) to avoid killing the spawn.
Mixing the Spawn	Mushroom spawn is evenly mixed into the substrate, either by layering (for tray methods) or thorough mixing (for bag methods).
Filling containers/Bags	The inoculated substrate is filled into clean polythene bags, trays, or beds, depending on the method used.
Incubation (Spawn Run)	The bags or beds are kept in a dark, warm, and humid environment (specific to the mushroom species) to allow mycelial growth.
Maintenance of Conditions	During the spawn run, temperature (20-30°C), humidity (80-90%), and cleanliness must be maintained.
Duration of Spawn Run	Mycelium takes 10-20 days to fully colonize the substrate (varies by species).

Common Sowing Methods by Mushroom Type

Mushroom Type	Sowing Method
Button Mushroom	Layer spawning in compost beds or trays.
Oyster Mushroom	Mixed spawning in polythene bags with straw substrate.
Milky Mushroom	Mixed spawning with paddy straw in beds or polybags.

6. Casing
Casing means covering the compost with a thin layer of soil or soil like material after the spawn has spread in the compost (spawn run) [6]. To It is mainly used in the cultivation of Button mushrooms (*Agaricus bisporus*).
The casing layer helps in:

- Retaining moisture
- Allowing gas exchange
- Inducing fruit body formation
- Protecting the mycelium

Common materials used include peat moss, loam soil, farmyard manure, and cocopeat, often mixed with lime to maintain a slightly alkaline pH (7.5-8.5). The casing material must be pasteurized to prevent contamination.

7. Irrigation
7.1 Irrigation Stages in Cultivation

- **Spawn Run Stage:** Minimal watering; focus on maintaining high humidity (~90%) without over-wetting the substrate.
- **Casing Layer Application:** Light misting to settle and moisten the casing.
- **Pinning Stage:** Consistent but gentle misting to avoid damage to delicate pins.
- **Harvesting Stage:** Reduced watering just before harvest to prevent waterlogging of mature mushrooms [15].

7.2 Theoretical Considerations

- **Water Quality:** Should be clean and pathogen-free to avoid contamination.
- **Evapotranspiration Dynamics:** Mushroom beds lose moisture through evaporation and mycelial activity; irrigation must compensate for this loss.
- **Interaction with Ventilation:** Proper ventilation must

accompany irrigation to prevent excess humidity and ensure oxygen supply [12].

8. Harvesting

To collect mushrooms at the optimal maturity stage for best quality, flavor and ensure maximum yield over successive flushes (crop cycles) and hygiene and integrity of the remaining crop for future flushes.

8.1 Maturity Signs

Mushroom Type	Ideal Harvesting Stage
Button Mushroom	When the cap is still closed and compact, just before opening.
Oyster Mushroom	When the edges of the caps start to flatten but are not curled upward.
Milky Mushroom	When the cap is fully developed and firm, before it flattens.

Mushrooms are harvested manually by twisting and pulling gently from the base. Avoid cutting with knives in many cases to prevent contamination. After harvesting, the base of the stem is trimmed to remove soil or substrate. The harvested mushrooms are cleaned and sorted based on size and quality.

8.2 Harvesting Schedule

- Mushrooms are harvested in flushes (usually 2-4 per crop cycle).
- Each flush occurs every 7-10 days, depending on species and environmental conditions.
- Timely harvesting prevents over-maturity, which can reduce shelf life and encourage disease.
- After the harvesting Immediate cooling (at 2-4°C) to extend freshness.

9. Drying and Freezing

Feature	Drying	Freezing
Shelf Life	6-12 months (if stored properly)	6-8 months (at -18°C)
Nutrient Loss	Some loss of vitamin C	Better nutrient retention
Texture Change	Becomes brittle	Softens upon thawing
Cost	Low to moderate	Moderate to high (especially IQF)

[16, 17 & 19]

10. Value addition of mushrooms

Value addition in mushrooms refers to the processes and techniques used to enhance the quality, shelf life, utility, and market value of mushrooms beyond their fresh form. It transforms perishable produce into economically valuable products, reduces post-harvest losses, and opens up new markets [16-19, 21-23].

10.1 Methods Used in Value Addition

- Drying/Dehydration
- Freezing
- Pickling and Fermentation
- Canning and Bottling
- Grinding into powder
- Packaging innovations [20]

10.2 Major Value-Added Mushroom Products

Product	Description
Dried Mushrooms	Sun-dried or dehydrated mushrooms for long-term storage [24, 25]
Mushroom Powder	Ground from dried mushrooms; used in soups, seasonings, and health products [26]
Pickled Mushrooms	Preserved in vinegar, spices, and oil [2]
Frozen Mushrooms	Cleaned, blanched, and frozen; used in commercial kitchens [27]
Canned Mushrooms	Sterilized and sealed in brine or sauces; shelf-stable [2]
Mushroom Snacks	Chips, crisps, or fritters made from mushrooms [28]
Mushroom Soup & Sauces	Ready-to-eat or ready-to-cook mushroom-based liquids [30]
Medicinal Extracts	Extracted compounds from species like *Ganoderma* for health supplements [29]
Mushroom Capsules/Tablets	Made from medicinal mushrooms; used in nutraceutical industry [30]

11. Discussion

The cultivation and value addition of mushrooms present a multifaceted opportunity to address nutritional, economic, and environmental challenges, particularly in regions with limited agricultural diversity. This study reaffirms that mushroom cultivation, especially of species such as *Pleurotus ostreatus* (oyster), *Agaricus bisporus* (button), and *Ganoderma lucidum* (reishi), is both feasible and scalable using low-cost substrates like paddy straw, sawdust, and agro-industrial waste [2].

A key outcome of the study is the positive correlation between controlled environmental parameters (temperature, humidity, light, and ventilation) and mushroom yield. The findings echo prior research indicating that optimal conditions can significantly enhance biological efficiency and shorten crop cycles. However, variability in yield due to local climate and substrate inconsistency highlights the need for standardized protocols, especially for small-scale growers [9].

In terms of value addition, the research demonstrates substantial market potential for processed mushroom products, including dried mushrooms, powders, soups, snacks, and medicinal formulations [25,26,27 & 30]. Drying and powdering methods, such as sun drying, hot air drying, and freeze-drying, were found to affect nutrient retention differently.

The development of mushroom-based snacks and functional foods showed promising consumer acceptability, particularly when combined with cereal flours and spices. Sensory evaluations of extruded snacks and fortified soups indicate that mushrooms can enhance both nutritional quality and umami flavour without compromising taste or

texture [27,28,29 & 30].

Value addition not only increases product shelf-life and marketability but also diversifies income streams for cultivators. The integration of cultivation with small-scale processing units could substantially improve rural livelihoods. However, challenges such as lack of cold-chain infrastructure, inadequate processing technology, and limited awareness among farmers and consumers continue to hinder scalability [31 & 32].

12. Conclusion

The study highlights that with appropriate technical support and market linkages, mushroom cultivation and value addition can serve as a viable agri-business model. It provides nutritional, medicinal, and environmental benefits while offering economic empowerment to smallholder farmers, especially women and marginalized communities.

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