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Morphological characterization of different *Pleurotus* species under Kashmir conditions

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Abstract
Oyster mushroom commonly known as "Dhingri" is a delicate and nutritious mushroom that is grown and consumed as a food item. Morphology and nutritional contents are highly influenced by climatic conditions as well as the quality of the substrate. The most important *Pleurotus* species that grow naturally in abundance are *Pleurotus ostreatus*, *Pleurotus Florida, Pleurotus flabellatus*, and *Pleurotus sajor cajun*. In present study, the morphological characteristics of three *Pleurotus* species *viz*., *Pleurotus sajor cajun, Pleurotus Florida*, and *Pleurotus djamor*, were studied. Six different morphological features i.e., stipe size (cm), pileus size (cm), pileus shape, colour of fruiting body, lamellae and spore shape and size (µm) were recorded. The results suggest that the morphological characteristics of all three *Pleurotus* species share many similar features and hence belong to the same genus.

Keywords: *Pleurotus* spp., morphology, veil, spores, morphological characterization

Introduction
Mushrooms are achlorophyllous, saprophytic macrofungi with a fleshy fruiting body that derives food from lignocellulosic materials like dead stumps and other agro wastes. White button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus* spp.), paddy-straw mushroom (*Volvariella volvacea*) and white milky mushroom (*Calocybe indica*) are commonly cultivated species in India (Avinash *et al*., 2022) [13].
According to (Royse *et al*., 2017) [11] oyster mushroom, gilled fungi, belongs to the class Basidiomycota and is the second-largest edible and third-largest cultivated mushroom in the world, with China being the world's leading producer. With 14.2 per cent of total annual global production of 6160.8 thousand metric tons, *Pleurotus* species ranks third in terms of production after *Agaricus bisporus* and 25.2% of *Lentinula edodes* (Chang *et al.*, 1991) [4]. It is one of the most popular edible mushrooms that can be grown in the tropics. Due to its excellent flavour and easy marketability, it is widely grown in many subtropical and temperate zones. *Pleurotus* is a diverse genus of mushrooms with great nutritional value and medicinal potential (Corra *et al.*, 2016) [6].
Oyster mushrooms are gaining popularity because of their simple cultivation, excellent production potential, and high nutritional content. Substrate availability throughout the year is also the main reason for increased cultivation (Amin *et al.*, 2007) [1]. However, Falck (Falck 1917) in Germany made the first successful attempt to cultivate *Pleurotus ostreatus* for human consumption. Earlier, paddy straw was used as a readily available substrate for cultivation (Bano *et al.*, 1962) [3]. Many species of the genus *Pleurotus* are currently valued for their culinary properties as well as their adaptability to a wide range of agro-climatic conditions, which attracted the attention of researchers all over the world.
The cultivation strategies mainly depend on the genetic makeup of the strain and suitability with the substrate. The main objective of the current study is to characterize the morphological characteristics of three different strains of *Pleurotus* spp. *i.e., Pleurotus sajor- caju*, *Pleurotus Florida* and *Pleurotus djamor*.

Materials and Methods
Procurement and maintenance of culture
The pure cultures of *Pleurotus* spp. (*Pleurotus sajor-cajun, Pleurotus Florida* and *Pleurotus djamor*) used in present investigation were procured from the Directorate of Mushroom Research, Chambaghat, Solan.

The cultures were maintained on Potato Dextrose Agar (PDA) medium through periodical sub-culturing at three weeks intervals and pure cultures were used for spawn preparation.

Macroscopic characters

The three *Pleurotus* species varied in their macro-morphological characteristics. Macro-morphological parameters like length of stipe, thickness of stipe, pileus size, pileus shape, the colour of the fruiting body and lamellae were studied.

Microscopic examination of mushroom spore: Mushroom spores were examined on cotton blue dyed slides using a light microscope (Olympus CX41) at 400X.

Results and Discussion

The morphological characterization of three different strains of oyster mushroom *i.e. Pleurotus florida, Pleurotus sajor-cajun, Pleurotus djamor* was studied and differential observations like microscopic characters *i.e.* spore length and diameter and other macroscopic traits were recorded.

Pleurotus Florida

Cap size ranged from 4-11 cm to 5-23 cm broad, colour was whitish to creamish white. The surface was smooth and velvety; fan-shaped to shell-shaped, broadly convex to plane at maturity and flat having depression at center with thick flesh. Gills were whitish with a grayish tinge in colour, decurrent, closed towards stipe, veil absent. Stipe was short and thick measuring 1.0-2.4 cm long, 0.8-1.4cm thick, eccentric and lateral with dense white hairs at the base. The microscopic observations revealed that the spores were smooth with cylindrical to narrowly kidney-shaped, elliptical basidiospores ranging from 7.0-8.1x 3.4-4.4 µm, in size.

Pleurotus sajor-cajun

Cap size ranged from 3-7 cm to 4-15 cm broad, grayish to grayish brown in colour, pileus surface smooth, velvety with greasiness; fan-shaped; curled and enrolled inwardly towards top. The margin was lobed and splitted at maturity. The lamellae were crowded and completely exposed and the gills were decurrent, creamish white in colour with a smooth and lanceolate surface. Stipe was short and thick measuring 1.0-2.5 cm long, 1.0-1.5 cm thick, eccentric or lateral with dense white hairs at the base. Microscopically, basidiospores ranged from 6.0-8.5×3.1-4.3 µm, in size and were smooth with cylindrical to narrowly kidney-shaped, elliptical spores.

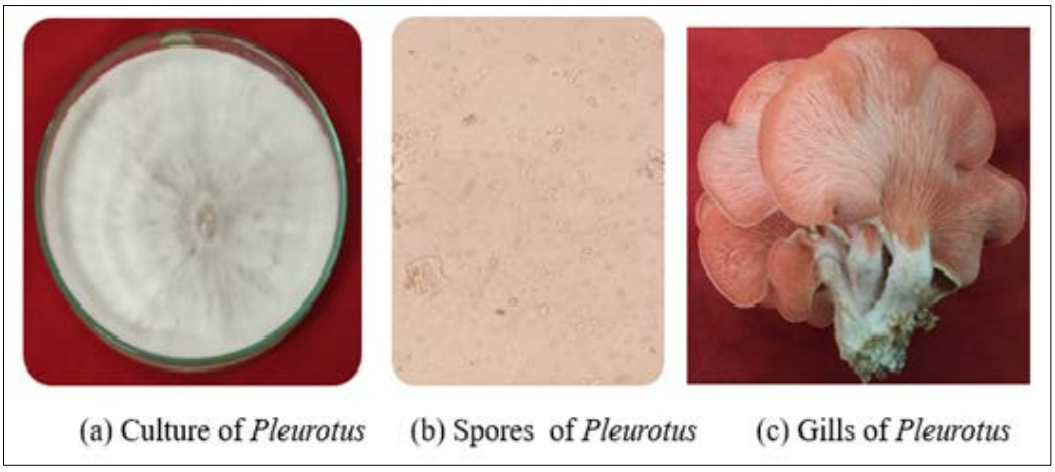
Pleurotus djamor

Cap size ranged from 3-6 cm to 4-14 cm broad, peach pink to reddish pink in colour; pileus surface smooth, velvety, flat, fan-shaped to shell-shaped at maturity; broadly convex and almost plane with greasy texture. The margin surface was smooth enrolled towards stipe and later becomes wavy. The lamellae were pinkish to reddish pink in colour with decurrent, closed, lanceolate gills that were almost attached to the stipe. The stipe was short and thick, measuring 1.0-3.5 cm long and 0.6-1.3 cm thick, and was pinkish in colour. Basidiospores varied in size from 7-8.1x3-4.4 µm and were smooth, ellipsoid, cylindrical or kidney-shaped.

Table 1: Morphological characters of three studied species of *Pleurotus* Mushroom

Features	*Pleurotus Florida*	*Pleurotus Sajor-cajun*	*Pleurotus djamor*
Colour of fruiting body	White to creamish	White to gray	Cream to pinkish
Pileus: Size	4-11 to 5-23 cm	3-7 to 4-15 cm	3-6 to 4-14 cm
Pileus, Shape	Flat-fan, margin enrolled towards the gill	Leaf/ petal, the entire disc is curled and enrolled inwardly	Flat-fan, margin enrolled towards the gill
Lamellae	Gills decuurent, veil absent	Gills decurrent, veil present	Gills decuurent, veil absent
Stipe/Stalk	1.0-2.4 cm long 0.8-1.4 cm thick	1.0-2.5 cm long 1.0-1.5 cm thick	1.0-3.5 cm long 0.6-1.3cm thick
Basidiospores	7-8.1x3.4-4.4 µm Smooth and elliptical	6-8.5x3.1-4.3 µm Smooth and elliptical	7-8.1x3-4.4 µm Smooth and elliptical

These results were in confirmation by Shubhra Shukla and AK Jaitly 2011, Mishra *et al*., 2015, Anshu Priyadarshini 2018 and Mala *et al*., 2023 [12, 10, 9] who also reported the variation in morphological characters of different *Pleurotus* species.



(a) Culture of *Pleurotus* (b) Spores of *Pleurotus* (c) Gills of *Pleurotus*

Plate 1: Morphological characteristics of *Pleurotus djamor*, *Pleurotus Florida* and *Pleurotus major-cajun*

Conclusions

Through morphological characteristics, fungus species belonging to ecological proximity or different geographical origins can be differentiated. The current study revealed that morphological evaluation is effective for characterization, genetic diversity, and establishing links among *Pleurotus* species. It has now been determined that the three species namely *Pleurotus Florida*, *Pleurotus sajor cajun*, and *Pleurotus djamor*, share many similar morphological characteristics and are thus placed in the same genus *Pleurotus.*

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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