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CHARACTERIZATION AND NUTRITIONAL ANALYSIS OF CULTIVABLE WILD EDIBLE MUSHROOMS COLLECTED FROM DISTRICT AYODHYA (U.P.), INDIA

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Abstract: Holy city Ayodhya is situated at the bank of river Saryu and has a vast diversity of macrofungi, especially mushroom mycoflora. Some of which are excellently edible and cultivable. Characterization and nutritional composition of four selected cultivable naturally growing mushrooms viz. *Agaricus bisporus*, *Pleurotus ostriatus*, *Volvariella volvacea* and *Calocybe indica* from different sites of study area (Ayodhya) were evaluated. Macroscopic and microscopic characteristics expressed with natural photographs. The proximate analysis of nutritional values was done by encountering complete mushroom samples that were shade dried, powdered and processed. The macronutrients profiles revealed that the cultivable wild edible mushroom contains protein, carbohydrate, lipid, fiber and ash content ranged from 30.21-34.21%, 22.56-38.39%, 2.35-4.15%, 11.79-23.94% and 7.75-12.97% respectively on dry weight basis. Current study confirms that the selected cultivable wild edible mushrooms are a healthy and good source of food and major alternative source of protein. It also exposed the use of varieties of mushroom in their cultivation practice as well as diet to decrease malnutrition and increase socioeconomic values.

Keywords: *Agaricus bisporus*, Ayodhya, Mushroom mycoflora, Nutritional analysis.

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INTRODUCTION

Mushroom is a seasonal and cultivable mycoflora that shows very much and diverse role in ecology as well as society (Chaudhary *et al.*, 2015). Mushrooms have been existing on earth earlier to human and have been used as food prior to civilization (Paliwal *et al.*, 2013; Singh and Singh, 2022). The macrofungal mushrooms are characterized by their distinct macroscopic fruiting bodies of underground mycelium of certain fungi belonging to the class of Basidiomycetes and Ascomycetes (Tripathi *et al.*, 2017; Vishwakarma and Tripathi, 2019). The fungi for the first time elevated as a separate kingdom in five kingdom system (Verma and Prakash, 2020). The edible status of mushroom mycoflora is pioneer and later become a cultivable mycoflora in favour to need. Only limited number of species are available in practice to cultivation and remaining are wild

(Singh and Singh, 2022). The wild edible mushroom has value as both edible and medicinal by human, especially local ethical communities. More than 10000 species of mushroom are reported and about 2000 species of them considered being edible. All of these, around 25 species are widely accepted as food and only about 12 species are considered as artificially cultivated (Tripathi *et al.*, 2017; Bhandari and Jha, 2017).

The edible mushrooms are utilized frequently from ancient era as human food. Most of countries including India, mushrooms are referring as an important food because of their unique flavour, test, and nutritional constituents (Kumari and Srivastava, 2020). Mushroom is an ideal food item and enumerated as vegetarian meat because of their high nutritional components such as protein, carbohydrates, fiber, with low fat and ash contents (Chaudhary *et al.*, 2015; Tripathi *et al.*, 2017; Sankarnarayanan and Kumari, 2021). In India, four major species *viz*. *Agaricus bisporus*, *Pleurotus ostriatus*, *Volvariella volvacea* and *Calocybe indica* are cultivated. These cultivable species are commonly known as button mushroom, oyster mushroom, paddy straw mushroom and milky mushroom respectively and their cultivational status are 73%, 16%, 7% and 3%, respectively across the India (Rautela *et al.*, 2019).

The legendary city of Ayodhya is an important part of Avadh province of Uttar Pradesh and world widely known for the birth place of Lord Rama. Ayodhya, also known as Saket, was an ancient city of India and setting of the great epic Ramayana. In the area of interest, major cultivational mushroom species is *Agaricus bisporus* (button mushroom) and remaining cultivational species viz. *Pleurotus ostriatus* (Oyster Mushroom), *Volvariella volvacea* (Paddy Straw Mushroom) and *Calocybe indica* (Milky Mushroom) are negligible. Whereas this place is suitable for the cultivation of all-cultural mushroom species. The aim of the present study to analyse the nutritional value i.e. content of protein, carbohydrate, lipid, fiber, and ash contents of all the cultivable species therefore, providing a reference for people to reasonably used and mixed in their diets. It may be proved helpful to regional people relax from their malnutrition and also increase their socio-economic awareness.

MATERIALS AND METHODS

Sample Collection, Identification and Processing

Sample of four wild edible mushroom mycoflora viz. *Agaricus bisporus*, *Pleurotus ostriatus*, *Volvariella volvacea* and *Calocybe indica* were collected from different sites of district Ayodhya. Collected mushroom samples were identified based on macroscopic and microscopic characters and confirmed by following several literatures (Alam *et al.*, 2008; Soosairaj *et al.*, 2012; Chittaragi *et al.*, 2014; Vishwakarma *et al.*, 2016; Singh and Singh, 2022).

Sample preparation

Collected mushroom samples were cleaned and dried in shadow at room temperature (25-30^{O}C) for two weeks. After that, the fine powdered samples were made for their biochemical analysis.

Nutritional analysis

For the determination of nutritional value and composition, several biochemical parameters were studied from the mushroom samples:

1. Protein contents

10 gram of grinned mushroom was taken with 100 ml. of 0.1 N NaOH and boiled for 30 min. The solution was cooled in room temperature (25-30 ^{O}C) and centrifuged at tabletop centrifuge in the laboratory. The supernatant was collected and total protein content measured (Lowry *et al.*, 1951; Alam *et al.*, 2008).

2. Lipid contents

10 gram of grinned mushroom sample was suspended in 100 ml. of chloroform: methanol (2:1 V/V) solution then mixed thoroughly and let relaxed for 3 days. The solution was filtered and centrifuged at tabletop centrifuge. After centrifugation, the upper layer of methanol was removed by pipette and chloroform was evaporated by heating. After this the remaining was crude lipid (Folch *et al.*, 1957; Alam *et al.*, 2008).

3. Fiber contents

10 grams of fat-free and dried sample was taken in a beaker and 200 ml of boiling 0.255 N H_2SO_4 was added. The mixture was boiled for 30 minutes keeping the volume constant by the addition of water at frequent intervals. The mixture was then filtered through a muslin cloth and the residue washed with hot water till free from acid. The material was then transferred to the same beaker, and 200 ml of boiling 0.313 N NaOH added. After boiling for 30 minutes and keeping the volume constant as before. The mixture was filtered through a muslin cloth and the residue washed with hot water till free from alkali, followed by washing with some alcohol and ether. After this the residue was transferred to a crucible, dried overnight at 80-100°C, and weighed (A) in an electric balance. The crucible was heated in a muffle furnace at 100°C for 5-6 hours, cooled and weighed again (B). The difference in the weights (A-B) represents the weight of crude fiber (Raghuramulu *et al*., 2003; Alam *et al*., 2008).

Crude fiber (g/100g sample) = [100 – (moisture + fat)] × (A – B) / Weight of Sample

1. Carbohydrate contents

For detection of total carbohydrates content, Phenol Sulphuric Acid method was followed. For this, 0.1 ml of the sample, 1 ml phenol solution (5%, v/v) and 5 ml of H_2SO4 (96%, v/v) were added. The volume of the test sample made 10 ml with adding of distilled water and mixed well followed by incubation for 20 min at 25-30°C in water bath. The absorbance was measured at 490 nm against glucose as standard (Dubois *et al*., 1956).

2. Ash contents

10 gram powdered mushroom sample was ashed in muffle furnace in previously ignited and cooled crucible of known weight at 550±5°C for 1 hr. The crucible and its contents were then cooled in desiccators and reweighed. The rate of the incombustible residue accounts for ash content (AOAC, 2000).

$$\text{Ash Content (\%)} = \frac{\text{Weight of Ash}}{\text{Weight of Sample}} \times 100$$

Statistical analysis

All the data presented in g/100gm and values are given as mean ± standard deviation (SD). The probability range (p) = 0.05 were taken and difference at $p < 0.05$ were considered to be significant (Vishwakarma *et al*., 2016).

RESULTS AND DISCUSSION

Based on macroscopic and microscopic study of collected sample, it is clearly denoted that the collected specimen of mushroom was *Agaricus bisporus*, *Pleurotus ostriatus, Volvariella volvacea* and *Calocybe indica*. The formal description such as sample number, date and place of collection, nature and morphological description with their respective taxonomic position of collected and selected macrofungi expressed as following:

Sample1: *Agaricus bisporus* (Fig.1)
Family: Agaricaceae
Description: Pileus 5-10 cm. diameter, hemispherical to flattening (button shaped), grey-brown coloured; gills free, crowded, narrow, pink or reddish brown to dark brown coloured; stipe cylindrical, 5-6cm. length and 1-2 cm. thick, single ringed; spore print dark brown, oval to spherical, 4-6μm × 5-7μm.
Status: Edible and Cultivable
Sample ID: Saket006
Collection Date: 24.10.2021
Collection Site: Village- Chandpuri, Block- Masaudha, Tahsil- Sohawal
Common name: Button Mushroom

Sample 2: *Pleurotus ostriatus* (Fig. 2)
Family: Pleurotaceae
Description: Pileus 4-27cm. diameter, fan or oyster shaped, white or grey to dark brown coloured; gills descend on stipe, white to grey coloured; stipe off-centre, 1-4cm. length and 1-2cm. thick, lateral attachment with substrate (wood); spore print white to yellowish, cylindric-ellipsoid, smooth, 7-11μm × 2-4μm.
Status: Edible and Cultivable
Sample ID: Saket065
Collection Date: 25.06.2022
Collection Site: Village-Datauli, Block- Poora Bajar, Tahsil-Sadar
Common name: Oyster Mushroom

Sample 3: *Volvariella volvacea* (Fig. 3)
Family: Pluteaceae
Description: Pileus 4-10cm. diameter, folded to open umbrella shaped, broadly convex, light grey to dark grey coloured; gills free, light pink to brown coloured, with marginate and fimbriate

edges; stipe cylindrical, 2-12cm. length and 1-2cm. thick, ringed; spore print brown, smooth, ellipsoid or oval, 7-9μm × 4-6μm.
Status: Edible and Cultivable
Sample ID: Saket096
Collection Date: 23.12.2021
Collection Site: Village- Sewar, Block- Milkipur, Tahsil- Milkipur
Common name: Pady Straw Mushroom

Sample 4: *Calocybe indica* (Fig. 4)
Family: Lyophyllaceae
Description: Pileus 5-11cm. diameter, broadly convex, white milky coloured; gills free sinuated to adnate, narrow, crowded, white coloured; stipe bare, 4-10cm. length and 1-2cm. thick, fleshy, sinuate, base expanded, surface smooth; spore print whit, smooth, spherical or oval, 4-6μm × 3-3.5μm.
Status: Edible and Cultivable
Sample ID: Saket060
Collection Date: 11.08.2022
Collection Site: Village-Akhtiyarpur, Block-Rudauli, Tahsil-Rudauli
Common name: Milky Mushroom

Fig. (1-4): 1. *Agaricus bisporus*, 2. *Pleurotus ostriatus*, 3. *Volvariella volvacea*, 4. *Calocybe indica.*

After identification of all four samples of mushrooms, a nutritional study was conducted, and the mean values along with standard deviation are presented in the Table-1.

Table 1: Nutritional value of collected Mushroom samples.

Mushroom	Protein%	Carbohydrate%	Lipid%	Fibre%	Ash%	Total Dry Weight%
Agaricus bisporus	30.60±0.58	29.90±0.15	3.65±0.33	12.55±0.26	12.97±0.07	89.68±1.07
Pleurotus ostriatus	31.58±0.37	22.56±0.22	4.15±0.16	23.94±0.20	07.75±0.28	90.00±0.69
Volvariella volvacea	34.21±0.11	38.70±0.36	3.01±0.24	11.79±0.17	08.11±0.05	95.85±0.34
Calocybe indica	30.21±0.42	38.39±0.29	2.35±0.17	14.38±0.27	12.11±0.42	97.46±0.38

Note: The value denoted mean ± SD (n=3) (100% - Total Dry Weight % = Moisture %).

In the present study we find that the Protein content were much higher in Paddy Straw mushroom (*Volvariella volvacea* 34.21%) followed by Oyster mushroom (*Pleurotus ostriatus* 31.58%) and the lowest protein content reported in milky mushroom (*Calocybe indica* 30.21%) followed by button mushroom (*Agaricus bisporus* 30.60%). Carbohydrate content reported as *Volvariella volvacea* (38.70%) > *Calocybe indica* (38.39%) > *Agaricus bisporus* (29.90%) > *Pleurotus ostriatus* (22.56%). Lipid content were also reported in increasing order as *Calocybe indica* (2.35%) < *Volvariella volvacea* (3.01%) < *Agaricus bisporus* (3.65%) < *Pleurotus ostriatus* (4.15%). Dietary fiber is higher in *Pleurotus ostriatus* (Oyster mushroom 23.94%) and lower in *Volvariella volvacea* (11.79%) whereas *Calocybe indica* (14.38%) and *Agaricus bisporus* (12.55%) reported moderate amount of fiber contents. Ash content of analyzed mushroom samples were recorded as higher in *Agaricus bisporus* (12.97%) followed by *Calocybe indica* (12.11%) and lower in *Pleurotus ostriatus* (7.75%) followed by *Volvariella volvacea* (8.11%). Comparatively, the total dry weight content is higher in *Calocybe indica* (97.46%) followed by *Volvariella volvacea* (95.85%) whereas lowest reported in *Agaricus bisporus* (89.68%) followed by *Pleurotus ostriatus*

(90.00%). Earlier Rautela *et al*. (2019) describe the cultivable status of mushroom India as *Agaricus bisporus* 73%, *Pleurotus ostriatus* 16%, *Volvariella volvacea* 7% and *Calocybe indica* only 3%. The authors found that the nutritional status was higher (based on total dry weight contents) in the low cultivable mushrooms comparatively to high cultivable species.

CONCLUSIONS

Authors found that button mushroom has a good nutritional value with high protein, carbohydrate and dietary fibers. Rather than button mushrooms, one can use three more verities in cultural practices and diet such as oyster, paddy straw and milky mushrooms. In the present study, authors analyzed four major cultivable mushrooms of India and reveal their nutritional value for public awareness. By this study, it can be concluded that all the four species of mushroom have a very good nutrient composition with high protein, carbohydrate, fiber and low lipid and ash contents.

In Ayodhya, 98% of mushrooms are used by people is button mushroom (*A. bisporus*) for dietary purpose and remaining 2% are wild edible mushrooms whereas 100% in case of cultivation. By this study, people will aware for cultivation of mushroom verities and their nutritional status. It will be helpful to check the malnutrition and develop socioeconomic values.

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