Diversity and Ethno-Mycological Importance of Mushrooms from Western Himalayas, Kashmir.

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Abstract

Wild edible mushrooms (WEM) are economically significant and used in traditional medicines worldwide. The region of Jammu and Kashmir (Western Himalayas) is enriched with the diversity of edible mushrooms, collected by the rural people for food and income generation. This is the first detailed study on diversity and ethno-medicinal uses of mushrooms from the State of Jammu and Kashmir.

Methods: Consecutive surveys were conducted to record ethno-mycological diversity and socio-economic importance of wild edible mushrooms value chain in rural areas of Azad Jammu and Kashmir during 2015-2020. Data were collected with a semi-structured questionnaire having a set of questions on indigenous mycological knowledge and collection and retailing of wild edible mushrooms. A total of 923 informants from the study area provided results identifying the gender, type of mushroom species, medicinal uses, and marketing of mushrooms. Principal component analysis (PCA) was also applied to the data set to analyse the relationship between species distribution, the underlying environmental factors and habitat types. PCA identified the major species specific to the sites and put them close to the sites of distribution.

Results: A total of 131 mushroom species were collected and identified during 2015-2020 from the study area. One hundred and one species of mushrooms were reported new to the State of Jammu and Kashmir. The dominant mushroom family was Russullaceae with 23 species followed by Agaricaceae, 16 species. Major mushroom species identified and grouped by the PCA were Coprinus comatus, Lactarius sangufulus, Amanita fulva, Armillaria gallica, Lycoperdon perlatum, Lycoperdon pyriforme, and Russula creminicolor. Sparassis crispa, Pleurotus sp and Laetiporus sulphurous were recorded most edible and medicinally significant fungi. Morels were the most expensive and medicinally important among all harvested macro-fungal species. These were reported to use against the common ailments and various health problems.

Conclusions: Collection and retailing of WEM contribute to improve the socioeconomic status, providing alternative employment and food security to rural people of the area. These mushrooms are used as a source of food and traditional medicines among the rural informants and could be used a potential source of antibacterial and anticancer drugs in future.

Background

Mushrooms are fruiting bodies with distinctive carpophores of Basidiomycetes and some Ascomycetes [1]. They grow in the wild and cultivated for food and medicines worldwide [2] due to the presence of bioactive compounds and applications in the traditional medicines, health-promoting benefits, and antioxidant activity [3, 4, 5, 6]. These are rich in amino acids, protein, fibre elements, vitamins, and different minerals and play a significant role as anticholesterol, antitumor, antimicrobial, antioxidant, antilipidemic, antidiabetic antihyperglycemic, antihypertensives, anti-inflammatory hepatoprotective, immune-modulatory, anti-ageing properties and used against neuro-degenerative diseases [7,8, 9]. Due to diverse ecological, medicinal, nutritional, and health-promoting properties mushrooms are gaining prime importance among scientific and research communities throughout the world [10]. They possess remarkable dietetic and medicinal values and are rich in carbohydrate, protein, and bioactive metabolites effective against cardiovascular, and hepatic problems and contain anti-viral, antioxidant, and antimicrobial contents [11, 12, 13]. Pleurotus is used as protein-rich food with many health benefits worldwide [14]. Extracts of edible mushrooms are considered a rich source of carbohydrates, proteins and mineral elements [15, 16]. They have low contents of saturated fats and higher contents of proteins and fibres and might reduce the blood cholesterol level [17]. Different low molecular weight bioactive compounds, anthraquinones, sesquiterpenes, quinolines and oxalic acid with reported antimicrobial activity have been identified from mushrooms [18]. Edible mushrooms contain polysaccharides, terpenoids, vitamins, amino acids and minerals elements with maximum antibacterial activity and anti-ageing properties [19, 20, 21]. Ganoderma lucidum has been used for centuries by different tribes as an alternative traditional medicine to promote health and to treat specific disorders [22]. It was reported that Hericium erinaceus, Sarcodon scabrosus, Ganoderma lucidum and Grifola frondosa have neuro-protective health benefits [23].

Different common edible mushrooms like Pleurotus species, Boletus edulis, Agaricus rubescens, Sparassis crispa, Cantharellus cibarius and Lactarius deliciosus and M. deliciosa are good in natural antioxidants, phenolic compounds,
minerals, and other nutrients (24, 3). They have important antioxidant and biologically active compounds and used worldwide from ancient times in traditional medicines due to health-promoting and immune-stimulating properties [25, 26, 27]. Different functional bioactive compounds Cardiac glycosides Anthraquinones, flavonoids, Tannins, Terpenoids and proteins were reported from mushrooms [28, 29, 30]. Water extract of Chaga mushrooms contains potent anti-cancer compounds [31]. Mushrooms are gaining importance by researchers worldwide due to their nutritional and pharmacological importance [32, 33]. Biomolecules of mushrooms have good biological and medicinal potential against different diseases [34].

Morels (Morchella) have been used as food with various health benefits [35] Different polysaccharides have been identified from Morchella sextelata with immune-modulating properties [36]. Morchella esculenta has a wide variety of antioxidant and antitumor compounds and is used as a source of food and traditional medicines [37]. It contains polyunsaturated fatty acids, carbohydrates, and bioactive compounds with antibacterial activity [38]. The whole region of AJK is blessed with diverse geographic and climatic conditions with a diversity of mushrooms but there are no comprehensive studies have been taken previously to explore such resources for human welfare. There is a lack of proper documentation on the diversity, specific habitat, ethno-mycological uses, production, harvesting and export of mushrooms. Present research work will contribute towards a detailed overview of the species diversity of mushrooms in AJK, their ethno-mycological uses and commercial and economic importance.

Methods

Study area

The study area lies in the Western Himalayan regions of Azad Jammu and Kashmir between 32°-17 and 36° - 58 North latitude and 73°-6 and 80° - 30 longitude in the western part of the Indian sub-continent with an area of 13297 square Kilometres. The elevation from sea level ranges from three-sixty meters in the south to 6325 meters in the north. Average annual rainfall 1300 mm. The population is 4 million and the ratio between rural to urban populations is 88:12. Forestry, livestock and agriculture are major economic activities for rural income. The climate of the study area is Subtropical monsoon type in the lower range to moist Temperate in the middle and Subalpine to Alpine in upper regions. The summer is hot at lower altitudinal zones and pleasant in upper zones with very cold winters. The area above 1200 m altitude receives heavy snowfall from November to April. The average temperature recorded in summer remains 34°C to 25°C and in winters, 10°C to 4°C. Annual rainfall (average) in the monsoon region is 900-1300 mm and in monsoon free region it remains 35-140 mm [39].

All the major terrestrial ecological sites and hotspots for mushroom species from the state of Azad Jammu and Kashmir were selected for this study. Sampling sites were finalized through consecutive field visits based on specific geographic and ecological significance from representative vegetation zones of Azad Jammu and Kashmir. A total of 21 sites were selected from Neelum, Muzaffarabad, Hattian, Bagh, Heveli, Poonch and Kotli districts of Azad Jammu and Kashmir during 2015-19 to study mushroom diversity (Figure 1 & Table 1).

Collection and preservation of sporophores

Sporophores of fungi were collected from Cedrus deodara and Pinus wallichiana forest communities. Sporocarps were collected by using standard methods (Gateri et al., 2014). Ethno-mycological knowledge was obtained from different field visits and semi-structured questionnaires and interviews with rural people. A specific collection number was assigned to each sample in triplicate. Specific characters of habitat and associated plant species were also recorded. Sporophores were cleaned gently, soil particles were removed, and photographs were taken with a digital camera Nikon D5600. Morphological characters of the sporophores were recorded during collection in the field. Fruiting bodies were left into the air for drying before packing for preservation. For easy drying, the larger Sporophores were cut down into many smaller pieces. Dried samples were packed and labelled with separate tag numbers for further analysis and future references. A sample of the selected type of mushroom was assigned a voucher number and carried to the laboratory of Botany, University of Punjab, Lahore, Pakistan for detailed morpho-anatomical examination. Specimens were finally cross-checked with the published
material, literature at the morpho-anatomical level. Appropriate taxonomic literature was used for the proper identification of mushrooms [40, 41, 42, 43, 44]. Further citations were checked on mycobank and the index fungorum database. Final identification was made from fungal biology and systematic research laboratory Department of the Botany University of the Punjab Lahore after studying detailed morpho-anatomical study (identification keys and published material). Voucher specimens were deposited with the accession numbers at the Herbarium of Botany, University of Azad Jammu and Kashmir Muzaffarabad.

Table 1. Different study sites and coordinates

| No | Site Name       | District  | N          | E          | Elevation (m) |
|----|----------------|-----------|------------|------------|---------------|
| 1  | Peer Chinasi   | Muzaffarab| 34°23’2.41 | 73°33’33.67 | 2596          |
| 2  | Shaheed Gali   | Muzaffarab| 34°23’1.01 | 73°25’16.55 | 1346          |
| 3  | Peer Hassimar  | Muzaffarab| 34°92’4.58 | 73°37’00.42 | 1901          |
| 4  | Haji Peer      | Bagh      | 33°58’2.61 | 74°04’40.43 | 2261          |
| 5  | Las Dana       | Bagh      | 33°55’2.54 | 73°57’06.81 | 2331          |
| 6  | Sudhan Gali    | Bagh      | 34°44’6.34 | 73°44’11.74 | 2307          |
| 7  | Banjosa        | Poonch    | 33°48’2.75 | 73°49’25.92 | 1910          |
| 8  | Toolipir       | Poonch    | 33°53’4.72 | 73°54’34.00 | 2334          |
| 9  | Noon Bangla    | Hattian   | 34°07’1.06 | 73°40’11.50 | 2023          |
| 10 | Chakar         | Hattian   | 34°15’5.96 | 73°37’01.85 | 1567          |
| 11 | Palandri       | Sudhnoti  | 33°43’3.37 | 73°38’10.43 | 1517          |
| 12 | Salkhala       | Neelum    | 34°33’0.56 | 73°53’14.53 | 1859          |
| 13 | Dawarian       | Neelum    | 34°44’0.53 | 74°02’26.60 | 2431          |
| 14 | Surgon         | Neelum    | 34°47’5.80 | 74°11’38.28 | 1921          |
| 15 | Changan        | Neelum    | 34°43’10.56| 74°4’20.66  | 1920          |
| 16 | Sharda         | Neelum    | 34°46’5.36 | 74°11’52.35 | 2475          |
| 17 | Keil           | Neelum    | 34°48’3.44 | 74°21’25.70 | 2425          |
| 18 | Forward Kahota | Haveli    | 33°54’1.58 | 74°04’13.97 | 1883          |
| 19 | Khursheed Abad | Haveli    | 33°54’9.40 | 74°12’21.59 | 2426          |
| 20 | Nakyel         | Kotli     | 33°29’9.72 | 74°6’55.53  | 1649          |
| 21 | Leepa Valley   | Hattian   | 34°18’5.25 | 73°54’50.69 | 2373          |
| 22 | Kerin (Nagdar valley) | Neelum | 34°44’0.76 | 74°02’26.00 | 2471          |

Results

Demographic characteristics and community involvement
Wild mushroom value chain is seen to be gender oriented dominated by women in collection (61.1%, n=564) while men occupy only 38%, n=359 out of the 923 respondents (Table 2). Women were found to participate in every mushroom activity such as collection to preservation while men contributed only to collection and selling. Similar findings were reported by [6] where female was found dominant in WEM collection. However, it was found that men dominated in selling of mushrooms (70%) to local shops, restaurant, markets, and local mushrooms entrepreneurs. The preponderance of female collectors in present study is supported by another research [45, 46, 47]. Every stage of mushroom activities from collection to processing and even marketing was led by women in this study. Poor involvement of men in mushroom activities might be due to the belief that mushroom collection is only art for remote areas of women. In remote areas of studied districts of AJK, women are mostly unemployed, dedicating themselves to household and subsistence activities. Mushroom collection and selling are one of their sources of food and income. The study revealed that collection activities are dominated by people of middle age (53.9%) especially those of 31-50 years old between the ages ranged 14-85, followed by 19-30 (25.8%), by 14 and over (17.6%), and by 50 and above (13.3%) (Table 2). Similar findings were also reported from the Finland [48] where it was shown that middle aged people by 30 (96.6 %) or above involved in mushrooms collection activity. It revealed the participation of older, more experienced people in mushroom collection. Similar results on age distribution were also reported by [47]. Among 923 respondents, 25.8 % had an education level of primary school, 22.8 % middle school, 20.9 % secondary or high school, 17 % illiterate and 13.5 % higher secondary, university or colleges (Table 2). There were 41 % housewives 39.7 % farmers & entrepreneur, 12.6% employed, 6.7 % retired from 923 respondents (Table 2). Data on education in the present study revealed that almost 83 % informants had a middle school education in accordance with the findings of [49] who indicated that mushroom collection or cultivation were mostly managed by less educated people in the rural areas.

Table 2. Demographic characteristics of Mushroom collectors in 6 Districts of AJ&K, (N=923)

| S. No. | Characteristics     | Frequency | Percentage | Mean ±SEM |
|--------|---------------------|-----------|------------|-----------|
| 1.     | Sex                 |           |            |           |
|        | Male                | 359       | 38.9       | 1.61±0.01 |
|        | Female              | 564       | 61.1       |           |
| 2.     | Age group           |           |            |           |
|        | <18                 | 163       | 17.6       | 2.80±0.41 |
|        | 19-30               | 238       | 25.8       |           |
|        | 31-40               | 259       | 28.1       |           |
|        | 41-50               | 140       | 15.2       |           |
|        | >50                 | 123       | 13.3       |           |
| 3.     | Education level     |           |            |           |
|        | Illiterate          | 157       | 17.0       | 2.88±0.06 |
|        | Primary             | 238       | 25.8       |           |
|        | Middle              | 210       | 22.8       |           |
|        | Secondary           | 193       | 20.9       |           |
|        | HS above            | 125       | 13.5       |           |
| 4.     | Employment status   |           |            |           |
|        | Govt servant        | 116       | 12.6       | 2.41±0.26 |
|        | Farmer              | 366       | 39.7       |           |
|        | Housewife           | 379       | 41.0       |           |
|        | Retired             | 62        | 6.7        |           |

Collection and identification mushrooms

A total of 131 mushroom species were collected and identified during the study. Out of 131 mushroom species, 101 species of mushrooms were recorded new to the state of Azad Jammu and Kashmir (Figure 2), however few of these species have
been identified from different parts of Pakistan at molecular level previously. Already identified mushroom species were morphologically cross checked with published material. Many of these species were collected by the rural peoples based on folk taxonomy and only a few are considered edible. The dominant mushroom family was Russulaceae with 23 species followed by Agaricaceae, 16 species, Boletaceae, 10 species, Halvallaceae, 7 species and from Tricholomataceae and Physalaeiraceae 6 species were recorded in present investigations. Amanitaceae, Hymenochaetaceae and Pleurotaceae were identified with five species each. *Russula* and *Lactarius* were the dominant genera. Only a few species of these genera were edible and maximum number of sporophores decay on substratum after maturity. Inedible species were often collected for wound healing and other medicinal purposes. Most of the mushroom species growing naturally were collected by the rural for food and medicinal purposes. Maximum diversity of fungi was calculated in the Neelum valley followed by Las Dana, Chakar, Noon bangla and Leepa in Jhelum valley. The sites surveyed for collection of mushrooms had maximum forest cover that is responsible for the diversity variation including Tooli peer and forests of Peer Chinasi. The basidiomycetes constituted the major proportion i.e; 115 species while Ascomycetes constituted 16 species. Majority of mushrooms collected belong to gilled fungi. Species of *Coprinus, Flammulina, Peziza, Armillaria* and *Morchella* were found in clusters while as other species occur in scattered patches. In Previous studies six species of *Agaricus* were reported from Rawalakot, Azad Kashmir by [50]. Similarly [51] collected and described edible mushrooms viz. *Armillaria mellea, Cantharellus cibarius, Craterellus comucopiodes, Flammulina velutipes* and *Macrolepiota procera* from this state. Furthermore, more they added, *Amanita elliptica, A. muscaria var. alba, Ramaria aurea R. botytis, Phallus impudicus, Morphella elata and M. semilibera, Amanita ceciliae, A. subglobosia, A. pantherina, A. pachycolea, A. virosa, Volvariella bombycina* and *V. speciosa* to Kashmir. [52, 53] also contributed to mushroom flora of AJK. They reported 25 edible mushrooms from different sites of the state.

**Mushrooms edibility in the study area**

The state of Azad Jammu & Kashmir (AJ&K) has a land of rich diversity of wild mushrooms which might have been contributed by the tropical and moist temperate forests, mostly Quercus and coniferous woodlands, and higher rainfall and annual precipitation. Among the identified wild mushrooms, 54 (48%) were identified as edible only, 24 (21%) as inedible, 14 (12%) as edible and medicinal (Figure 3). The detail of different categories of identified wild mushrooms with their percentage is given in figure (3).

**Principal component analysis**

PCA is used to determine and analyse the relationship between species distribution and the underlying environmental factors and habitat types. It is an advanced technique which maximizes the species scores with respect of sampling sites having linear and appropriate weights. PCA identified the major species specific to the sites and put them close to the sites of distribution. The sites grouped together by the PCA based upon their species interrelationship are Pir Chinasi, Haji peer and Peer hasimar, Toolipeer, and Leepa. All these sites have little variations in the biotic factors including species composition and topography. These sites have some common geographic features which are responsible for the similar species composition. Major mushroom species collected from these sites and grouped together by the PCA are *Coprinus comatus, Lactarius sangufulus, Amanita fulva, Armillaria gallica, Lycoperdon perlatum, Lycoperdon pyriforme, and Russula creminicolor*, these sites have shown a little correlation with a village Khawaja bandi kahuta Havali. The mushroom species grouped together by the PCA are the common fungi which are present in these sites.

On the other hand, Nagdar (Upper Neelum), Dawarian, Sharda, Taobut, Chakar (Noonbangla), Sudhan Gali and Banjosa are grouped near to each other. These sites are almost lying in the temperate forest of AJK and almost have same topography, Forest cover and precipitation pattern so their mushroom composition is nearly like each other. Major fungal species of these sites were *Amanita muscaria, Lactarius deliciosus, Gyromitra esculenta, Armillaria sp, Agaricus campestris, Russula breviceps, Polyporus squamosus, Trametes versicolor and Laccaria* sp. Other mushroom species grouped at the centre of the PCA axis show that these species are almost equally distributed and present in all the sites of the study area. These species have no specific distribution pattern. These species are most common and grow almost in different geographic condition with slight changes in their growth period and maturation.
PCA identified five major keystone species from the data matrix and separated them along X-axis. *Lactarius piperatus*, *L. deliciousus*, *L. torminosus*, *Hygrocybe flavesence* and *Russula delica* were extracted as most significant vectors having maximum Eigen vale scores represented by their distinct placement on PCA biplot. These five species were characterized by the higher IVI values in the species dataset and enjoyed abundance and broad distribution across the study area. The major bulk of the fungal elements were clustered in the centre of the PCA biplot showing their random distribution without specific site or habitat preference (Fig. 4).

**Discussion**

**Ethno-mycological and socio-economic importance of wild mushrooms**

A total of 923 informants from 22 sites of selected districts were interviewed based on the harvesting, selling and consumption of wild edible mushrooms. Consecutive field visits were carried out to different villages, local markets, shops of the study area for gathering of information about mushroom collection and selling. A semi-structured questionnaire (Appendix.1) was used to collect the information on wild edible mushrooms value chain, hunting, collection, preservation, and retailing [54]. Primary and secondary information was collected from all the available resources. Primary information gathered by structured and semi structured interviews with collectors, consumers, and sellers. Secondary information was collected from different literature, thesis, maps, and web sites. Both formal and informal discussions with forestry professionals, key informants, village elders, farmers, women, schoolteachers, social workers, shopkeepers were carried out to identify and verify the facts. Information on edibility, medicinal uses, preservation methods and any other uses was also collected. Mushrooms play a significant role in rural development. Many species of edible mushrooms and morels have been collected by the poor rural for socioeconomic purpose [55] and rural livelihood in terms of economic development [56].

Morels are collected by the people of rural areas of AJK for medicinal and commercial purposes. *Morchella conica*, *M. costata*, *Morchella esculanta*, *M. elata* and *M. tridentina* were considered highly prized morel species. These morel species widely grow under the dense forest cover of *Pinus wallichiana* and *Cedrus deodar* in association with *Viburnum grandiflorum*. Among morels, *Morchella esculanta* and *M. tridentina* were valuable morels and due to compact fruiting bodies, less moisture, and higher nutritional contents and considered good for export. *M. conica* has more water contents than the *M. esculanta* and turns dark black, which affects the preservation as well as its marketing. Edible fungi i.e., *Cantharellus cibarius*, *Lactarius deliciosus*, *Russula* sp were collected and sold in the market for food purposes [57]. *Morchella* species were collected mostly due to their commercial importance as one kilogram of dried morel was solid in the market up to 32 thousand PKR. One kilogram of dry morels can full fill the basic needs of a family of average size. Prices of dried morels vary from market to market. In a village (Neelum) average price of 1 kg of dried morel was 30000 PKR. Other edible mushroom species *Pleurotus ostreatus* and *Agaricus campestris* were supplied to the famous hotels of the city. One Kg of dried mushroom was sold in 1500-2000PKR. These mushrooms are mostly used in dishes for foreign visitors. Mushrooms are collected worldwide as a source of income. More than 300 species of mushrooms were collected by different ethnic groups in Mexico for nutritional and medicinal purposes [58]. In China, local farmers earn up to 62% of their cash income through mushroom export [59].

Prices of dry mushrooms in this region were higher than fresh mushrooms. Similarly, those mushrooms which were exported showed higher prices. The most common species collected and used for trade-in neighbouring countries of Pakistan were e.g. *Boletus* spp. *Lactarius* spp., *Thelephora ganbajun*, *Suillus bovinus*, *Russula* sp. and *Termitomyces* spp. [59, 60]. In the present investigation, the socio-economic data showed that a family collects an average of 3-4 kg morels with an average income of about Rs. 100000-120000 in a season. Mushrooms are collected and exported from Pakistan to the neighbour countries for revenue generation. Fifty-six (56) species of mushrooms were reported as edible previously from Pakistan and unfortunately because of over-collection, urbanization, and deforestation some species are threatened [52]. Mushrooms are natural sources of bioactive compounds used in alternative traditional medicines. Today, in parallel with the increase in the number of diseases, alternative medicine and their usage is increasing due to the insufficiency of synthetic medicines and their disadvantages or side effects. Mushrooms have compounds that decrease oxidative stress and improve health [61, 62].
Many unexplored species of medicinally and commercially important mushrooms were widely distributed in the forests of Azad Jammu and Kashmir. Mushroom species growing naturally were collected by the rural people for food and medicines. Previously we reported medicinally significant mushrooms from the Neelum Valley [78]. They are also collected in different advanced countries of the world like the United Kingdom, Sweden and France [64]. In the present study, Twenty-six (26) species of mushrooms were recorded as medicinally important which are used for the treatment of some common ailments. Among these mushrooms Fistulina sp, Hericium erinaceous, Laetiporus sulphurous, Polyporus squamosus, Ramaria fennica, Sparassis crispa, Morchella elata, M. conica, M. tridentina and M. deliciosa were the most delicious and widely used species as a nutritive food by the rural people of Neelum valley and Hattian in Jhelum Valley. Morchella esculanta is reported to contain antioxidant, anticancer and anti-inflammatory properties and is used as delicious food [62]. Soup of dried fruiting bodies of Ramaria fennica is used by women during breastfeeding to improve lactation. Ramaria fennica and morel species were considered effective against common cough and cold. Many mushroom species are considered medicinally important and used against stomach problems, heart burning and wound healing without considering any side effects or toxicity. Previously it is reported that extract and powder of mushrooms are used in traditional medicines and have reported uses as a liver tonic, blood purifiers, fertility issue and diabetes [65]. Fruiting bodies of Laetiporus sulphureus were dried into a fine powder and used with milk as a portion of healthy food and anti-seminal weakness. Previously it is reported that Laetiporus sulphureus is used against speedy recovery of wounds and common cold [6]. In another study, it is found that dry powder of this mushroom is helpful to expel a retained placenta in women and against stomach pain [66]. Use values of mushrooms are given in (Table. 3). In the present study, we have found the use of morels in different traditional home remedies against common ailments, fever, cough and cold. Soup of Morchella is considered nutritious and used to treat the common cold. Extract of many edible species of mushrooms is effective against different human diseases like coronary disorders, oxidative stress, and cancer and provides different physiological benefits to consumers [67]. Sparassis crispa and Polyporus squamosus were used to treat stomach issues and considered healthy food. Old villagers prefer to use these mushrooms as a source of food and traditional medicines. People use Morchella species, Hydnum repandum, Sparassis crispa and Polyporus squamosus for stomach problems, Lycoperdon perlatum and Auricularia auricula in wound healing and as anti-hypertension. Armillaria mellea, Boletus badius, Cantharellus cibarius, Pleurotus ostreatus and Lactarius deliciosus contain bioactive organic contents, p-coumaric protocatechuic, ferulic, sinapic, p-hydroxybenzoic, vanillic and Cinnamic with reported uses in traditional medicines [68]. [69] reported that morels were utilized both for food as well as medicines to cure different diseases.

Ethno-mycological uses of mushrooms vary from region to region and even among the communities of the same area [70]. Extract of mushrooms can be used due to cosmaceutical and nutricosmetic ingredients to treat inflammatory skin disease and hyperpigmentation [71]. Aqueous Extracts of Polyporus squamosus, Morchella spp and Sparassis crispa are considered more effective against common diseases of the stomach by the rural informants of Kashmir. As it is reported that mushrooms are effective against different diseases, but chemical evaluation is very important before using an extract of mushroom species [72]. It is concluded that mushrooms, potentially can provide opportunities to rural communities to generate income for household's development in rural areas of Azad Jammu and Kashmir. Mushroom collection can provide opportunities to the low-income areas to improve their living standards in terms of income generation and socio-economic development. It is very important to raise awareness among the local communities/mushroom collectors, about the importance of mushrooms as food and medicines. Mushrooms, if well addressed in society, are a potential source of traditional medicines, anti-cancer compounds, food, and nutrition security specifically in developing countries.

Table 3. List of Mushrooms species with their Ethno-mycological uses
| No. | Name of Species | Family | Edibility Status | Ethnomycological uses | Ecology | Region | Reference |
|-----|----------------|--------|------------------|-----------------------|---------|--------|-----------|
| 1   | *Agaricus amicosus* Kerrigan. | Agaricaceae | Edible | Not used | Saprobic, scattered in fir litter | Neelum, AJK | Present study |
| 2   | *Agaricus campestris* L. | Agaricaceae | Edible | Consumed as food | Saprobic, growing in grassy area | AJK | [50, 51] |
| 3   | *Agaricus silvicolaesimilis* Bohus & Locsmándi | Agaricaceae | Edible | Not consumed | Saprobic, growing in wood | AJK | [50, 51] |
| 4   | *A. subrutilescens* (Kauffman) Hotson & D. E. Stuntz | Agaricaceae | Edible | Consumed as food | Saprobe, growing in coniferous forest | AJK | Present study |
| 5   | *Amanita fulva* Fr. | Amanitaceae | Inedible | Not consumed | Mycorrhizal with conifers or hardwoods | AJK | Present study |
| 6   | *Amanita hemibapha* (Berk. &Broome) Sacc. | Amanitaceae | Poisonous | Poisonous | Saprobic, growing in hardwood leaf litter | AJK | Present study |
| 7   | *Amanita muscaria* (L.) Lam. | Amanitaceae | Poisonous | Poisonous | Mycorrhizal with pine and oak | AJK | Present study |
| 8   | *Amanita phalloides* (Vaill. ex Fr.) Link. | Amanitaceae | Deadly poisonous | Poisonous | Mycorrhizal with oaks | AJK | Present study |
| 9   | *Amanita vaginata* (Bull.) Lam. | Amanitaceae | Edible | Not consumed as food | Mycorrhizal with pines and oaks | AJK | Present study |
| 10  | *Apoioperdon pyriforme* (Schaeff.) Vizzini | Agaricaceae | Edible/medicinal | Consumed as food | Saprobic on deadwoods of hardwoods or conifers | Pak | [52] |
| 11  | *Armillaria gallica* Marxm. & Romagn | Physalacriaceae | Edible | Consumed as food | Saprophytic, on organic matter and soil | AJK | Present study |
| 12  | *Armillaria mellea* (Vahl) P. Kumm. | Physalacriaceae | Edible | Consumed as food | Parasitic on the hardwoods, on conifers produce white rot in the wood | Neelum, AJK | Present study |
| 13  | *Auricularia auricula-judae* (Bull.) Quel. | Auriculacaeae | Edible/medicinal | Used in weakness after childbirth, anti-hypertension | Grows in groves of trees, on logs and dead branches. | AJK/KPK | [53] |
| 14  | *Aureoboletus gentilis* (Quél.) Pouzar | Boletaceae | Edible | Not consumed | Mycorrhizal with conifers | AJK | Present study |
| 15  | *Boletus aureissimus* (Murrill) Singer | Boletaceae | Edible | Not consumed | Mycorrhizal with oaks | AJK | Present study |
| 16  | *Boletus chrysenteroides* Snell | Boletaceae | Edible | Used as food | Mycorrhizal with oaks and conifers | AJK | Present study |
| 17  | *Boletus edulis* Bull. Herb. Fr. | Boletaceae | Edible | Used as food | Mycorrhizal with hardwoods | AJK/KPK | [52, 53] |
| 18  | *Bovista utriformis* (Bull.) Fr. | Agaricaceae | Edible | Consumed as food | Sandy ground | AJK | Present study |
| 19  | *Coprinellus micaceus* (Bull.) Vilgalys, Hoppie & Jaq. Johnson | Psathyrelliaceae | Medicinal | Used in traditional medicines | Saprobic grow on decaying wood | AJK | Present study |
| 20  | *Calvatia cyathiformis* (Bosc) Morgan | Agaricaceae | Edible | Consumed as food | Saprobic, grow in grass | Kaghan valley | Ahmed, 1950 |
| 21  | *Calvatia gigantea* (Batsch) Lloyd | Agaricaceae | Edible when young | Consumed as | Saprobic, | AJK | Present study |
| No. | Species                        | Family             | Habit          | Habitat Details                                                                 | Location | Study   |
|-----|--------------------------------|--------------------|----------------|-------------------------------------------------------------------------------|----------|---------|
| 22  | *Cantharellus cibarius* Fr.    | Cantharellaceae    | Edible/medicinal | Consumed as food; Coniferous forest associated with moss                      | Pakistan | [75]    |
| 23  | *Cantharellus ignicolor* (R.H. Petersen) Dahlman | Cantharellaceae    | Edible/medicinal | Consumed as food; Mycorrhizal with oaks, found in cluster of mosses and grass | AJK      | Present study |
| 24  | *Chlorophyllum rhacodes* (Vittad.) Vellinga | Agaricaceae        | Edible         | Consumed as food; Saprobic, found in roadside, lawns etc.                    | AJK      | Present study |
| 25  | *Chlorophyllum olivieri* (Barla) Vellinga | Agaricaceae        | Potentially dangerous | Consumed as food; Found in open areas                                        | AJK      | Present study |
| 26  | *Clavaria fumosa* Pers.        | Clavariaceae       | Edible         | Consumed as food; Saprobic, found in dense cluster in grass                  | AJK      | Present study |
| 27  | *Clavariadelphus ligula* (Schaeff.) Donk | Clavariaceae       | Edible         | Consumed as food; Saprobic, associated with fir needles on ground            | AJK      | Present study |
| 28  | *Desarmillaria tabescens* (Scop.) R.A. Koch & Aime | Physalaciaceae    | Edible         | Consumed as food; Saprobic on oaks                                           | AJK      | Present study |
| 29  | *Clavulinopsis fusiformis* (Sowerby) Corner. | Clavariaceae       | Edible         | Consumed as food; Saprobic, under hardwoods or conifers                      | Neelum AJK | Present study |
| 30  | *Clavulina alta* Corner.       | Clavulinaceae      | Edible         | Consumed as food; Mycorrhizal with conifers                                  | Neelum AJK | Present study |
| 31  | *Clavulina cinerea* (Bull.) J. Schrot. | Clavulinaceae      | Edible         | Consumed as food; Mycorrhizal association with conifers                      | Neelum AJK | Present study |
| 32  | *Clavulina coralloides* (L.) J. Schröt. | Clavulinaceae      | Edible         | Consumed as food; Mycorrhizal with conifers and hardwoods                    | Neelum AJK | Present study |
| 33  | *Clitocybe acicula* Singer.    | Tricholomataceae   | Edible         | Not consumed; On debris of conifers                                           | AJK      | Present study |
| 34  | *Clitocybe nebularis* (Batsch) P. Kumm. | Tricholomataceae   | Edible/uncommon/medicinal | Not consumed; Found under conifers                                           | AJK      | Present study |
| 35  | *Clitopilus prunulus* (Scop.) P. Kumm. | Entolomataceae     | Edible         | Not consumed; Saprobic, under or conifers                                     | AJK      | Present study |
| 36  | *Coprinus coffeicola* Massea, Bull. | Hymenochaetaceae   | Inedible       | Inedible; Saprobic, under hardwoods                                           | AKJK     | Present study |
| 37  | *Coprinus comatus* (O. F. Mull.) Pers. | Coprinaceae        | Edible when young | Not consumed; Widely in grassland                                             | AJK      | Present study |
| 38  | *Crepidotus applanatus* (Pres.) P. Kumm. | Cortinariaceae     | Edible         | Not consumed; Under forest                                                     | AJK      | Present study |
| 39  | *Desarmillaria tabescens* (Scop.) R.A. Koch & Aime | Physalaciaceae    | Edible         | Consumed as food; Saprophysics on oaks                                       | AJK      | Present study |
| 40  | *Exidia recisa* (Ditm.!) Fr.   | Auriculareaceae    | Inedible       | Not consumed; Under wood and conifers                                         | Neelum AJK | Present study |
| 41  | *Floccularia luteovirens* (Alb. & Schwein.) Pouzar | Russulaceae        | Edible         | Not consumed; Ecto-Mycorrhizael, grow on ground with pines                  | AJK      | Present study |
| 42  | *Floccularia straminea* (P. Kumm.) Pouzar | Agaricaceae        | Inedible       | Not clear; Under conifers                                                    | AJK      | Present study |
| 43  | *Flammulina tennae* Bas.       | Physalaciaceae     | Edible         | Not consumed; On older tree trunks and                                       | AJK      | Present study |
| **No.** | **Species** | **Family** | **Edibility** | **Consumption** | **Habitat** | **Region** | **Study** |
|--------|-------------|------------|---------------|----------------|-------------|------------|----------|
| 44     | *Flammulina ononidis* Arnolds | Physalaciaceae | Edible | Not consumed | On ground and rotten trees | AJK | Present study |
| 45     | *Fistulina* sp | Agaricomycetes | Edible/medicinal | Consumed as food | At the tree trunk of *Prunus padis* | Neelum AJK | Present study |
| 46     | *Ganoderma adspersum* (Schulzer) Donk | Ganodermataceae | Inedible/med. | Not consumed | On ground and rotten trees | AJK | Present study |
| 47     | *Gyromitra intermedia* (Benedix) Harmaja | Discinaceae | Edible on choice | Not consumed | Under forest | AJK | Present study |
| 48     | *Gyromitra bubakii* (Velen.) J. Moravec | Discinaceae | Edible on choice | Not consumed | Under forest | AJK | Present study |
| 49     | *Ganoderma lucidum* (Curtis) P. Karst. | Ganodermataceae | Inedible/med. | Medicinal | On ground and rotten trees | AJK | Present study |
| 50     | *Ganoderma applanatum* (Pers.) Pat. | Ganodermataceae | Medicinal | Medicinal | Under Quercus trees | AJK | [73] |
| 51     | *Geastrum saccatum* Fr. | Geastraceae | Inedible | Not consumed | Under Quercus trees | Pakistan | [74] |
| 52     | *Geastrum pedicellatum* (Batsch) Dörfelt & Müll. Uri | Agaricaceae | Unknown | Not confirm | On grassy ground | AJK | [51] |
| 53     | *Geastrum triplex* Jungh. | Geastraceae | Inedible | Not consumed | Under Quercus trees | Pakistan | [51, 52] |
| 54     | *Gyromitra esculenta* (Pers.) Ex. Fr. | Discinaceae | Conditionally edible/medicinal | Conditionally edible | Under Quercus trees | AJK | Present study |
| 55     | *Helvella sulcata* Afzel. | Helvellaceae | Edible | Consumed as food | On decaying hardwoods stumps | AJK | Present study |
| 56     | *Helvella elastica* Bull. | Helvellaceae | Inedible | Inedible | On ground, on decaying wood | AJK | Present study |
| 57     | *Helvella crispa* (Scop.) Fr. | Helvellaceae | Edible | Consumed as food | Mycorrhizal. Growing under conifers or hardwoods. | Kaghan Valley | [74] |
| 58     | *Helvella lacunosa* Afzel. | Helvellaceae | Conditionally edible/medicinal | Consumed as food | Not consumed | Kaghan valley | [74] |
| 59     | *Helvella fibrosa* (Wallr.) Korf | Helvellaceae | Edible | Not consumed | On conifers or wood of hardwoods | Pakistan | [74] |
| 60     | *Hohenbuehelia* sp. T-62 (LAH, 1193) | Pleurotaceae | Edible/medicinal | Consumed as food | Saprobic, grows on decaying sticks and branches in damp spots on forest floor | Neelum AJK | Present study |
| 61     | *Hydnum repandum* L. | Hydaneaceae | Edible/medicinal | Consumed as food | Under Quercus trees | AJK | Present study |
| 62     | *Hygrocybe acutoconica* (Clem.) Singer | Hygrophoraceae | Edible | Consumed as food | On conifers or wood of hardwoods | AJK | Present study |
| 63     | *Hygrocybe flavescens* (Kauffman) Singer | Tricholomataceae | Inedible | Not consumed | On conifers or wood of hardwoods | AJK | Present study |
| 64     | *Hygrophorus piceae* Kuhner. | Hygrophoraceae | Edible | Unknown | On conifers or wood of hardwoods | AJK | Present study |
| 65     | *Hygrophorus persooni* Arnolds. | Hygrophoraceae | Edible/medicinal | Unknown | On conifers or wood of | AJK | Present study |
| No. | Name of Species                          | Family                  | Edibility                        | Ethnomycological uses | Ecology                     | Region | Reference |
|-----|----------------------------------------|-------------------------|----------------------------------|------------------------|----------------------------|--------|-----------|
| 66  | Imleria pallida (Frost) A. Farid, A.R. Franck, & J. Bolin | Boletaceae              | Unknown                          | Not consumed           | Mycorrhizal with oaks       | AJK    | Present study |
| 67  | Laccaria amethystina Cooke              | Hydnangiaceae           | Edible on choice/medicinal       | Not consumed           | Mycorrhizal with oaks       | AJK    | Present study |
| 68  | Laccaria bicolor Maire                  | Hydnangiaceae           | Conditionally edible             | Not consumed           | Mycorrhizal with conifers, found in mosses | AJK    | Present study |
| 69  | Lactarius deliciosus (L.) Gray          | Russulaceae             | Edible/medicinal                 | Not consumed           | Mycorrhizal with conifers   | Pak    | [52]       |
| 70  | Lactarius sp                           | Russulaceae             | Edible                           | Consumed as food       | grows under conifers on acidic soils | AJK    | Present study |
| 71  | Lactarius helvus (Fr.) Fr               | Russulaceae             | Poisonous                        | Poisonous              | Mycorrhizal with conifers   | AJK    | Present study |
| 72  | Lactarius quieticolor Romagn            | Russulaceae             | Edible                           | Not consumed           | Mycorrhizal                 | AJK    | Present study |
| 73  | Lepista ovispora (J.E. Lange). Gulden   | Tricholomataceae        | Conditionally edible/med.        | Not consumed           | Open grassland              | AJK    | Present study |
| 74  | Lactarius salmonicolor R. Heim & Leclair A. H. Sm. | Russulaceae             | Edible                           | Not consumed           | Mycorrhizal with conifers, usually with cedar | AJK    | Present study |
| 75  | Lactifluus piperatus (L.) Roussel       | Russulaceae             | Inedible                         | Inedible               | On oak                      | AJK    | [51]       |
| 76  | Lactarius torminosus (Schaeff.) Pers    | Russulaceae             | Inedible                         | Inedible               | Mycorrhizal, mixed forest   | AJK    | Present study |
| 77  | Laetiporus sulphureus Bull. Murrill     | Fomitopsidaceae         | Edible/medicinal                 | Consumed as food       | On oak, prunus, Salix etc.  | AJK    | [52]       |
| 78  | Lepiota cristata. (Bolton) P. kumm.    | Agaricaceae             | Edible                           | Consumed as food       | Saprobic, on forest, lawns etc. | Sohawa shareef | Present study |
| 79  | Lepiota magnispora Murill.             | Agaricaceae             | Inedible                         | Inedible               | Saprobic, Found under hardwoods and conifers | Neelum AJK | Present study |
| 80  | Lepista iucina (Fr.) Singer            | Tricholomataceae        | Edible                           | Not consumed           | In mixed forest             | AJK    | Present study |
| 81  | Lepista irina (Fr.) H.E. Bigelow       | Tricholomataceae        | Unknown                          | Not consumed           | In mixed forest             | AJK    | Present study |
| 82  | Lycoperdon perlatum Pers.              | Agaricaceae             | Edible when young/medicinal      | Consumed as food and wound healing | Open areas, grassy ground | Pak    | [74]       |
| 83  | Leucopaxillus giganteus Calonge & M    | Stereaceae              | Inedible                         | Inedible               | Saprobic on deadwood of oaks | AJK    | Present study |
| 84  | Morchella tridentina Bres.              | Morchallaceae           | Edible/medicinal                 | Used in cough and cold, highly medicinal | Saprobic on deadwoods or conifers | AJK    | Present study |
| 85  | Morchella deliciosa Fr.                | Morchallaceae           | Edible/medicinal                 | Consumed as food and medicinal | On humus rich soil          | AJK    | Present study |
| 86  | M. costata Pers.                       | Morchallaceae           | Edible/medicinal                 | Consumed as food and medicinal | On leaf litter              | Pak    | [77]       |
| 87  | Morchella conica Pers.                 | Morchallaceae           | Edible/medicinal                 | Consumed as food and medicine | On grasses                  | Pak    | [77]       |
| 88  | Morchella esculenta Pers               | Morchallaceae           | Edible/medicinal                 | Used in cough and cold, highly medicinal | Saprobic on deadwoods of hardwoods or conifer | AJK    | [74]       |
| 89  | Morchella elata Fr.                    | Morchallaceae           | Edible/medicinal                 | Consumed as food and medicinal | On grasses                  | Pak    | [77]       |
| No. | Species | Family | Edibility | Use | Habitat | Location | Notes |
|-----|---------|--------|-----------|-----|---------|----------|-------|
| 90  | *Marasmius abruptipes* Corner | Marasmiaceae | Inedible | Not used | On humus rich soil | AJK | Present study |
| 91  | *Marasmius abundans* Corner | Marasmiaceae | Inedible | Not used | On leaf litter | AJK | Present study |
| 92  | *Marasmius rotula* (Scop.) Fr. | Marasmiaceae | Inedible | Not used | Saprobic on deadwoods of hardwoods or conifer | AJK | Present study |
| 93  | *Marasmius strictipes* (Peck.) Singer | Marasmiaceae | Inedible | Not confirmed | Saprobic on deadwoods of hardwoods or conifer | AJK | Present study |
| 94  | *Marasmius acerinus* Peck | Marasmiaceae | Inedible | Not confirmed | On grasses | AJK | Present study |
| 95  | *Pleurotus dryinus* (Pers.) P. Kumm. | Pleurotaceae | Edible when young | Consumed as food and medicinal | Saprobic, growing on oaks | AJK | Present study |
| 96  | *Pholiota brunnescens* A.H. Sm. & Hesler | Strophariaceae | Inedible | Not consumed | Saprobic on wood | AJK | Present study |
| 97  | *Pleurotus ostreatus* (Jacq.) P. Kumm | Pleurotaceae | Edible | Consumed as food | Saprobic on decaying hardwood logs etc. | AJK | Present study |
| 98  | *Polyporus septosporous* P.K. Buchanan & Ryvarden | Polyporaceae | Edible/medicinal | Consumed as food | Saprobic, growing on oaks | AJK | Present study |
| 99  | *Ramaria fennica* (P. karst.) Ricken | Gomphaceae | Edible | Consumed as food | Mycorrhizal with hardwoods | AJK | Present study |
| 100 | *Ramaria barenthalensis* Franchi & M. | Russulaceae | Edible | Not consumed | Mycorrhizal with trees and shrubs | AJK | Present study |
| 101 | *Ramaria stricta* (Pers.) Quel. | Gomphaceae | Edible | Consumed as food | Mycorrhizal and Saprobic | AJK | Present study |
| 102 | *Rhodocollybia butyracea* (Bull.) Lennox | Omphalotaceae | Inedible | Not consumed | Saprobic, decomposing the litter of conifers | AJK | Present study |
| 103 | *Russula amoenolens* Romagn | Russulaceae | Conditionally edible | Not consumed | Mycorrhizal with hardwoods | AJK | Present study |
| 104 | *Russula brevipes* Peck. | Russulaceae | Edible | Not consumed | Mycorrhizal with conifers | Pakistan [76] |
| 105 | *Russula cinereovinosa* Fatto | Russulaceae | Inedible | Inedible | Mycorrhizal with conifers, fir | AJK | Present study |
| 106 | *Russula collina* Velen Frost. | Russulaceae | Inedible | Inedible | Mycorrhizal with hardwoods and conifers | AJK | Present study |
| 107 | *Russula cremoricolor* Earle | Russulaceae | Unknown | Not clear | Mycorrhizal, mixed forests | AJK | Present study |
| 108 | *Russula cystidiosa* Murrill | Russulaceae | Unknown | Not clear | Mycorrhizal with oaks | AJK | Present study |
| 109 | *Russula delica* Fr. | Russulaceae | Edible | Consumed as food | Found under broadleaved and coniferous wood | AJK | Present study |
| 110 | *Russula densifolia* Secr. ex Gillet | Russulaceae | Edible | Not consumed | Mycorrhizael with conifers | AJK | Present study |
| 111 | *Russula fragrantissima* Romagn | Russulaceae | Inedible | Inedible | Mycorrhizael with hardwoods and conifers | AJK | Present study |
| 112 | *Russula integra* (L.) Fr | Russulaceae | Conditionally edible | Inedible | Mycorrhizael with hardwoods and conifers | AJK | Present study |
| 113 | *Russula acriuscula* Buyck | Russulaceae | Edible/med. | Not consumed | Mycorrhizal | AJK | Present study |
| no. | Species | Family | Edibility | Use | Mycorrhizal Type | Study |
|-----|---------|--------|-----------|-----|-----------------|-------|
| 114 | *Russula tenuiceps* Kauffman | Russulaceae | Inedible | Inedible | Mycorrhizal with oaks | AJK Present study |
| 115 | *Russula violacea* Quel. | Russulaceae | Edible | Not consumed | Mycorrhizal with oaks and conifers | AJK Present study |
| 116 | *Rhizopogon roseolus* (Corda)Th. Fr. | Rhizopogonaceae | Medicinal | Consumed as food | Ectomycorrhizal fungus | Bagh Present study |
| 117 | *Suillus granulatus* (L.) Roussel, | Boletaceae | Edible | Not consumed | Mycorrhizal with pines | AJK Present study |
| 118 | *Sulilellus luridus* (Schaeff.) Murrill | Boletaceae | Conditionally Edible | Consumed as food | Mycorrhizal with pines and other hardwoods | AJK Present study |
| 119 | *Scleroderma bovista, Fr.* | Sclerodermataceae | Inedible | Inedible | Saprobic on ground, mycorrhizal with hardwoods | Kaghan valley [77] |
| 120 | *Stromatinia rapulum* (Bull.) Boud. | Pezizaceae | Conditionally edible | Not consumed | Saprobic on well-decayed logs | AJK Present study |
| 121 | *Scleroderma citrinum* Pers | Sclerodermataceae | Medicinal/ Poisonous | Consumed as food | Attached to soil my mycelial cords | Bagh AJK Present study |
| 122 | *Sparassis spathulata* (Schwein.) Fr. | Sparassidaceae | Edible when young | Used as stomach tonic and food | Pathogenic and Saprobic | AJK Present study |
| 123 | *Sparassis crispa* (Wulfen) Fr. | Sparassidaceae | Edible/ medicinal | Consumed as food/ medicinal | Pathogenic and saprobic | Pakistan [75] |
| 124 | *Suillus luteus* (L.) Roussel | Suillaceae | Edible | Not consumed | Mycorrhizal with pines | Pakistan [73] |
| 125 | *Tricholoma portentosum* (Fr.) Quel. | Tricholomataceae | Edible and medicinal | Consumed as food | On Coniferous woods and oaks | AJK Present study |
| 126 | *Volvopluteus gloiocephalus* (DC.) Vizzini, Contu & Justo | Pleurotaceae | Edible | Consumed as food | Saprobic, growing aggregates in gardens, lawns, woodchips tc, | AJK/KPK [77] |
| 127 | *Volvariella volvacea* (Bull.) Singer | Pleurotaceae | Edible | Consumed as food | Saprobic, growing in woodchips | AJK/KPK [77] |
| 128 | *Volvariella bombycina* (Schaeff.) Singer | Pleurotaceae | Edible | Consumed as food | Saprobic, growing in woodchips | AJK/KPK [77] |
| 129 | *Verpa bohemica* (Krombh.) J. Schroet | Helvellaceae | Conditionally edible | Consumed as food | Mycorrhizal. Found under hardwoods and conifers in early spring | Neelum AJK Present study |
| 130 | *Verpa conica* (O.F. Müll.) Sw | Helvellaceae | Conditionally edible | Consumed as food | Mycorrhizal. Found under hardwoods and conifers in early spring | Neelum AJK Present study |
| 131 | *Xerocomellus chrysenteron* (Bull.) Sutara | Boletaceae | Edible | Food | Mycorrhizal with oaks and conifers | AJK Present study |
Declarations

Authors' contributions

The first author carried the research including sampling of mushrooms. SSF and ANK designed the research, identified the mushroom samples and supervised at all the stages. HS and JH helped with data analysis.

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**Figures**
Figure 1

Map of the study area (Right) and sampling sites (Left)
Figure 2

Mushroom species recorded new to the state of AJK
Figure 3

Category, number with percentage and use value of identified Wild Mushrooms from the study area.

Figure 4

Expression of Principle component analysis

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix1.docx