

## A checklist of *Agaricus* from Pakistan

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**ABSTRACT**— We present a comprehensive checklist of the *Agaricus* species recorded from various regions of Pakistan. Thirty-two species are documented from Pakistan according to published reports and the latest literature. Orthographic variants and misidentified species have been excluded.

**KEY WORDS**— *Agaricaceae*, diversity, distribution, systematics, mycobiota

### Introduction

*Agaricus* L. (*Agaricaceae*, *Agaricales*) is a species-rich genus of saprotrophic fungi that comprises about 500 species distributed in various climates across all continents except Antarctica (Zhao & al. 2011; Karunarathna & al. 2016; Kerrigan 2016; Chen & al. 2017). Many new species have not yet been named and species diversity remains poorly known in several regions. This genus includes numerous edible species as well as toxic species (Parra 2008; Thongklang & al. 2014; Chen & al. 2015). Well-known cultivated mushrooms such as button mushroom *A. bisporus*, and *A. bitorquis* are included in this genus (Chen & al. 2017; Parra & al. 2018). Species of *Agaricus* are saprobic and grow in forests, grasslands, dunes, or any place with decaying organic matter. The *Agaricus* fungi are characterized by having a fleshy pileus with free lamellae, that produce a brown spore print, and an annulate stipe (Parra 2008; Zhao & al. 2011). According to the recent infrageneric classification, species of *Agaricus* are classified in 6 subgenera and 24 sections (Parra & al. 2018). Pakistan's climate and vegetation favors the growth of *Agaricus* species. There has been an effort to make a consolidated list of Agarics from the Kaghan valley of Pakistan by Sultana & al. (2011) and from Ayubia National Park by Ali & al. (2015). However, the list of *Agaricus* species so far reported from Pakistan in these documents remains incomplete and identification is based on morphological characterization that is questionable. More recently, some of the *Agaricus* species have been reported on based on phylogenetic studies (Thongklang & al. 2014; Chen & al. 2016; Bashir & al. 2018, 2021). In this checklist, IndexFungorum has been followed for the nomenclature of listed taxa of the genus *Agaricus*. In this work, an attempt has been made to document the validly published species and to remove those that are illegitimate or invalidly published. In this study, 32 taxa

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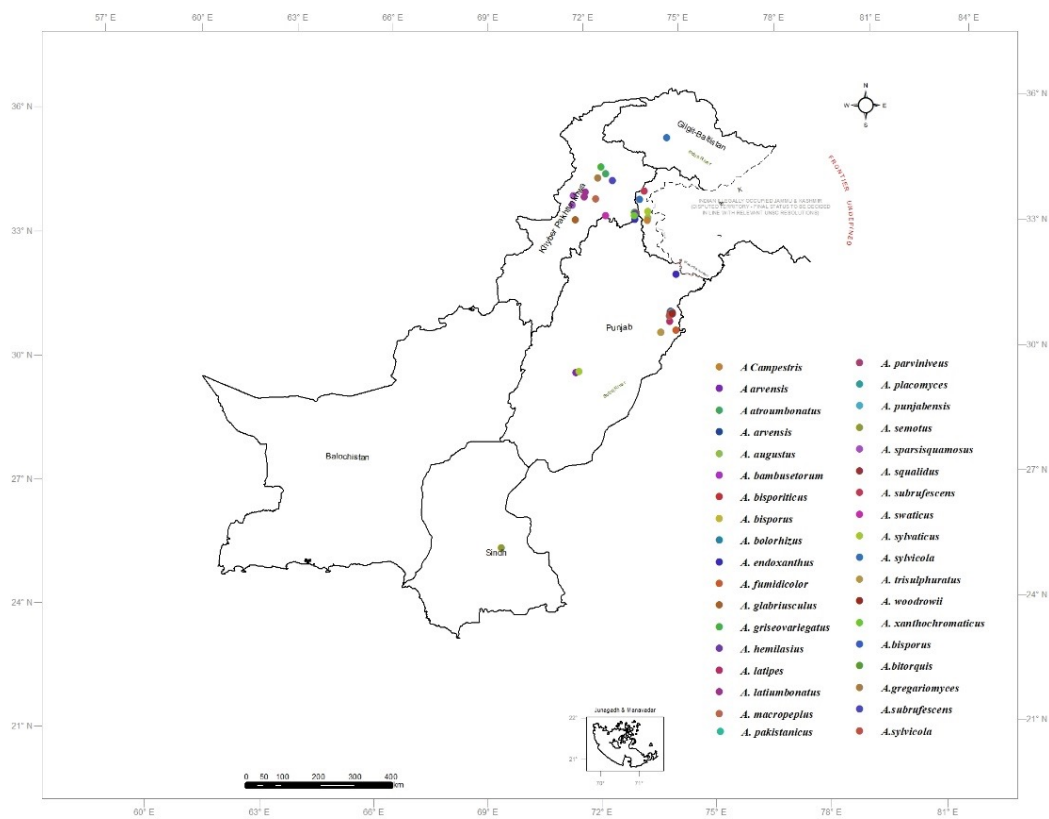
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have been listed. These are arranged in alphabetical order and information about the locality, section to which they belong, edibility and method of description of the respective taxon has also been provided.

**Materials & methods**

The checklist is based on published reports and literature. The current names of species are given according to [www.indexfungorum.org](http://www.indexfungorum.org).



**FIG. 1: Locality-wise distribution map of the *Agaricus* spp. reported from Pakistan.**

## Species list

### ***Agaricus* L., Sp. pl. 2: 1171 (1753)**

Type species: *Agaricus campestris* L., Sp. pl. :1173 (1753).

### ***Agaricus augustus* Fr.**

Subgenus: *Flavoagaricus*; Section: *Arvensis*

Locality: Azad Kashmir and Ayubia National Park

Identification method: morphology (Gardezi 1993; Ali & al. 2015).

Edibility: Edible and cultivated worldwide for its rich flavor of strong almond, also known as prince mushroom because of its sufficiently large sized basidiomata.

### ***Agaricus arvensis* Schaeff.**

Subgenus: *Flavoagaricus*; Section: *Arvensis*

Locality: Khanspur and Multan

Identification method: morphology (Iqbal & Khalid 1996; Sultana & al. 2007a).

Edibility: This species is considered as one of the most delicious edible mushrooms, commonly known as horse mushroom.

### ***Agaricus atroumbonatus* H. Bashir, J. Khan, Khalid, L.A. Parra & Callac**

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Miandam valley, Swat

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

### ***Agaricus bisporiticus* Nawaz, Callac, Thongkl. & Khalid**

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: University of the Punjab, Lahore.

Identification method: morphology and phylogeny (Thongklang & al. 2014).

Edibility: Poisonous

### ***Agaricus bisporus* (J.E. Lange) Imbach**

Subgenus: *Pseudochitonia*; Section: *Bivelares*

Locality: Khanspur and Lahore

Identification method: morphology (Sultana & al. 2007b).

Edibility: *Agaricus bisporus*, the most widely eaten and cultivated mushroom all over the world. It is the most famous mushroom having intense umami flavor.

### ***Agaricus bitorquis* (Quel.) Sacc.**

Subgenus: *Pseudochitonia*; Section: *Bivelares*

Locality: Lahore

Identification method: morphology (Ahmad 1980).

Edibility: Edible with a typical 'mushroomy' taste. The name supersedes *Agaricus rodmanii* Peck.

***Agaricus bolorhizus*** Berk. & Broome

Subgenus and Section: unknown

Locality: Lahore

Identification method: morphology (Ahmad 1980).

Edibility: Unknown

***Agaricus bambusetorum*** H. Bashir & Niazi

Subgenus: *Pseudochitonia*; Section: *Hondenses*

Locality: Changa Manga forest

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus campestris*** L.

Subgenus: *Agaricus*; Section: *Agaricus*

Locality: Rawalakot

Identification method: morphology (Gardezi 1993).

Edibility: A widely eaten species, commonly known as field mushroom or meadow mushroom. Its taste resembles with *A. bisporus*.

***Agaricus endoxanthus*** Berk. & Broome

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Sialkot and Murree

Identification method: morphology (Ahmad 1980).

Edibility: Poisonous

***Agaricus fumidicolor*** H. Bashir, Niazi, Khalid & L.A. Parra

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Changa Manga Forest

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus glabriusculus*** S. Hussain

Subgenus: *Minores*, Section: *Minores*

Locality: Malakand

Identification method: morphology and phylogeny (Hussain & Sher 2019).

Edibility: Inedible

***Agaricus gregariomyces*** J.L. Zhou & R.L. Zhao

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Khanspur

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus griseovariiegatus*** H. Bashir, S. Ullah & Khalid

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Khanspur

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus hemilasius*** Berk. & Broome

Subgenus and Section: Unknown

Locality: Lahore and Ayubia National Park

Identification method: morphology (Ahmad 1980; Iqbal & Khalid 1996).

Edibility: Unknown

***Agaricus latipes*** Berk.

Subgenus: *Agaricus*; Section: *Agaricus*

Locality: Lahore

Identification method: morphology (Iqbal & Khalid 1996).

Edibility: Inedible

***Agaricus latiumbonatus*** S. Hussain

Subgenus: *Minores*; Section: *Minores*

Locality: Malakand and Dargai

Identification method: morphology and phylogeny (Hussain & Sher 2019).

Edibility: Unknown

***Agaricus macropeplus*** H. Bashir, J. Khan, Khalid & L.A. Parra

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Manglor and Swat

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus pakistanicus*** H. Bashir, Khalid, L.A. Parra & Callac

Subgenus: *Pseudochitonia*; Section: *Brunneopicti*

Locality: Lahore

Identification method: morphology and phylogeny (Bashir & al. 2018).

Edibility: Inedible

***Agaricus parviniveus*** H. Bashir & Khalid

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Lahore

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus placomyces*** Peck

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Malakundi

Identification method: morphology (Shibata 1992).

Edibility: Poisonous

***Agaricus punjabensis*** Qasim, A. Ashraf & Khalid

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Lahore

Identification method: morphology and phylogeny (Chen & al. 2016).

Edibility: Poisonous

***Agaricus semotus*** Fr.

Subgenus: *Minores*; Section: *Minores*

Locality: Khipro

Identification method: morphology (Ahmad 1980).

Edibility: Unknown

***Agaricus sparsisquamosus*** H. Bashir, S. Hussain, Khalid & H. Ahmed

Subgenus: *Pseudochitonia*; Section: *Brunneopicti*

Locality: Qaldara Dargai and Malakand

Identification method: morphology and phylogeny (Bashir & al. 2018).

Edibility: Inedible

***Agaricus squalidus*** Lasch

Subgenus and Section: Unknown

Locality: Lahore

Identification method: morphology (Iqbal & Khalid 1996).

Edibility: Unknown

***Agaricus subrufescens*** Peck

Subgenus: *Flavoagaricus*; Section: *Arvensis*

Locality: Kashmir and Shangla

Identification method: morphology (Gardezi & Ayub 2003).

Edibility: An edible and medicinal mushroom with slight sweet taste and an odor of almonds, also known as Almond mushroom, God's mushroom, mushroom of sun and a variety of other names are designated to this mushroom.

***Agaricus swaticus*** H. Bashir, S. Jabeen, S. Ullah, Khalid & L.A. Parra

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Mashkun, Swat, and Khyber Pakhtunkhwa

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus sylvaticus*** Schaeff.

Synonym: *Agaricus silvaticus*

Subgenus: *Pseudochitonia*; Section: *Sanguinolenti*

Locality: Azad Kashmir and Multan

Identification method: morphology (Gardezi 1993; Sultana & al. 2007a).

Edibility: Inedible

***Agaricus sylvicola*** (Vittad.) Peck

Subgenus: *Flavoagaricus*; Section: *Arvensis*

Locality: Rawalakot, Gilgit, and Lahore

Identification method: morphology (Gardezi 1993; Razaq & Shahzad 2012).

Edibility: Edible and most popular in Europe, commonly known as wood mushroom.

***Agaricus trisulphuratus*** Berk.

Subgenus: *Pseudochitonia*; Section: *Trisulphurati*

Locality: Change Manga Forest and Lahore

Identification method: morphology (Ahmad 1980; Iqbal & Khalid 1996).

Edibility: Inedible

***Agaricus xanthochromaticus*** H. Bashir, Khalid, L.A. Parra & Callac

Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*

Locality: Khanspur

Identification method: morphology and phylogeny (Bashir & al. 2021).

Edibility: Poisonous

***Agaricus woodrowii*** Masee

Subgenus and Section: Unknown

Locality: Lahore

Identification method: morphology (Ahmad 1980)

Edibility: Unknown

**Excluded species**

Nine taxa of *Agaricus* have been excluded from the Pakistan records here. Five species have been removed due to generic placement changes: *Agaricus alphitochrous* Berk. & Broome (Ahmad 1980) to *Hymenagaricus alphitochrous* (Berk. & Broome) Heinem.; *A. flavidorufus* Berk. & Broome (Ahmad 1980) to *Xanthagaricus flavidorufus* (Berk. & Broome) Little Flower & al.; *A. muticolor* Berk. & Broome (Ahmad 1980) to *Lepiota muticolor* (Berk. & Broome) Sacc.; *A. rufoalbus* Berk. (Iqbal & Khalid 1996) to *Stropharia rufoalba* (Berk.) Sacc.; and *A. subaeruginosus* Berk. & Broome to *Xanthagaricus subaeruginosus* (Berk. & Broome) S. Hussain. *Agaricus rodmanii* Peck is now recognized as the synonym of *A. bitorquis*. *Agaricus silvaticus* is excluded from list because *A. silvaticus* is an orthographic variant of *A. sylvaticus*. The descriptions of *A. lateritiicolor* and *A. callipelus* never find in the text but recorded in the 'Fungi of Pakistan' (checklist), hence these two names also stand deleted from the Pakistan records. Bashir (2019) analyzed the systematic diversity and culturability of *Agaricus* spp. from Khyber Pakhtunkhwa and Punjab, Pakistan. She has described 20 *Agaricus* species new to science (Bashir & al. 2018, Bashir & al. 2021), there still remains species that are in the process of publishing, these are therefore not included here.

**Conclusion**

The current investigation gives a comprehensive overview of the wild *Agaricus* species from Pakistan, some of which are known to be good for edibility because of their enriched nutritional and medicinal values. The climatic conditions of Pakistan favor the natural growth of *Agaricus* species but only few species have been reported from Pakistan as compared to our neighboring countries, this shows the need for further exploration of this nutritionally and pharmaceutically important genus of mushroom from Pakistan. In general, this study indicates that our country is rich in indigenous mushroom flora, however, anthropogenic factors along with very limited indigenous knowledge and poor conservation strategies are threatening the economically and ecologically valuable mushrooms survival. Therefore, conservation strategies



and processes to support the cultivation industry of edible mushrooms, are recommended at a national level.

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#### Literature cited

- Ahmad S. 1980. A Contribution to the Agaricales of Pakistan. *Bulletin of Mycology* 1(1): 35–90.
- Ali M, Shahid AL, Asif M, Azam MA. 2015. Contribution to the previous study for genus *Agaricus* in and around Ayubia National Park, Pakistan. *Journal of Biology, Agriculture and Healthcare* 5(9): 96–98.
- Bashir H, Hussain S, Khalid AN, Niazi AR, Parra LA, Callac P. 2018. First report of *Agaricus* sect. *Brunneopicti* from Pakistan with descriptions of two new species. *Phytotaxa* 357(3):167–178.
- Bashir H, Chen J, Jabeen S, Ullah S, Khan J, Niazi AR, Zhang M, Khalid AN, Parra LA, Callac P. 2021. An overview of *Agaricus* section *Hondenses* and *Agaricus* section *Xanthodermatei* with description of eight new species from Pakistan. *Scientific Reports* 11(1): 1–35.
- Chen J, Parra LA, Guelly A, Rapior S, Hyde KD, Zao RL, Callac P. 2015. *Agaricus* section *Brunneopicti*: a phylogenetic reconstruction with description of four new taxa. *Phytotaxa* 192: 145–168.
- Chen J, Parra LA, Kesel AD, Khalid AN, Qasim T, Ashraf A, Hyde KD, Zhao R, Callac P. 2016. Inter- and intra-specific diversity in *Agaricus endoxanthus* and allied species reveals a new taxon, *A. punjabensis*. *Phytotaxa* 252(1): 1–16.
- Chen J, Callac P, Parra LA, Karunarathna SC, He MQ, Moinard M, De Kesel A, Raspé O, Wisitrassameewong K, Hyde KD, Zhao RL. 2017. Study in *Agaricus* subgenus *Minores* and allied clades reveals a new American subgenus and contrasting phylogenetic patterns in Europe and Greater Mekong subregion. *Persoonia* 38:170–196.
- Gardezi RA. 1993. Agaric fungi from Rawalakot, Azad Kashmir [Pakistan]. *Sarhad Journal of Agriculture* 9(3): 225–226.
- Gardezi SRA, Ayub N. 2003. Mushrooms of Kashmir VI. *Asian Journal of Plant Sciences* 2: 804–810.
- Hussain S, Sher H. 2019. Study in *Agaricus* section *Minores* in Pakistan with the description of two new species. *Mycological Progress* 18(6): 795–804.
- Iqbal SH, Khalid AN. 1996. Material for the fungus flora of Pakistan. I. Check list of agarics, their distribution and association with the surrounding vegetation. *Science International (Lahore)* 8: 51–64.
- Karunarathna SC, Chen J, Mortimer PE, Xu JC, Zhao RL, Callac P, Hyde KD. 2016. Mycosphere essay 8: a review of genus *Agaricus* in tropical and humid subtropical regions of Asia. *Mycosphere* 7:417–439.
- Kerrigan RW. 2016. *Agaricus* of North America. New York Botanical Garden 114: 1–574.
- Parra LA. 2008. *Agaricus* L. *Allopsalliota* Nauta & Bas. *Fungi Europaei* 1. Edizioni Candusso, Alassio, Italy.
- Parra LA, Angelini C, Ortiz-Santana B, Mata G, Billette C, Rojo C, Chen J, Callac P. 2018. The genus *Agaricus* in the Caribbean. Nine new taxa mostly based on collections from the Dominican Republic. *Phytotaxa* 345: 219–271.

- Razaq A, Shahzad SA. 2012. New records of *Agaricaceae* from Pakistan. *Pakistan Journal of Botany* 44(4): 1475–1477.
- Shibata H. 1992. Higher basidiomycetes from Pakistan. 145–164, in: T Nakaike, S Malik (eds). *Cryptogamic Flora of Pakistan*, vol. 1. National Museum of Nature and Science, Tokyo.
- Sultana K, Gul M, Firdus SS, Asghar R. 2007a. Hymenomycetes from Multan district. *Pakistan Journal of Botany* 39(2): 651–657.
- Sultana K, Shinwari ZK, Farida I. 2007b. Diversity of edible mushrooms in Pakistan. *Pakistan Journal of Agricultural Research* 20(1/2): 88–91.
- Sultana KI, Rauf CA, Riaz AB, Naz FA, Irshad G, Haque MI. 2011. Checklist of agarics of Kaghan valley – 1. *Pakistan Journal of Botany* 43(3): 1777–1787.
- Thongklang N, Nawaz R, Khalid AN, Chen J, Hyde KD, Zhao R, Parra LA, Hanif M, Moinard M, Callac P. 2014. Morphological and molecular characterization of three *Agaricus* species from tropical Asia (Pakistan, Thailand) reveals a new group in section *Xanthodermatei*. *Mycologia* 106(6): 1220–1232.
- Zhao RL, Karunarathna SC, Raspé O, Parra LA, Guinberteau J, Moinard M, De Kesel A, Barroso G, Courtecuisse R, Hyde KD, Gelly AK, Desjardin ED, Callac P. 2011. Major clades in tropical *Agaricus*. *Fungal Diversity* 51: 279–296.