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 saprotophic 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
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.

**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
Edibility: Poisonous

*Agaricus bisporiticus* Nawaz, Callac, Thongkl. & Khalid
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: University of the Punjab, Lahore.
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
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
Edibility: Poisonous

*Agaricus glabriusculus* S. Hussain
Subgenus: *Minores*, Section: *Minores*
Locality: Malakand
Identification method: morphology and phylogeny (Hussain & Sher 2019).
Agaricus species in Pakistan ...

Edibility: Inedible

**Agaricus gregariomyces** J.L. Zhou & R.L. Zhao
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: Khanspur
Edibility: Poisonous

**Agaricus griseovariegatus** H. Bashir, S. Ullah & Khalid
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: Khanspur
Edibility: Poisonous

**Agaricus hemilasius** Berk. & Broome
Subgenus and Section: Unknown
Locality: Lahore and Ayubia National Park
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
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
Edibility: Poisonous

*Agaricus placomyces* Peck
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: Malakundi
Edibility: Poisonous

*Agaricus punjabensis* Qasim, A. Ashraf & Khalid
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: Lahore
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: Quldera 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 sylvaticus** H. Bashir, S. Jabeen, S. Ullah, Khalid & L.A. Parra
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: Mashkun, Swat, and Khyber Pakhtunkhwa
Edibility: Poisonous

**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 Mang Forest and Lahore
Edibility: Inedible

**Agaricus xanthochromaticus** H. Bashir, Khalid, L.A. Parra & Callac
Subgenus: *Pseudochitonia*; Section: *Xanthodermatei*
Locality: Khanspur
Edibility: Poisonous

*Agaricus woodrowii* Massee
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 *Leptota muticolor* (Berk. & Broome) Sacc.; *A. rufoalbus* Berk. (Iqbul & Khalid 1996) to *Stropharia rufoalba* (Berk.) Sacc.; and *A. subaeruginosus* Berk. & Broome to *Xanthagaricus subaeruginosus* (Berk. & Broome) S. Hussain. *Agaricus rodomani* 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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