

## A checklist of agaricoid russulaceous mushrooms from Jammu and Kashmir, India

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### ABSTRACT

A literature based checklist of the family *Russulaceae* occurring in Jammu and Kashmir (J&K), India is presented. It consists of 51 species of russulaceous mushrooms belonging to three genera viz., *Russula*, *Lactarius* and *Lactifluus*. Genus *Russula* is the most speciose rich (35 spp.), followed by *Lactarius* (12 spp.) and *Lactifluus* (4 spp.). This checklist provides a comprehensive data of the russulaceous mushrooms from J&K.

**KEYWORDS:** Ectomycorrhizal, Inventory, Jammu, Kashmir Valley, *Russulaceae*.

### INTRODUCTION

Fungal family *Russulaceae*, one of the 12 families recognized under the order *Russulales*, is well known for its ectomycorrhizal association with higher plants (Kirk *et al.*, 2008). Being ectomycorrhizal, these mushrooms play a critical ecological role in terrestrial ecosystems through symbiotic association with higher plants. Initially, macro-fungal species belonging to this family were placed with other gilled species in the order *Agaricales*. Subsequent microscopic, molecular and phylogenetic studies confirmed that these mushrooms form a distinct lineage and are now placed under a different order *Russulales*. Members of this family can be differentiated from all other gilled mushrooms by the anatomy of the cap and stipe tissue that is interspersed with a large number of spherical cells called sphaerocysts, which impart typical brittle consistency to these mushrooms (Arora, 1986). Furthermore, they are characterized by fleshy and often bright coloured fruiting bodies with prominent broad lamellae, absence of clamp connections and warted, light-coloured, amyloid spores that exhibit diverse types of exosporial ornamentation.

The family exhibits global distribution and is represented by more than 1900 species (Kirk, 2014). Amongst all the genera of family *Russulaceae*, *Russula* is the largest genus (ca. 1100 spp.), followed by *Lactarius* (ca. 550 spp.) *Lactifluus* (ca. 120 spp.), *Boidinia* (13 spp.), *Multifurca* (6 spp.), *Gloeopeniophorella* (6 spp.) and *Pseudoxenasma* (1 species) (Lebel *et al.*, 2013; Kirk, 2014). Till 2016, 158 taxa of *Russula*, 83 taxa of *Lactarius*, 29 taxa of *Lactifluus*, 1 species each of *Multifurca* and *Gloeopeniophorella* and 2 species of *Boidinia* have been reported from India (Sharma *et al.*, 2018).

The agaricoid genera (*Russula*, *Lactarius*, and *Lactifluus*) constitute 95% of the family *Russulaceae*. Members of *Russula* are characterised by bright coloured, brittle sporocarps while those of *Lactarius* and *Lactifluus* have latex exuding feature. These genera are cosmopolitan in distribution and are one of the main ectomycorrhizal symbionts in diverse vegetation types ranging from the rainforests to the boreal coniferous forests.

Pioneering work on the russulaceous mushrooms from Jammu and Kashmir was done by Berkeley (1854, 1876) who documented 8 *Russula* and 5 *Lactarius* species from the

Himalayan region. After a long gap, Watling and Gregory (1980) started the work on russulaceous mushrooms which was further carried out by Abraham *et al.* (1980, 1981, 1984), Abraham and Kaul (1985) and Watling and Abraham (1992). Majority of the work on russulaceous mushrooms of Jammu and Kashmir was done by Saini, Atri and coworkers (Saini and Atri, 1982, 1984, 1989, 1990, 1993; Saini *et al.*, 1982, 1988, 1989; Atri and Saini 1986, 1988; Atri *et al.*, 1993, 1994). A significant contribution to these mushrooms from Kashmir was made by Beig *et al.* (2008, 2011), Dar *et al.* (2009), Pala *et al.* (2012) and Itoo *et al.* (2013). A vast number of studies have been conducted from Jammu province on different aspects but the family *Russulaceae* in particular have not been sufficiently dealt with except for a few reports by Kumar and Sharma (2011, 2012). Recently, Kaur *et al.* (2014) and Kaur and Rather (2016) reported few *Russula* species from J&K. The present paper provides comprehensive details of diversity of the family *Russulaceae* from the Jammu and Kashmir.

Jammu and Kashmir is predominantly a Himalayan landscape in the northwestern part of India. It has two geographically distinct regions viz., Jammu Province and Kashmir Province, each showing its unique geographical, climatic, demographic, biological and cultural characteristics. While Jammu is rich in subtropical flora, Kashmir Province is predominated by the temperate vegetation and alpine desert or dry cold desert flora, respectively. The major conifers include *Pinus roxburghii*, *Cedrus deodara*, *Abies pindrow*, *A. spectabilis*, *Taxus wallichiana* and *Picea smithiana* while the broad-leaved evergreen forests are predominantly represented by *Buxus wallichiana*, *Ilex dipyrrena*, *Quercus semicapifolia*, etc. and deciduous forests by *Aesculus indica*, *Populus alba*, *Acer caesium*, *Viburnum* spp., *Salix* spp., *Alnus* spp., etc. This diverse vegetation provides host to the members of the family *Russulaceae* as these are well known to form ectomycorrhizal associations with these plants.

### METHODS

This checklist is based on the information gathered from published sources and the information retrieved from the literature including distribution, general habitat and edibility status of each taxon. Nomenclature used for each species was

checked against the classification system provided on the Index Fungorum web site (<http://www.indexfungorum.org/names/names.asp>) and MycoBank ([www.mycobank.org](http://www.mycobank.org)). Names of some species reported in the cited publications have been replaced by currently accepted name. The checklist is prepared by compiling all the available data and is organized alphabetically.

## CHECKLIST

### I. Genus *Lactarius* Pers.

#### 1.1 *Lactarius angustifolius* Hesler and A.H. Sm.

Habit and habitat: Humicolous, solitary, putatively ectomycorrhizal, with coniferous forest dominated by *Cedrus deodara*.

Locality: Gulmarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Atri and Saini, 1986; Saini and Atri, 1993; Atri *et al.*, 1994).

#### 1.2 *Lactarius deterrimus* Gröger.

Habit and habitat: Humicolous, solitary, putatively ectomycorrhizal with coniferous trees of *Pinus wallichiana* and *Cedrus deodara*.

Locality: Bhadarwah, Gulmarg and Tangmarg (J&K).

Edibility: not edible in the locality but reported edible in some parts of the world.

Jammu and Kashmir (Abraham *et al.*, 1980; Kumar, 2009).

#### 1.3 *Lactarius fuliginosus* (Krapf) Fr.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal, association with *Viburnum* species.

Locality: Gulmarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Abraham and Kaul, 1985).

#### 1.4 *Lactarius hepaticus* Plowr.

Habit and habitat: Humicolous, solitary to gregarious, scattered, putatively ectomycorrhizal in coniferous forests of *Cedrus*, *Pinus* and *Taxus*.

Locality: Doodhpatheri (J&K).

Edibility: not edible.

Jammu and Kashmir (Pala and Wani, 2014).

#### 1.5 *Lactarius pubescens* Fr.

Habit and habitat: Humicolous, scattered or gregarious, putatively ectomycorrhizal in mixed forests under *Betula*.

Locality: Rajouri (J&K).

Edibility: not edible, considered poisonous.

Jammu and Kashmir (Atri and Saini, 1986; Atri *et al.*, 1994; Anand *et al.*, 2014).

#### 1.6 *Lactarius spinosulus* Quéf.

Habit and habitat: Humicolous, scattered, gregarious, putatively ectomycorrhizal in the forests of *Pinus roxburghii* and *P. wallichiana*.

Locality: Poonch, Gulmarg and Pahalgam (J&K).

Edibility: not edible.

Jammu and Kashmir (Beig *et al.*, 2008).

#### 1.7 *Lactarius scrobiculatus* (Scop.) Fr.

Habit and habitat: Humicolous, solitary to gregarious, putatively ectomycorrhizal in coniferous forests.

Locality: Yusmarg and Gulmarg (J&K).

Edibility: unknown, but have medicinal value.

Jammu and Kashmir (Watling and Gregory, 1980; Abraham *et al.*, 1980; Saini and Atri, 1984; Atri *et al.*, 1994; Farooq *et al.*, 2017).

#### 1.8 *Lactarius scrobiculatus* var. *canadensis* (A.H.Sm.)

Hesler and A.H.Sm.

Habit and habitat: Humicolous, solitary to gregarious, putatively ectomycorrhizal with conifers.

Locality: Tangmarg and Gulmarg (J&K).

Edibility: unknown.

Jammu and Kashmir, (Atri and Saini, 1986, 1988; Atri *et al.*, 1994).

#### 1.9 *Lactarius subpurpureus* Peck

Habit and habitat: Humicolous, scattered to gregarious, putatively ectomycorrhizal with *Viburnum* species.

Locality: Gulmarg (J&K).

Edibility: edible, medicinally important.

Jammu and Kashmir (Watling and Gregory, 1980; Saini and Atri, 1990).

#### 1.10 *Lactarius subisabellinus* var. *murrillianus* (A.H.Sm.

and Hesler) Hesler and A.H.Sm.

Habit and habitat: Humicolous, gregarious, putatively ectomycorrhizal, usually mixed with broad leaf forests.

Locality: Sonamarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Atri and Saini, 1986; Atri *et al.*, 1994).

#### 1.11 *Lactarius uvidus* (Fr.) Fr.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal, under *Salix*.

Locality: Dachigam (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980; Abraham *et al.*, 1981).

#### 1.12 *Lactarius vellereus* (Fr.) Fr.

Habit and habitat: Humicolous, solitary, putatively ectomycorrhizal with coniferous forests of *Pinus wallichiana* and *Cedrus deodara*.

Locality: Bhaderwah, Kalinag forest area (J&K).

Edibility: not edible.

Jammu and Kashmir (Kumar and Sharma, 2011).

### 2. Genus *Lactifluus* (Pers.) Roussel.

#### 2.1 *Lactifluus controversus* (Pers.) Kuntze

Habit and habitat: Humicolous, solitary to gregarious, putatively ectomycorrhizal with *Salix alba*.

Locality: Gulmarg and Tangmarg (J&K).

Edibility: edible.

Jammu and Kashmir (Watling and Abraham 1992, Abraham *et al.*, 1981, Atri *et al.*, 1994 as *Lactarius controversus* Pers.).

**2.2 *Lactifluus corrugis* (Peck) Kuntze.**

Habit and habitat: Humicolous, solitary, putatively ectomycorrhizal, under *Quercus* forest.

Locality: Gulmarg and Tangmarg (J&K).

Edibility: not edible in Jammu and Kashmir but reported to be edible from some parts of the world.

Jammu and Kashmir (Atri and Saini, 1986; Saini and Atri, 1993 as *Lactarius corrugis* Peck).

**2.3 *Lactifluus deliciosus* (L.) Kuntze**

Habit and habitat: Humicolous, gregarious, putatively ectomycorrhizal in *Pinus roxburghii* forests.

Locality: Yusmarg and Mammer (J&K).

Edibility: highly edible.

Jammu and Kashmir (Watling and Gregory, 1980; Abraham *et al.*, 1980; Farooq *et al.*, 2017 as *Lactarius deliciosus* (L.) Gray).

**2.4 *Lactifluus volemus* (Fr.) Kuntze**

Habit and habitat: Humicolous, solitary, ectomycorrhizal, forests of *Pinus wallichiana* and *Cedrus deodara*.

Locality: Bhaderwarh, (J&K).

Edibility: not edible in the J&K but reported to be edible in Uttarakhand.

Jammu and Kashmir (Kumar and Sharma, 2011 as *Lactarius volemus* (Fr.) Fr.).

**3. Genus *Russula* Pers.****3.1 *Russula alutacea* (Pers.) Fr.**

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with coniferous temperate forests dominated by *Abies* and deciduous forests of *Salix*.

Locality: Gulmarg (J&K)

Edibility: not edible

Jammu and Kashmir (Berkeley, 1876).

**3.2 *Russula aurea* Pers.**

Habit and habitat: Humicolous, solitary to scattered, putatively ectomycorrhizal with *Picea* species.

Locality: Kellar, Gulmarg and Mammer (J&K).

Edibility: edible having medicinal properties.

Jammu and Kashmir (Saini and Atri, 1984; Atri *et al.*, 1994; Dar *et al.*, 2010; Farooq *et al.*, 2017).

**3.3 *Russula azurea* Bres.**

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with *Quercus* but also recorded occasionally under *Picea*.

Locality: Tangmarg (J&K).

Edibility: not edible in J&K but reported to be edible from some parts of the world.

Jammu and Kashmir (Saini and Atri, 1984; Saini *et al.*, 1989).

**3.4 *Russula alachuana* Murr.**

Habit and habitat: Humicolous, solitary to scattered, putatively ectomycorrhizal associated with *Quercus semecarpifolia*.

Locality: Pahalgam and Gulmarg (J&K).

Edibility: unknown.

Jammu and Kashmir (Saini and Atri, 1982).

**3.5 *Russula albida* Peck.**

Habit and habitat: Humicolous, solitary to scattered in small groups, putatively ectomycorrhizal mostly with *Quercus semecarpifolia*.

Locality: Baramulla (J&K).

Edibility: unknown.

Jammu and Kashmir (Kaur and Rather, 2016).

**3.6 *Russula annulata* var. *evanescens* Kumar S and Sharma YP.**

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with mixed forests of *Alnus nepalensis* and *Juglans regia*.

Locality: Dugga, Bhaderwah (J&K).

Edibility: not edible.

Jammu and Kashmir (Kumar and Sharma, 2012).

**3.7 *Russula atropurpurea* (Krombh.) Britzelm.**

Habit and habitat: Humicolous, gregarious, putatively ectomycorrhizal, in coniferous forests of *Pinus roxburghii* and *P. wallichiana*.

Locality: Poonch, Hirpora (J&K).

Edibility: not edible.

Jammu and Kashmir (Pala *et al.*, 2012).

**3.8 *Russula aerugenia* Lindblad.**

Habit and habitat: Humicolous, putatively ectomycorrhizal, growing scattered, or gregariously under conifer trees or under *Salix*.

Locality: Hirpora (J&K).

Edibility: edible.

Jammu and Kashmir (Pala *et al.*, 2012).

**3.9 *Russula brevipes* Peck.**

Habit and habitat: Humicolous, putatively ectomycorrhizal, associated with *Cedrus* in coniferous to mixed temperate forests.

Locality: Pahalgam (J&K).

Edibility: edible.

Jammu and Kashmir (Abraham *et al.*, 1980; Watling and Gregory, 1980).

**3.10. *Russula cyanoxantha* (Schaeff.) Fr.**

Habit and habitat: Humicolous, solitary to scattered, putatively ectomycorrhizal, coniferous forests of *Pinus wallichiana* and *Cedrus deodara*.

Locality: Bhaderwah, Hirpora, Chenani, Patnitop and Sanasar (J&K).

Edibility: not edible but edible in certain parts of the world.

Jammu and Kashmir (Kumar and Sharma 2012, Pala *et al.*, 2012).

**3.11. *Russula delica* Fr.**

Humicolous, scattered, putatively ectomycorrhizal under *Pinus*.

Locality: Hirpora, Patnitop and Sanasar (J&K).

Edibility: edible.

Jammu and Kashmir (Saini and Atri, 1984; Saini *et al.*, 1988; Dar *et al.*, 2009; Pala *et al.*, 2012).

**3.12. *Russula densifolia*** Secr. ex Gillet

Habit and habitat: Humicolous, putatively ectomycorrhizal, in association with species of *Cedrus*, *Picea* and *Quercus* in deciduous to mixed temperate forests.

Locality: Gulmarg, Sonamarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980; Abraham *et al.*, 1981; Atri and Saini, 1986; Atri *et al.*, 1994).

**3.13 *Russula emetica*** (Schaeff.) Pers.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal in coniferous forests.

Locality: Aru, Hirpora (J&K).

Edibility: not edible.

Jammu and Kashmir (Beig *et al.*, 2011; Pala *et al.*, 2012).

**3.14. *Russula foetens*** Pers.

Habit and habitat: Humicolous, gregarious, putatively ectomycorrhizal, under coniferous forests.

Locality: Gulmarg, Pahalgam (J&K).

Edibility: edible.

Jammu and Kashmir (Saini and Atri, 1984).

**3.15. *Russula firmula*** Jul. Schaff.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal, with coniferous forests dominated by *Abies*.

Locality: Gulmarg and Pahalgam (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980; Itoo *et al.*, 2013; Farooq *et al.*, 2017).

**3.16. *Russula fragrantissima*** Romagn.

Habit and habitat: Humicolous, solitary, scattered in putatively ectomycorrhizal association with coniferous forests dominated by *Abies*.

Locality: Pahalgam (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980).

**3.17 *Russula fragilis*** Fr.

Habit and habitat: Humicolous, putatively ectomycorrhizal, generally scattered under both coniferous and broad leaved trees.

Locality: Chadoora, Budgam (J&K).

Edibility: not edible.

Jammu and Kashmir (Pala *et al.*, 2011).

**3.18. *Russula lepida*** Fr.

Habit and habitat: Humicolous, solitary to scattered, putatively ectomycorrhizal under *Pinus wallichiana* and *Cedrus deodara*.

Locality: Pahalgam, Bhaderwah and Kishtwar (J&K).

Edible: not edible.

Jammu and Kashmir (Atri and Saini, 1986; Saini *et al.*, 1989; Kumar and Sharma, 2012).

**3.19. *Russula lutea*** (Huds.) Gray

Habit and habitat: Humicolous, common, gregarious, putatively ectomycorrhizal, under the canopy of *Cedrus deodara* and *Abies* trees during autumn season.

Locality: Gulmarg and Bandipora (J&K).

Edibility: edible.

Jammu and Kashmir (Beig *et al.*, 2008).

**3.20. *Russula nauseosa*** (Pers.) Fr.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with *Pinus*.

Locality: Gulmarg (J&K).

Edibility: edible.

Jammu and Kashmir (Watling and Gregory, 1980; Abraham *et al.*, 1980).

**3.21. *Russula nauseosa* var. *atropurpurea*** Allesch.

Habit and habitat: Humicolous, putatively in ectomycorrhizal association with *Viburnum*.

Locality: Pahalgam and Tangmarg (J&K).

Edibility: unknown.

Jammu and Kashmir (Watling and Gregory, 1980).

**3.22. *Russula nigricans*** Fr.

Habit and habitat: Humicolous, gregarious, scattered, putatively in ectomycorrhizal association with species of *Quercus* and *Cedrus* in coniferous, deciduous and mixed temperate forests.

Locality: Gulmarg and Sonamarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Saini and Atri, 1984; Saini *et al.*, 1988).

**3.23. *Russula nobilis*** Velen.

Humicolous, scattered, putatively ectomycorrhizal under broad leaf forest dominated by *Quercus* species.

Locality: Hirpora wildlife sanctuary (J&K).

Edibility: Poisonous.

Jammu and Kashmir (Pala *et al.*, 2012).

**3.24. *Russula paludosa*** Britzelm.

Habit and habitat: Humicolous, scattered in conifer-dominated forests under the canopy of *Pinus wallichiana*, putatively ectomycorrhizal.

Locality: Tangmarg J&K).

Edibility: edible but easily mistaken with *Russula emetica*.

Jammu and Kashmir (Dar *et al.*, 2009).

**3.25. *Russula puellaris*** Fr.

Habit and habitat: Humicolous, solitary to scattered, putatively ectomycorrhizal with *Pinus wallichiana* and *Cedrus deodara*.

Locality: Bhaderwah (J&K).

Edibility: not edible

Jammu and Kashmir (Kumar and Sharma, 2012).

**3.26. *Russula persicina*** Krombh.

Habit and habitat: Humicolous, solitary to scattered, putatively ectomycorrhizal in mixed forest dominated with *Salix alba*.

Locality: Sarband, Dachigam (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980).

**3.27. *Russula rosea*** Pers.

Habit and habitat: Humicolous, putatively ectomycorrhizal,

scattered, under coniferous forests.

Locality: Patnitop, Sanasar and Gulmarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Atri and Saini, 1986; Saini *et al.*, 1989; Kumar and Sharma, 2012).

### 3.28. *Russula rubicunda* Quél.

Habit and habitat: Humicolous, solitary, scattered, in putatively ectomycorrhizal association with *Viburnum*.

Locality: Tangmarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980).

### 3.29. *Russula sanguinea* (Bull.) Fr.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with conifers.

Locality: Gulmarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980).

### 3.30. *Russula stutzii* Grund.

Humicolous, solitary, putatively ectomycorrhizal in mixed forest.

Locality: Baramulla (J&K).

Edibility: not edible but considered edible in some parts of the world.

Jammu and Kashmir (Kaur *et al.*, 2014).

### 3.31. *Russula sardonias* Fr.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with *Abies pindrow*.

Locality: Babareshi, Baramulla (J&K).

Edibility: not edible.

Jammu and Kashmir (Beig *et al.*, 2011).

### 3.32. *Russula tuberculosa* R. Heim

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal in coniferous forests of *Pinus wallichiana* and *Cedrus deodara*.

Locality: Bhaderwah, (J&K).

Edibility: not edible.

Jammu and Kashmir (Kumar and Sharma, 2012).

### 3.33. *Russula velutipes* Velen.

Habit and habitat: Humicolous, solitary, scattered, putatively ectomycorrhizal with coniferous forests.

Locality: Gulmarg and Tangmarg (J&K).

Edibility: unknown.

Jammu and Kashmir (Saini *et al.*, 1989).

### 3.34. *Russula veternosa* Fr.

Habit and habitat: Humicolous, scattered, putatively ectomycorrhizal with *Quercus* species.

Locality: Sonamarg and Gulmarg (J&K).

Edibility: not edible.

Jammu and Kashmir (Watling and Gregory, 1980).

### 3.35. *Russula xerampelina* (Schaeff.) Fr

Habit and habitat: Humicolous, solitary, rare, putatively ectomycorrhizal with species of *Quercus* in temperate

deciduous forests.

Locality: Sonamarg and Gulmarg (J&K).

Edibility: edible.

Jammu and Kashmir (Saini and Atri, 1984; Saini *et al.*, 1988).

## CONCLUSIONS

Jammu and Kashmir is one of the biodiversity rich regions of India owing to varied climatic conditions and topographical features. Several investigations related to fungal diversity especially mushrooms have been undertaken in the region, yet the literature does not reveal much on russulaceous members as only 51 species of the family have been reported from Jammu and Kashmir so far. Owing to rich hosts and habitats such as coniferous forests, species of *Betula*, *Quercus*, *Viburnum*, *Salix* etc, supporting mushroom growth, a large number of ectomycorrhizal russulaceous taxa may exist in this region but seemingly there is a considerable gap between the number of ectomycorrhizal russulaceous taxa actually existing in nature and the number of documented species. Therefore, extensive exploratory studies are ardently called for in different geographical locations of Jammu and Kashmir.

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