

Checklist of Turkish Truffles

Türkiye Trüfleri Kontrol Listesi

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Abstract

Truffles are ecologically and commercially valued macrofungi group and they attract the people since ancient times. Similarly, Turkey has suitable conditions for truffles. So, the list of truffles that reported from Turkey is given in this paper.

Keywords: Truffle, checklist, biodiversity, Turkey

Öz

Trüfler ekolojik ve ticari olarak değerli bir makrofungus grubudur ve eski çağlardan beri insanları etkilemektedirler. Benzer şekilde, Türkiye trüfler için uygun şartlara sahiptir. Bu nedenle, sunulan bu çalışmada Türkiye'den kaydedilen trüflerin listesi verilmiştir.

Anahtar Kelimeler: Trüf, kontrol listesi, biyoçeşitlilik, Türkiye

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1. Introduction

Truffles are fungi group which produced potato like fruiting body under the ground. In mycological terms, the fungi growing or developing subterraneously are called "hypogeous fungi", so this term is used for describing the truffles (Trappe et al. 2009). Truffles differ from the other mushrooms by production and dispersion of spores. The spores are produced within interior the fruiting body, so they don't expose the air (Trappe et al. 2009). The spore dispersion strategy depends on animals. Mature truffles produce sui generis odor which affects the animals such as squirrels, mice and pigs (Pegler et al. 1993; Trappe et al. 2009). The animals dig the ground for hunting and eating the truffles. Thus, the spores pass the animals' digestive system and disperse far from the fruiting bodies (Trappe et al. 2009).

The odors of truffles, also, attract the people for gastronomic purposes since ancient times. Especially, some of them such as *Tuber melanosporum* Vittad. and *T. aestivum* (Wulfen) Spreng. (Fig. 1) are cultivated for the gastronomic purposes and they are commercially valued species at worldwide. Turkey is located at the convergence of three phytogeographical regions: the Euro-Siberian, Mediterranean and Irano-Turanian and this situation encourages biological diversity. Besides of this, three main climate conditions occur in Turkey as a consequence of the diverse geographical formations. So, Turkey has large macrofungi potentials and nearly 2400 fungi taxa have been reported until today (Solak et al. 2007; Sesli and Denchev 2008; Solak et al. 2015).

Although the studies on Turkish mycobiota have been conducted more than 100 years (Sesli and Denchev 2008; Solak et al. 2015), the macrofungi biodiversity have not been fully determined. Particularly, there is limited data about truffles and their distributions in Turkey (Türkoğlu and Castellano 2014). So, we aimed to determine the truffles distributed in Turkey in order to create literature to further studies.

2. Materials and Methods

In the present study, the checklist of truffles of Turkey was generated in accordance with the current literatures. The names of the authors are checked and abbreviated according to Index Fungorum (www.indexfungorum.org; access date 1 December 2016).

The list of taxa is given in two main groups; Ascomycota and Basidiomycota. Also, the taxa were placed families as referred in Index Fungorum. The taxa are given alphabetical order in the families.

3. Results and Discussion

In this study, hypogeous macrofungi taxa known as truffles, and their distributions are given in Table 1. According to current literature, 67 truffles taxa belonging to 23 genus within 15 family have been grown in Turkey. The list contains 26 Ascomycetes truffles and they are 37.87 % of all taxa. The family distribution of Ascomycetes

Table 1. Turkish truffles, their distributions and references

Taxa	Locality	References
ASCOMYCOTA		
Elaphomycetaceae Tul. ex Paol.		
<i>Elaphomyces leucocarpus</i> Vittad.	Artvin, Tekirdağ, Trabzon	Türkoğlu et al. (2015)
<i>E. muricatus</i> Fr.	Artvin, Karabük	Türkoğlu et al. (2015)
Pezizaceae Dumort.		
<i>Terfezia arenaria</i> (Moris) Trappe	Aydın, Isparta, Konya, Malatya	Öder (1988) Işıloğlu and Öder (1995) Afyon (1996) Kaşık et al. (1998) Türkoğlu et al. (2015)
<i>T. boudieri</i> Chatin	Batman, Denizli, Diyarbakır, Elazığ, Gaziantep Karaman, Malatya, Niğde, Şanlıurfa	Gücin (1990) Yıldız and Ertekin (1997) Kaşık et al. (2001) Doğan and Öztürk (2006) Demir et al. (2007) Kaya et al. (2012) Gezer et al. (2014) Kaya (2015)
<i>T. claveryi</i> Chatin	Adana, Aksaray, Denizli, Diyarbakır, Karaman, Konya, Şanlıurfa, Yozgat	Türkoğlu et al. (2015) Doğan and Kurt (2016)
<i>T. leptoderma</i> (Tul. & C. Tul.) Tul. & C. Tul.	Denizli, Uşak	Castellano and Türkoğlu (2012) Türkoğlu and Castellano (2014)
<i>T. olbiensis</i> (Tul. & C.Tul.) Sacc.	Gaziantep, Konya, Nevşehir, Uşak	Türkoğlu and Castellano (2014) Uzun et al. (2015)
<i>Tirmania pinoyi</i> (Maire) Malençon	İzmir	Yılmaz Ersel and Solak (2004)
Pyronemataceae Corda		
<i>Genea klotzschii</i> Berk. & Broome	Samsun	Türkoğlu and Castellano (2014)
<i>G. sphaerica</i> Tul. & C. Tul.	İzmir	Türkoğlu et al. (2015)
<i>G. verrucosa</i> Vittad.	Muğla	Türkoğlu and Castellano (2014)
<i>Geopora cooperi</i> Harkn.	Bolu, Burdur, Denizli, İzmir, Muğla	Solak et al. (2003) Türkoğlu et al. (2015)
<i>Picoa juniperi</i> Vittad.	Afyon, Antalya, Denizli, Elazığ, Kayseri Konya, Nevşehir, Uşak	Türkoğlu and Yağız (2012) Türkoğlu and Castellano (2014) Türkoğlu et al. (2015)
<i>P. lefebvrei</i> (Pat.) Maire	Aksaray, Denizli, Elazığ, Konya, Şanlıurfa	Gücin et al. (2010) Kaya (2015) Türkoğlu et al. (2015)
<i>Stephensia bombycina</i> (Vittad.) Tul. & C.Tul.	Samsun	Türkoğlu and Castellano (2014)
Tuberaceae Dumort.		
<i>Choiromyces meandriformis</i> Vittad.	Bolu, Samsun, Uşak	Türkoğlu and Castellano (2014)
<i>Reddellomyces parvulosporus</i> (G.W. Beaton & Malajczuk) Trappe, Castellano & Malajczuk	Antalya, Muğla	Türkoğlu (2015)
<i>Tuber aestivum</i> Vittad.	Antalya, Artvin, Bolu, Burdur, Denizli, Düzce, Hatay, İstanbul, İzmir, Muğla, Kırklareli, Ordu, Osmaniye	Gezer et al. (2014) Türkoğlu et al. (2015)
<i>T. brumale</i> Vittad.	Denizli, Niğde, Osmaniye, Samsun	Öztürk et al. (1997) Gezer et al. (2014) Türkoğlu and Castellano (2014)

<i>T. borchii</i> Vittad.	Aydın, Denizli, Kahramanmaraş, Muğla, Samsun, Tekirdağ	Kaya (2009a) Gezer et al. (2014) Elliot et al. (2016)
<i>T. excavatum</i> Vittad.	Denizli	Türkoğlu and Castellano (2014)
<i>T. ferrugineum</i> Vittad.	Antalya, Aydın, Denizli	Elliot et al. (2016)
<i>T. mesentericum</i> Vittad.	Denizli	Castellano and Türkoğlu (2012) Türkoğlu and Castellano (2014)
<i>T. nitidum</i> Vittad.	Denizli, Burdur, Kastamonu, Osmaniye	Castellano and Türkoğlu (2012) Türkoğlu and Castellano (2014) Türkoğlu et al. (2015)
<i>T. puberulum</i> Berk. & Broome	Aydın, Denizli, Muğla, Osmaniye	Elliot et al. (2016)
<i>T. rufum</i> Picco.	Aydın, Antalya, Bolu, Burdur, Denizli, Kastamonu, Konya, Muğla, Osmaniye	Türkoğlu and Castellano (2014) Türkoğlu et al. (2015)
BASIDIOMYCOTA		
Albatrellaceae Nuss		
<i>Leucogaster liosporus</i> R.Hesse	---	Pilát (1937)
<i>L. luteomaculatus</i> Zeller & C.W.Dodge	---	Pilát (1937)
<i>L. nudus</i> (Hazsl.) Hollós	Çankırı, Kastamonu	Pilát (1937) Türkoğlu et al. (2015)
<i>L. tozzianus</i> (Cavara & Sacc.) Mattir. ex Zeller & C.W. Dodge	Kastamonu, Trabzon	Türkoğlu et al. (2015)
<i>Leucophleps aculeatispora</i> Fogel	Kastamonu	Elliot et al. (2016)
Boletaceae Chevall.		
<i>Octaviania asterosperma</i> Vittad.	Artvin, Ordu, Trabzon	Türkoğlu et al. (2015)
Cortinariaceae R. Heim		
<i>Protoglossum aromaticum</i> (Velen.) J.M. Vidal	Ankara, Artvin, Kastamonu	Türkoğlu et al. (2015)
Hymenogastraceae Vittad.		
<i>Hymenogaster citrinus</i> Vittad.	Samsun	Türkoğlu et al. (2015)
<i>H. hessei</i> Soehner	Kastamonu	Türkoğlu et al. (2015)
<i>H. griseus</i> Vittad.	Muğla	Türkoğlu and Castellano (2013)
<i>H. luteus</i> Vittad.	Isparta, Osmaniye, Tekirdağ, Yalova	Türkoğlu et al. (2015)
<i>H. lycoperdineus</i> Vittad.	Isparta	Türkoğlu et al. (2015)
<i>H. olivaceous</i> Vittad.	Denizli	Türkoğlu and Castellano (2013)
<i>H. rehsteineri</i> Bucholtz	Artvin, Samsun, Tekirdağ, Yalova	Elliot et al. (2016)
<i>H. thwaitesii</i> Berk. & Broome	Denizli, Muğla, Osmaniye	Türkoğlu and Castellano (2013) Türkoğlu et al. (2015)
<i>H. vulgaris</i> Tul. & C. Tul.	Muğla, Samsun, Tekirdağ, Yalova	Türkoğlu and Castellano (2013) Türkoğlu et al. (2015)
Hysterangiaceae E. Fisch.		
<i>Hysterangium calcareum</i> R. Hesse	Ordu	Elliot et al. (2016)
<i>H. clathroides</i> Vittad.	Gaziantep, Kütahya, Trabzon	Türkoğlu et al. (2015) Uzun et al. (2015)
<i>H. epiroticum</i> Pacioni	Kastamonu	Türkoğlu et al. (2015)
<i>H. fragile</i> Vittad.	Kastamonu, Ordu	Türkoğlu et al. (2015)
<i>H. inflatum</i> Rodway	Muğla	Ünal et al. (2016)
<i>H. nephriticum</i> Berk.	Sakarya	Türkoğlu et al. (2015)
Gomphaceae Donk		
<i>Gautieria graveolens</i> Vittad.	---	Pilát (1937)

<i>G. monticola</i> Harkn.	Gaziantep, Kahramanmaraş	Kaya (2009a) Uzun et al. (2015)
<i>G. otthii</i> Trog	Bolu, Kastamonu	Türkoğlu et al. (2015)
<i>G. retirugosa</i> Th. Fr.	Bolu	Türkoğlu et al. (2015)
<i>G. trabutii</i> (Chatin) Pat.	Burdur, Muğla	Türkoğlu et al. (2015)
Paxillaceae Lotsy		
<i>Alpova corsicus</i> P.-A. Moreau & F. Rich.	Artvin	Türkoğlu et al. (2015)
<i>Melanogaster ambiguus</i> (Vittad.) Tul. & C. Tul.	Hakkari, Gaziantep, Muğla	Uzun et al. (2014) Uzun et al. (2015) Elliot et al. (2016)
<i>M. broomeanus</i> Berk.	Artvin, Denizli, Erzurum, Gaziantep, Kastamonu, Samsun, Trabzon	Demirel (1998) Türkoğlu and Castellano (2013) Türkoğlu et al. (2015) Uzun et al. (2015)
<i>M. macrosporus</i> Velen.	Trabzon	Elliot et al. (2016)
<i>M. variegatus</i> (Vittad.) Tul. & C. Tul.	Trabzon	Sesli and Moreau (2015)
Phallogastraceae Locq.		
<i>Phallogaster saccatus</i> Morgan	Kastamonu	Doğan (2006)
Rhizopogonaceae Gäum. & C.W. Dodge		
<i>Rhizopogon luteolus</i> Fr.	Adana, Adıyaman, Antalya, Denizli, Eskişehir, Erzurum, Gaziantep, Isparta, İzmir, Kahramanmaraş, Kastamonu, Kayseri, Konya, Mersin, Tokat, Şanlıurfa	Solak et al. (1999) Gezer (2000) Demirel et al. (2003) Kaşık et al. (2003) Öztürk et al. (2003) Türkekul (2003) Köstekçi et al. (2005) Kaya (2006) Köse et al. (2006) Kaya (2009b; 2009c) Türkoğlu and Gezer (2006) Türkoğlu et al. (2007) Akata et al. (2010) Alkan et al. (2010) Doğan et al. (2010) Güngör et al. (2015) Kaya (2015) Doğan and Kurt (2016)
<i>R. marchii</i> (Bres.) Zeller & C.W.Dodge	Trabzon	Sesli and Castellano (2009)
<i>R. obtextus</i> (Spreng.) R. Rauschert	Gümüşhane	Akata et al. (2016)
<i>R. ochraceorubens</i> A.H.Sm.	Bolu, Kastamonu, Muğla, Yalova	Yağız et al. (2006a; 2006b) Candar and Allı (2012) Güngör et al. (2016)
<i>R. roseolus</i> (Corda) Th.Fr.	Adana, Antalya, Bursa, Bolu, Denizli, Gümüşhane, Isparta, İzmir, Karaman, Konya, Mersin, Muğla, Sinop, Sivas, Yozgat	Solak et al. (1999) Gezer (2000) Öztürk et al. (2003) Doğan and Öztürk (2006) Köse et al. (2006) Uzun et al. (2006) Yağız et al. (2006a; 2006b) Doğan et al. (2007) Türkoğlu et al. (2007)

Alkan et al. (2010)
Doğan et al. (2010)
Servi et al. (2010)
Kiriş et al. (2012)
Güngör et al. (2015)
Allı et al. (2016)
Doğan and Kurt (2016)
Güngör et al. (2016)

Russulaceae Lotsy

Gymomyces xanthosporus (Hawker) A.H.Sm. Denizli Türkoğlu and Castellano (2013)

Sclerogastraceae Locq.

Sclerogaster compactus (Tul. & C. Tul.) Sacc. Muğla Elliot et al. (2016)

S. hysterangioides (Tul. & C. Tul.) Zeller & C.W. Dodge Bolu Elliot et al. (2016)

--- Distribution of these species could not be observed.

truffles are Elaphomycetaceae 2; Pezizaceae 6; Pyrenomataceae 7; Tuberaceae 11. Similarly, 41 Basidiomycetes have been reported from Turkey and they are 64.13% of all taxa. The distribution of Basidiomycetes truffles in families are Albatrellaceae 5; Boletaceae 1; Cortinariaceae 1; Hymenogastraceae 9; Hysterangiaceae 6; Gomphaceae 5; Paxillaceae 5; Phallogastraceae 1; Rhizopogonaceae 5; Russulaceae 1; Sclerogastraceae 2.

It is shown that *Rhizopogon luteolus* and *R. roseolus* are the most common species in Turkey and they are reported from many locations (Table 1). The genus *Rhizopogon* Fr. is associated with *Pinaceae* (Pegler et al. 1993), so it might be common species depending on distribution of *Pinaceae* members.

Also, Pegler et al. (1993) was referred the genus *Tuber* as true truffles. According to Table 1, nine *Tuber* taxa have been reported from Turkey. But, Turkey might be a host for many *Tuber* species which are waiting to be discovered. The most commercially valuable species *Tuber magnatum* Picco has not been collected from Turkey yet, but growing of *T. borchii* Vittad. and *T. aestivum* is showed that this species is likely to grow naturally in our country (Çaka and Türkoğlu 2016). Also, *Tuber melanosporum* is not grown naturally in Turkey. But, the cultivation studies on *T. melanosporum* have been continued and truffles gardens are constituted in different locations led by Turkish Ministry of Forestry and Water Affairs. Also, some private organizations have begun to cultivated studies (Fig. 2).



Figure 1. *Tuber aestivum*, known as "Burgundy truffle" or "summer truffle"



Figure 2. A truffle garden from Fethiye

When it has been mentioned truffles, everyone might think about *Tuber P. Micheli* genus because of its gastronomic and commercial purposes.

It is likely to grow too many truffles in our country. But, it is too hard to find truffles species in the field by the reason of growing under the ground. So, the truffle collectors use

trained dogs for hunting. If you don't use trained dogs, some signals might help you find commercially valued truffles. When *Tuber* species grow, it creates an opening area within grasses called "brule". Also, mature *Tuber* species split the soil by upwards gently (Fig. 3). In addition to this, the chance of the finding of *Tuber* species is higher in the mixed forests of different tree species (Türkoğlu 2015).



Figure 3. The mature *Tuber aestivum* splits the ground

In Turkey, it should conduct much more studies on truffles species by reason of the fact that discover new species or records. However, to discover the commercially valued truffles are contributed the country's economy. Also, these species can be used some industrial area such as food and cosmetics industry.

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