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Amanita spadicea: Türkiye Mikotası İçin Yeni Bir Kayıt

Ertuğrul SESLİ

**Sorumlu yazar: ertugrulsesli@yahoo.com*

Trabzon Üniversitesi, Fatih Eğitim Fakültesi, Biyoloji Eğitimi Ana Bilim Dalı, Söğütlü, Trabzon, Türkiye

Orcid No:0000-0002-3779-9704 / e-mail: ertugrulsesli@trabzon.edu.tr

Öz: *Amanita spadicea*'nin früktifikasyon organları Türkiye'den ilk kez toplanmış, incelenmiş, arazi ve mikroskobik fotoğraflar ve kısa bir tartışma ile birlikte sunulmuştur. Yeni kayıt soluk veya sarımsı kahverengi, çizgili, 50−190 mm ve meme biçiminde şapka; serbest, beyaz veya krem rengi lameller, sarımsı kahverengi ve 70−235 × 10−30 mm sap; oval ve 12–16 × 10–14 µm bazidiyosporlar ile yakın akraba türlerden farklılık gösterir.

Anahtar kelimeler: Agarik, Bazidiyomikota, Taksonomi, Trabzon

Amanita spadicea: A New Record for the Turkish Mycota

Abstract: The fruiting bodies of *Amanita spadicea* were collected and studied for the first time from Türkiye and presented with field and microscopic photos and a brief discussion. The new record differs from the closely related species with pale or yellowish-brown, striated, 50−190 mm and nipple-shaped pileus; free, white or cream-coloured lamellae; yellowish brown and 70−235 × 10−30 mm stipe; spherical and 12–16 × 10–14 µm basidiospores.

Key words: Agaric, Basidiomycota, Taxonomy, Trabzon

Giriş

Amanitaceae ailesi güncel çalışmalara göre monofiletik bir grup olup *Amanita, Catatrama, Limacella, Limacellopsis* ve *Myxoderma* olmak üzere 5 cins içermektedir. Aile içerisindeki saptan ayrık lamelli, yüzüklü, higroskopik olmayan, çeşitli renklerde şapkaları olan türlerin hemen hemen %95'ini kapsayan *Amanita* üç alt cinse ve 11 seksiyona ayrılabilir (Alt cins *Amanita*: seksiyon *Amanita*, seksiyon *Amarrendiae*, seksiyon *Caesareae* ve seksiyon *Vaginatae.* Alt cins *Amanitina*: seksiyon *Amidella*, seksiyon *Arenariae*, seksiyon *Phalloideae*, seksiyon *Roanokenses*, seksiyon *Strobiliformes* ve seksiyon *Validae* ve alt cins *Lepidella*: seksiyon *Lepidella*) (Cui ve ark., 2018). *Amanita* içerisindeki bireylerin lamelleri kar beyazı veya az çok beyazımsı, bazen soluk gri veya yeşilimsi olabilir. Sap beyazımsı, dış zar beyazımsı, sarımsı veya yeşilimsi olup olgunlaştığı zaman bazı türlerin sap tabanında çanakçık ve bazılarında ise zar kalıntıları bırakır. Bazidiyosporları oval veya eliptik, şeffaf ve düz yüzeylidir. Şapka derisi düzgün paralel hiflerden veya jelatinli ve çeşitli yönlere uzayan hücrelerden meydana gelmiştir. Cins üyeleri kozalaklı ve geniş yapraklı ağaçlarla mikorizal yaşar (Knudsen ve Vesterholt, 2008). *Amanita* cinsi dünyada 1600'den fazla ve Türkiye'de ise 45 civarında türle ile temsil edilmektedir (Kirk ve ark., 2008; Sesli ve ark., 2020). Bu çalışmadan önce Türkiye'de yayılış gösteren *Amanita* türleri *Amanita alba* Pers. (Ters duvakluca), *A. argentea* Huijsman (Gümüşkese), *A. battarrae* (Boud.) Bon (Kötükese), *A. caesarea* (Scop.: Fr.) Pers. (İmparator mantarı), *A. ceciliae* (Berk. & Broome) Bas (Yalnızkese), *A. citrina* (Schaeff.) Pers. var. *citrina* (Patateskesesi, *A. citrina* var. *alba* (Gillet) E.–J. Gilbert, *A. codinae* (Maire) Bertault (Başlı duvakluca), *A. crocea* (Quél.) Singer (Safrankesesi), *A. echinocephala* (Vittad.) Quél. (Dikenlikese), *A. eliae* Quél. (Elkesesi), *A. excelsa* (Fr.: Fr.) Bertill. (Küllükese), *A. franchetii* (Boud.) Fayod (Köklükese), *A. friabilis* (P. Karst.) Bas (Serbestkese), *A. fulva* (Schaeff.) Pers. (Parlakkese), *A. gemmata* (Fr.) Bertill. (Kabakese), *A. gilbertii* Beauseign. (Tipsizkese), *A. lividopallescens* (Boud.) Kühner & Romagn. (Kasketkesesi), *A. magniverrucata* Thiers & Ammirati, *A. mairei* Foley (Çizgilişapka), *A. muscaria* (L.: Fr.) Pers. var. *muscaria* (Gelin mantarı), *A. nivalis* Grev. (Yamalıgelin),

A. ovoidea (Bull.: Fr.) Quél. (Peçeligelin), *A. pachyvolvata* (Bon) Krieglst. (Karayağız), *A. pantherina* (DC.: Fr.) Krombh. var. *pantherina* (Panter mantarı), *A. pantherina* var. *multisquamosa* (Peck) D.T. Jenkins (Siğillikese), *A. phalloides* (Vaill.: Fr.) Link (Köygöçüren mantarı), *A. porphyria* Alb. & Schwein.: Fr. (Karakese), *A. regalis* (Fr.) Michael (Sinek mantarı), *A. rubescens* Pers.: Fr. var. *rubescens* (Kızıl mantar), *A. rubescens* var. *annulosulphurea* Gillet, *A. strobiliformis* (Paulet ex Vittad.) Bertill. (Karyağdı), *A. subalpina* M.M. Moser (Dertveren), *A. submembranacea* (Bon) Gröger (Zarlıçanak), *A. subnudipes* (Romagn.) Tulloss, *A. torrendii* Justo (Buruşukgelin), *A. vaginata* (Bull.: Fr.) Vittad. var. *vaginata* (Yarıklıkese), *A. vaginata* var. *alba* Gillet, *A. valens* (E.–J. Gilbert) Bertault (Kumlukese), *A. verna* (Bull.: Fr.) Lam. (Ecelşapkası), *A. verna* var. *decipiens* Trimbach, *A. virosa* (Fr.) Bertill. (Ölüm meleği) ve *A. vittadinii* (Moretti) Vittad.'dır (Sesli ve ark., 2020). Materyalinin toplandığı yöre Doğu Karadeniz Dağlarında genellikle az rastlanan düzlük bir alan olup, Doğu ladini başta olmak üzere kayın, kızılağaç, mor ve sarıçiçekli ormangülleri, böğürtlen ve yer yer armut ağaçlarından oluşan ormanlarla kaplıdır. Orman içerisinde ve kenarlarında çayırlık alanlar bulunmaktadır. Materyali bir haftadan fazla süren yağmurlardan sonraki bulutlu günlerde orman kenarlarında bulmak kolaydır. Yaptığımız gözlemlerde früktifikasyon organlarının ortaya çıkması sonbaharda ancak bu özel hava koşullarının oluştuğu zamanlarda mümkün olabilmektedir. Bazı yıllar früktifikasyon oluşumu gözlenmemiştir.

Bu çalışmanın amacı oldukça büyük boyutlu fakat früktifikasyon organları yaygın olarak ortaya çıkmadığından daha önce rastlanılmamış bir *Amanita* türünü Türkiye'den ilk kez tanıtmaktır.

Materyal ve Metot

Araştırma materyali olan früktifikasyonlar 01.10.2010 tarihinde Trabzon, Akçaabat, Hıdırnebi Yaylası'ndan toplanmıştır. Öncelikli olarak früktifikasyonların yetişme ortamında fotoğrafları çekilmiş, dış morfolojik özellikleri ve koordinatları not edilmiştir. Standart yöntemlerle toplanan birkaç früktifikasyon laboratuvara getirilmiş, spor izleri elde edildikten sonra kurutulup etiketlenerek fungaryum dolabına yerleştirilmiştir. Bazidiyum ve hifal yapıları görüntülemek için keskin jiletle streo-binoküler mikroskop altında kesitler alınmış, %5'lik amonyak çözeltisi içerisinde muamele edilmiş ve nihayet lam lamel arası preparat yapılarak görüntülenen özel yapıların fotoğrafları çekilmiştir. Bazidiyosporların görüntülenebilmesi için früktifikasyon organından bir parça kesilerek 3 dakika %5'lik amonyak çözeltisi içerisinde tutulmuş, daha sonra bir pens yardımı ile lam üzerine alınmış ve bazidiyosporlar lam üzerinde düşünceye kadar sıkılıp bırakılmıştır. Bu işlemden sonra Zeiss Axio Imager A2 araştırma mikroskopu ile incelenmiş, 30 civarında ölçüm yapılarak fotoğrafları çekilmiştir. Diğer mikroskobik yapıların büyüklüklerinin belirlenebilmesi için de yine yaklaşık 30 civarında ölçüm yapılmış ve bunların ortalaması alınmıştır. Teşhisler arazi gözlemleri, mikroskobik incelemeler ve ölçüm sonuçlarının ilgili kaynaklar ile karşılaştırılması sonucunda yapılmıştır (Knudsen ve Vesterholt, 2008; Anonim, 2021). Kurutulmuş örnekler Trabzon Üniversitesi Fatih Eğitim Fakültesi'ndeki kişisel fungaryumda saklanmaktadır.

Bulgular

Amanitaceae E.-J. Gilbert

***Amanita spadicea* Pers., Tent. Disp. Meth. Fung.: 66 (1797) / Kahvekese** (Şekil 1)

Şapka koni, çan, yarım küre, konveks veya yayvan ve yaklaşık 50−190 mm büyüklüğünde; yüzeyi ıslak iken hafif yapışkan, pürüzsüz, açık veya sarımsı kahverengi, kenarı daha açık renkli, içeriye doğru çizgili ve bazen yarıktır. Tepe çıkıntısı meme ucuna benzer biçimde, büyük, geniş, yüksek ve yüzeye göre daha koyu renklidir. Lameller sapa birleşmemiş, beyaz veya krem rengi, geniş ve sıktır. Eti hafif tatlı beyaz veya sarımsıdır. Sap silindirik, yukarıya doğru daha ince, tabanı ortası ile hemen hemen aynı genişlikte, genellikle yüzüksüz fakat çanaklıdır. Yüzeyi genç iken daha açık, olgunlukta beyaz zemin üzerinde toprak rengi, açık veya sarımsı kahverengi, yılan derisi veya tavukayağına benzer pullarla kaplı ve yaklaşık 70−235 × 10−30 mm'dir. Çanak genellikle kenardan yarık, büyük, dayanıksız, yukarı kısımda sapa benzer renkte ve aşağıda beyazımsı miselyumla kaplıdır. Bazidiyumlar çomakçık şeklinde, 4 ve bazen de 2 sporlu ve 35−55 × 10−15 µm'dir. Bazidiyosporlar oval ve 12–16 × 10–14 µm'dir. Bazidiyumlara komşu hücreler çomakçık biçimindedir. Şapka derisi paralel hiflerden oluşmuştur. Ülkemizde günümüze değin sadece Doğu Karadeniz Bölümünde saptanmıştır. Yaz başlarından sonbahar sonlarına değin karışık ağaçlı ormanlarda, ormanlar arasındaki çimenliklerde ve parklarda tek tek veya gruplar halinde yetişir.

İncelenen örnekler: Türkiye, Trabzon, Akçaabat, Hıdırnebi yaylası, 40°57'05.08"K ve 39°26'02.73"D, 1255 m, 01.10.2010, gruplar halinde, ladin-kayın-kızılağaç ormanı kenarında, E. Sesli 2969.

Tartışma

Amanita spadicea büyük früktifikasyon organları, meme ucu biçimindeki tepe çıkıntısı, açık veya sarımsı kahverengi, 50−190 mm şapkası, serbest, beyaz veya krem renkli lamelleri, beyaz zemin üzerinde toprak rengi, açık veya sarımsı kahverengi, yılan derisi biçiminde ve

70−235 × 10−30 mm sapı, oval ve 12–16 × 10–14 µm bazidiyosporları ile yakın akraba türlerden farklılık gösterir. Koleksiyonumuza benzer renkte fakat farklı bir tür, *Amanita crocea* yarımküre veya çan biçiminde, 60−120 mm şapka ve daha küçük bazidiyosporlar ile (9.7−11.7 × 8.5−10.5) farklılık gösterir. Diğer bir tür, *A. lividopallescens* yayvan tepe çıkıntılı, turuncumsu gri şapka, beyazımsı sap ve geniş eliptik bazidiyosporları ile örneğimizden farklılık gösterir. *A. fulva* 50−100 mm, turuncumsu kahverengi şapkaya ve 70−120 × 5−15 mm sapa sahiptir. *A. submembranacea* daha küçük (50−80 mm), zeytini veya gri kahverengi şapka, beyazımsı sap ve çomak biçimindeki kenar hücreleri ile yeni kayıttan farklılık gösterir. A*. gemmata* daha küçük, hafif tepe çıkıntılı, 50−100 mm ve limon veya yumurta sarısı şapka, soğanlı sap, 9−11 × 7−9 µm ve geniş eliptik bazidiyosporları ile farklılık gösterir. *A. rubescens* turuncumsu veya kırmızımsı, 50−150 mm ve zar parçaları ile kaplı şapka, volvasız sap tabanı ve daha küçük (8−12 × 5−7 µm) ve eliptik bazidiyosporlara sahiptir. Renk yönünden benzerlik gösteren diğer bir farklı tür, *A. battarrae* daha küçük, yayvan tepe çıkıntılı, sarımsı, zeytini veya grimsi şapkaya, kırmızımsı veya grimsi kahverengi sapa ve biraz daha küçük bazidiyosporlara (9.5−15 × 9−14 µm) sahiptir. Bu çalışma ile ülkemiz mikotasında yer alan *Amanita* türlerinin sayısına katkıda bulunulmuştur. Tespit edebildiğimiz kadarı ile yeni kaydın besin amaçlı tüketilmesi uygun değildir (Breitenbach ve Kränzlin, 1995; Knudsen ve Vesterholt, 2008; Akata ve ark., 2014; Anonim, 2021). Bilindiği gibi *Amanita* grubu mantarlar öldürücü zehirli mantarları kapsamaktadır ve bu nedenle daha ayrıntılı araştırılıp Türkiye'de yayılış gösterenlerin bir bütün olarak ortaya çıkarılması zehirlenme vakalarının önüne geçebilmenin ilk adımı olacaktır.

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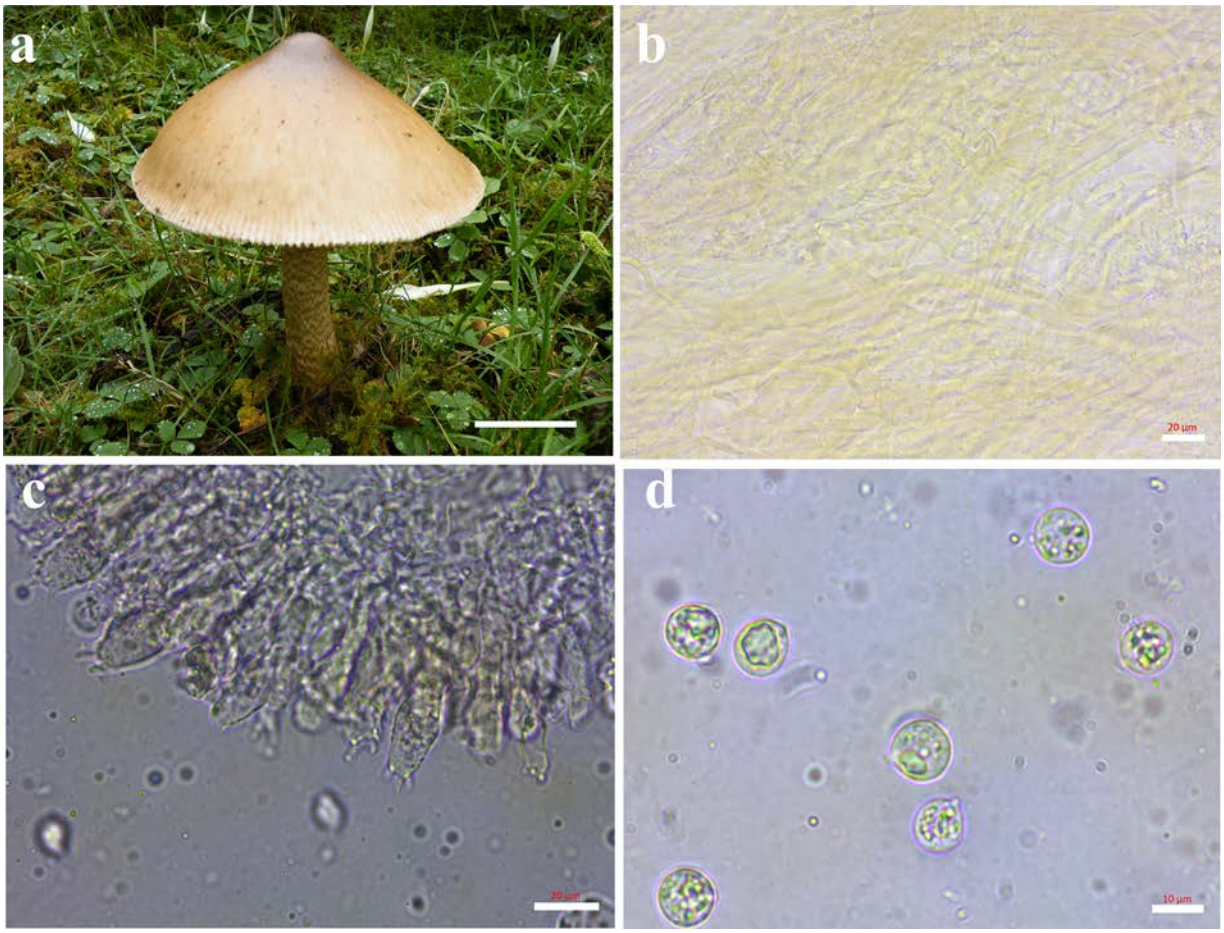

Şekil 1. *Amanita spadicea*: a. früktifikasyon organı, b. şapka derisi kesidi, c. lamelden kesit, d. bazidiyosporlar (ölçek çubukları: a: 50 mm, b ve c: 20 µm, d: 10 µm)

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Muğla Sıtkı Koçman Üniversitesi Kampüsünde Yetişen Makromantarlar

Hakan ALLI[1*]

**Sorumlu yazar: hakanalli@gmail.com*

[1] Muğla Sıtkı Koçman Üniversitesi Fen Fakültesi Biyoloji Bölümü
Orcid No: 0000-0001-8781-7029/hakanalli@gmail.com

Öz: Bu çalışma, Muğla Sıtkı Koçman Üniversitesi Yerleşkesindeki makromantarları tespit etmek amacıyla yapılmıştır. Araştırma alanımız Muğla ili sınırları içerisindedir. Bu araştırmada, 2014-2021 yılları arasında yapılan arazi çalışmalarında toplanan 1295 makromantar örneğinin değerlendirilmesiyle 50 familya ve 94 cinse ait 143 makromantar türü teşhis edilmiştir.

Anahtar kelimeler: Muğla Sıtkı Koçman Üniversitesi, Kampüs, Makromantarlar, Türkiye

Macrofungi Growing in Mugla Sıtkı Kocman University Campus

Abstract: This investigation was carried out determine macrofungi of Mugla Sitki Kocman University Campus. Research area is situated in provience of Mugla. In this study, during the period 2014-2021, by evaluating the collected 1295 macrofungi specimens, 143 species were identified within 50 families, 94 genera,

Key words: Mugla Sıtkı Kocman Universty, Campus, Macrofungi, Türkiye

Giriş

Muğla Sıtkı Koçman Üniversitesi faaliyetlerine 1992 yılında Muğla il merkezine 6 km uzaklıktaki Kötekli mevkiinde bulunan merkez yerleşkede Dokuz Eylül Üniversitesinden devredilen 168.554 m^2 lik arazi üzerinde başlamıştır. Kampüs alanı Muğla ili sınırları içinde olup coğrafi konum itibariyle 28° 22' 30" doğu boylamları ile 37° 09' 30" kuzey enlemi arasında bulunur. 2.300.000 m^2 (2.300 dönüm) lik bir alanı kapsayan Muğla Üniversitesi kampüsünün 1.000 dönümlük arazisi kısmen kullanılmış olup geriye kalan 1.300 dönümlük arazi kızılçam ormanı (*Pinus brutia* Ten.) ve yeşillik alanları kapsamaktadır (Ceylan, 2009). Kampüs içerisinde Fen Fakültesi önünde yapay bir havuz bulunmaktadır. Ayrıca Kampüs içerisinde yağmur suyu toplama havuzu yapılmaktadır. Kampüste toplam 244.633 m^2'lik kapalı alan bulunmaktadır (Şekil1).

Şekil 1. Araştırma alanının haritası ("Google Earth Pro" dan uyarlandı, 20.03.2022).

Kampüsün Jeolojik Yapısı alanını da içine alan Muğla polyesi ve çevresinde, MTA tarafından hazırlanmış jeoloji haritasına bakıldığında, Permo-Karbonifer yaşlı şistler, Triyas-Eosen yaşlı dolomitik kireçtaşları, Alt-Orta Triyas yaşlı meta-kumtaşı & meta-konglomera ve Liyas yaşlı kireçtaşı dolomitler, Alt Miyosen yaşlı konglomeralar, Üst Miyosen-Pliyosen yaşlı konglomera-kumtaşı-çamurtaşı, Kuvaterner yaşlı alüvyal yelpaze, yamaç molozu ve alüvyonlar gözlenmektedir.

Permiyen yaşlı şist (pş), kuvarsit ve kuvars şist (pq) olarak haritalanan, meta-çakıltaşı, şist-kuvarsit üste doğru mermerlerden oluşan birim, Aktimur ve diğ. (1996) tarafından Kavaklıdere Grubu adıyla anılmaktadır. (Aktimur ve diğ., 1996; Göktaş, 1982).

Literatürde Marçal grubu olarak adlandırılan ve jeoloji haritasında Orta Triyas-Liyas dolomitlerinin (t2j1-9-s), olarak gösterilen birim içerisinde, Yeniköy güneydoğusunda Kampaniyen-Maastrihtiyen çörtlü kireçtaşları, dolomit, fosilli kireçtaşları, flişler ve kırınıtlı çökeller ayırtlanmıştır Aktimur ve diğ., 1996; Göktaş, 1998).

Jeoloji haritasında Alt-Orta Triyas kumtaşı-çamurtaşı-kireçtaşı (t2-20-k) ve Üst Triyas-Liyas çakıltaşı-kumtaşı-çamurtaşı (t3j1-18-k) ve Alt Triyas yaşlı meta-kumtaşı-meta-çakıltaşı-meta-pelit (t1dm) bu olarak ayrılan birimlerin Ören Grubuna ait birimler olduğu düşünülmektedir (Aktimur ve diğ., 1996; Göktaş, 1982). Liyas yaşlı dolomitik kireçtaşı, pelajik-yarıpelajik kireçtaşı (Mandalya Formasyonu) Gereme Formasyonu olarak adlandırılan birim (Aktimur ve diğ., 1996) kampüs alanının üzerine kurulduğu birimdir. Kampüs içerisinde, bol kırıklı-çatlaklı olan birim, büyüklüğü ve tipleri değişken karstik boşluklu kristalize kireçtaşı, dolomitik kireçtaşlarından oluşmaktadır.

Yukarıda listelenen yaşlı birimler üzerine uyumsuz olarak gelen Neojen birimleri Akçay Grubu altında değerlendirilen Alt Miyosen-Akitaniyen Kerme Formasyonu (çakıltaşı, kumtaşı, çamurtaşı) ile, Muğla Grubu altında değerlendirilen Pliyosen yaşlı çakıltaşı, kumtaşı, çamurtaşı (pl-18-k) ibaret Yatağan Formasyonu bulunmaktadır (Göktaş, 1982).

Bu birimler Kuvaterner yaşlı alüvyal yelpaze, alüvyon ve yamaç molozları ile örtülmektedir (Gül ve diğ., 2013, 2015). Kampüs alanında ağırlık olarak kırmızı renkli lateritik toprağa rastlanmaktadır.

Araştırma alanımızın tamamı Akdeniz Fitocoğrafya bölgesine girmekte olup, başlıca üç önemli vejetasyon tipi görülmektedir. Alandaki önem sıralarına göre bu vejetasyon tipleri şunlardır: Orman Vejetasyonu: Bu vejetasyon yükseltiye ve bakıya göre 620 m'den 800 m'ye kadar farklı zonlarda bulunmaktadır. Ağaç katının genel bitkileri *Pinus brutia* Ten., *Cupressus sempervirens* L.'dir. Maki vejetasyonu: Bu vejetasyon tipi 600-700 m'ler le kızılçam ormanlarının tahribi sonucu lokal alanlarda yayılış göstermektedir. Bu katın belirgin bitkileri *Juniperus oxycedrus* L. subsp. *oxycedrus*, *Quercus coccifera* L., *Cistus creticus* L., *Pistacia terebinthus* L'dir. Step vejetasyonu: Bu vejetasyon tipi 620 m'ler den başlayarak alanın en üst noktası olan 700 m'lere kadar çıkmaktadır. Bu katın belirgin bitki türleri *Bromus hordeaceus* L. subsp. *hordeaceus*, *Minuartia hybrida* (Vill.) Schischk. subsp. *turcica* Mcneill, *Phlomis bourgaei* Boiss., *Cerastium brachypetalum* Pers. subsp. *roeseri* (Boiss.& Heldr.) Nyman, *Astragalus condensatus* Ledeb., *Centaurea solstitialis* L. subsp. *solstitialis*, C. *cyanus* L., *Gaqlium heldreichi* Hal., *Scorzonera cana* (C.A.Meyer) Hoffm. var. *jacquiniana* (W.Koch) Chamberlain dir (Ceylan, 2009).

Bu bitkilerin haricinde kampüste peyzaj çalışmaları kapsamında dikilen süs bitkileri vardır. Araştırma alanında yaygın olarak yetişen ve makromantarların yayılışında doğrudan etkili olan ağaç ve çalı türleri ise; *Tilia argentea* Desf. ex. DC. (ıhlamur), *Elaeagnus angustifolia* L (iğde), *Thuja orientalis* L. (mazı), *Pinus pinea* L. (fıstık çamı), *Pinus halepensis* Mill. (halep çamı), *Cedrus libani* A.Richard (lübnan sediri), *Cupressus macrocarpa* Hartw. ex Gord. (limon servi), *Cupressus sempervirens* L. (adi servi), *Juniperus horizontalis* Moench (yayılıcı ardıç), *Ligustrum vulgare* L. (kurtbağrı), *Olea europaea* L. var. *europaea* (zeytin), *Forsythia intermedia* Lynwood. (altın çanak), *Juglans regia* L. (ceviz), *Vitis vinifera* L. (asma), *Partherociscus quinque* Jolia Planch (amerikan sarmaşığı), *Mespilus germenica* L. (muşmula), *Pyracantha coccinea* Roemer. (ateş dikeni), *Pyrus communis* L. (armut), *Rosa canina* L. (gül), *Cydonia oblanga* Mill. (ayva), *Amygdalis communis* L. (badem), *Malus slyvestris* Miller subsp. *orientalis* (A.Uglitzkich) Browicz (yaban elma), *Cotoneaster horizontalis* Decne. (dağ muşmulası), *Cotoneaster salicifolia* (J.P. Paulin) (söğüt yapraklı dağ muşmulası), *Punica granatum* L. (nar), *Vicia faba* L. (bakla), *Wistaria sinensis* Sweet. (mor salkım), *Robinia pseudoacacia* L. (yalancı akasya), *Caesalpinia gillesii* Wall. (cennet çiçeği), *Cercis siliquastrum* L. subsp. *siliquastrum* (erguvan), *Cassia angustifolia* Vahl. (sinameki), *Nerium oleander* L. (zakkum), *Liquidambar orientalis* Mill. (sığla), *Rosmarinus officinalis* L. (kuşdili, biberiye), *Lavandula angustifolia* Mill.

(lavanta), *Myrtus communis* L. (mersin), *Eucalyptus camaldulensis* Dehnh. (ökaliptüs), *Ficus carica* L. subsp. *carica* (incir, yemiş), *Morus nigra* L. (karadut), *Acer platanoides* L. (*çınar yapraklı akçaağaç*), *Acer palmatum* Thunb. (el yapraklı akçaağaç), *Acer negundo* L. (isfendan), *Euonimus japonica* Luna (Japon taflanı), *Pittosporum tobina* Nana, (pitos), *Ulmus minor* Mill. subsp. *minor* (karaağaç), *Yucca filamentosa* L. (avize ağacı), *Datura stramonium* L. (boru çiçeği), *Lycopersicum esculentum* Miller (domates), *Petunia violacea* Lindl (petunya), *Lagerstroemia indica* L. (oya çiçeği), *Cerastium tomentosum* L. (farekulağı), *Berberis cretica* L. (hanım tuzluğu), *Berberis thunbergii* DC. (hanım tuzluğu), *Ailanthus altissima* Mill. (kokarağaç), *Viburnum tinus* L. (kartopu), *Populus nigra* L. (karakavak), *Salix babylonica* L. (salkım söğüt), *Salix caprea* L. (keçi söğüdü), *Agave americana* L. (sarı sabr), *Catalpa bignonioides* Walt. (sigara ağacı, katalpa), *Mirabilis jalaba* L. (akşamsefası), *Gazania rigens* (L.) Gaertn. (Koyun Gözü), *Cineraria maritima* L. (kül çalısı), *Senecio bicolor* (Willd.) Tod. subsp. *bicolor* (kanarya otu), *Santolina incana* Lam. (lâvantin), *Lobelia erinus* (lobelya-kardinal çiçeği), *Antirrhinum majus* L. (aslanağzı), *Abelia grandiflora* 'Edward Goucher' (güzellik çalısı), *Oenothera biennis* L.(eşek otu), *Hedera helix* L. (duvar sarmaşığı), *Carpinus betulus* L. (gürgen), *Tamarix africana* Poir (ılgın) (Görk ve Ceylan 2010).

Bu çalışmanın amacı araştırma alanı olarak seçilen Muğla Sıtkı Koçman Üniversitesi merkez kampüsü sınırları içerisinde ve çevresinde doğal olarak yetişen makromantar çeşitliliğini belirlenmektir. Üniversite kampüsü doğal bir ortama kurulmuş iken, her geçen gün yerleşim yerlerinin ve kapalı alanların artması ile bu doğal ortam ortadan kalkmakta bu da alandaki bitki ve hayvan çeşitliliğini buna bağlı olarak da mantar biyoçeşitliliğini direk etkilemektedir. Muğla Sıtkı Koçman Üniversitesi yerleşkesinde ilk defa yapılan bu çalışma ile kampüste yetişen mantarları ve lokalitelerinin tespit edilmesi ve ülkemiz mikobiyotasına katkı sağlanması amaçlanmıştır.

Materyal ve Metot

Çalışmanın materyalini oluşturan makromantar örnekleri 2014-2021 yılları arasında Muğla il sınırları sınırları içerisinde bulunan Muğla Sıtkı Koçman Üniversitesi Kampüsü sınırları içerisinden toplanmıştır. Mantar örnekleri genellikle yağışların bol olduğu ilkbahar ve sonbahar aylarında toplanmıştır. Toplanan örneklerin morfolojik ve etnomikolojik özellikleri arazi çalışmaları sırasında not edilerek örneklerin teşhisinde veri olarak kullanılmıştır. Araziden laboratuvara taşınan mantar örnekleri gerekli mikolojik teknikler uygulanarak fungaryum materyali haline getirilmiştir.

Arazi ve laboratuvar çalışmaları sonucunda elde edilen veriler ilgili literatür (Phillips, 1981; Moser, 1983; Buczacki, 1989; Bresinsky ve Besl, 1990; Ellis ve Ellis, 1990; Breitenbach ve Kranzlin, 1986, 1991, 1995; 2000; Jordan, 1995; Dähncke, 2004; Jordan, 2004; Kränzlin, 2005) ile karşılaştırılarak örneklerin teşhisleri yapılmıştır. Teşhis edilen örnekler Muğla Sıtkı Koçman Üniversitesi, Fen Fakültesi, Biyoloji Bölümü Fungaryumunda saklanmaktadır.

Bulgular

Bu çalışma Muğla Sıtkı Koçman Üniversitesi Kampüsü içerisinde doğal olarak yetişen makromantarların tespit edilmesi amacı ile yapılmıştır. Teşhis edilen türler Sesli ve ark., (2020) ve http://indexfungorum.org., veri tabanı baz alınarak sistematik sıraya dizilmiştir.

Ascomycota
Discinaceae
1. *Gyromitra esculenta* Pers. ex Fr.
06.04.2020, Allı 6940.

Elaphomycetaceae
2. *Elaphomyces granulatus* Fr.
19.11.2021, Allı 7036.

Helvellaceae
3. *Dissingia leucomelaena* (Pers.) K. Hansen & X.H. Wang.
06.04.2020, Allı 6943.
4. *Helvella acetabulum* (L.) Quél.
18.03.2017, Allı 6809.

Morchellaceae
5. *Morchella elata* Fr.
07.04.2014, Allı 6414.
6. *Morchella esculenta* (L.) Pers.
06.04.2020, Allı 6942.
7. *Morchella eximia* Boud.
07.04.2014, Allı 6418.

Otideaceae
8. *Otidea concinna* (Pers.) Sacc.
16.11.2019, Allı 6834.

Pezizaceae
9. *Geoscypha violacea* (Pers.) Lambotte
20.03.2019, Allı 6894.
10. *Sarcosphaera coronaria* (Jacq.) J. Schröt.
06.04.2020 Allı 6941.
11. *Peziza depressa* Pers.
18.03.2017, Allı 6817.

Pyronemataceae
12. *Geopyxis carbonaria* (Alb. & Schwein.) Sacc.
20.03.2019, Allı 6893.

Tuberaceae
13. *Tuber aestivum* (Wulfen) Spreng.
13.04.2018, Allı 6863.
14. *Tuber borchii* Vittad.
06.04.2020, Allı 6942.

Basidiomycota
Agaricales
Incertae sedis
15. *Baeospora myosura* (Fr.) Singer
Çam Kozalağı üzeri 30.11.2017, Allı 6835.
16. *Cystoderma amianthinum* (Scop.) Fayod
15.10.2019 Allı 6917.
17. *Cyathus olla* (Batsch) Pers.
Meşe dalı üzeri 23.04.2019, Allı 6904.
18. *Cystodermella granulosa* (Batsch) Harmaja
15.10.2019 Allı 6918.
19. *Infundibulicybe geotropa* (Bull.) Harmaja
30.11.2017, Allı 6838; 25.12.2020, Allı 7003.
20. *Infundibulicybe gibba* (Pers.) Harmaja
30.11.2017, Allı 6837.
21. *Melanoleuca cognata* (Fr.) Konrad & Maubl.
14.11.2021, Allı 7035.
22. *Melanoleuca stridula* (Fr.) Singer
20.12.2021, Allı 7041.
23. *Panaeolus ater* (J.E. Lange) Kühner & Romagn.
30.11.2017, Allı 6840.
24. *Panaeolus olivaceus* F.H. Møller
17.11.2019 Allı 6919.
25. *Panaeolus semiovatus* (Sowerby) S. Lundell & Nannf.
17.11.2019 Allı 6920.
26. *Panaeolus subbalteatus* (Berk. & Broome) Sacc.
30.11.2017, Allı 6841.
27. *Clitocybe costata* Kühner & Romagn.
20.12.2016, Allı 6773.
28. *Clitocybe odora* (Bull.) P. Kumm.
20.12.2016, Allı 6779.
29. *Lepista nuda* (Bull.) Cooke
25.11.2015, Allı 6749.
30. *Rhizocybe vermicularis* (Fr.) Vizzini, P. Alvarado, G. Moreno & Consiglio
20.12.2016 Allı 6877.

Agaricaceae
31. *Agaricus comtulus* Fr.
24.10.2018, Allı 6749.
32. *Coprinus comatus* (O.F. Müll.) Pers.
28.05.2020, Allı 6945.
33. *Lepiota clypeolaria* (Bull.) P. Kumm.
15.10.2019, Allı 6921.
34. *Lepiota erminea* (Fr.) P. Kumm.
09.11.2018, Allı 6883.
35. *Lepiota ignivolvata* Bousset & Joss. ex Joss.
15.10.2019, Allı 6923.
36. *Lepiota oreadiformis* Velen.
14.11.2014, Allı 6185.
37. *Leucoagaricus leucothites* (Vittad.) Wasser
15.10.2019, Allı 6927.
38. *Macrolepiota excoriata* (Schaeff.) Wasser
17.10.2014, Allı 5792.
39. *Macrolepiota procera* (Scop.) Singer
17.12.2021, Allı 7030.
40. *Mycenastrum corium* (Guers.) Desv.
10.05.2019, Allı 6905.
41. *Tulostoma squamosum* (J.F. Gmel.) Pers.
19.12.2020, Allı 7013.
Amanitaceae
42. *Amanita caesarea* (Scop.) Pers.
25.11.2015, Allı 6748, 16.11.2019, Allı 6931.
43. *Amanita pantherina* (DC.) Krombh
13.12.2014, Allı 6217.
44. *Amanita strobiliformis* (Paulet ex Vittad.) Bertill.
16.11.2019, Allı 6933.

Auriculariaceae
45. *Auricularia auricula-judae* (Bull.) Quél.
Akçaağaç gövdesi üzeri, 01.11.2018, Allı 6880.
46. *Auricularia mesenterica* (Dicks.) Pers.
Akçaağaç gövdesi üzeri, 24.10.2018, Allı 6871.

Bankeraceae
47. *Hydnellum peckii* Banker
23.11.2019, Allı 6927.

Bolbitiaceae
48. *Conocybe apala* (Fr.) Arnolds
20.12.2016, Allı 6771.

Boletaceae
49. *Caloboletus calopus* (Pers.) Vizzini
18.11.2016, Allı 6763.
50. *Hemileccinum impolitum* (Fr.) Šutara
18.12.2016, Allı 6770
51. *Neoboletus erythropus* (Pers.) C. Hahn
20.12.2016, Allı 6766.

Crepidotaceae
52. *Crepidotus mollis* (Schaeff.) Staude

İğde ağacı gövdesi üzeri, 30.11.2018, Allı 6884.

Diplocystidiaceae
53. *Astraeus hygrometricus* (Pers.) Morgan
17.12.2021, Allı 7046.

Entolomataceae
54. *Entoloma sericeum* Quél.
07.11.2021 Allı 7034.

Geastraceae
55. *Geastrum fimbriatum* Fr.
17.10.2014, Allı 5808.

Gloeophyllaceae
56. *Gloeophyllum sepiarium* (Wulfen) P. Karst.
Kesik *Pinus brutia* kütüğü üzeri, 06.04.2020, Allı 6939.

Gomphaceae
57. *Ramaria flava* (Schaeff.) Quél.
16.11.2019, Allı 6932.

Gomphidiaceae
58. *Chroogomphus rutilus* (Schaeff.) O.K. Mill.
20.12.2016, Allı 6783.

Hydnaceae
59. *Cantharellus cibarius* Fr.
20.12.2021, Allı 7047.

Hydnangiaceae
60. *Laccaria laccata* (Scop.) Cooke
07.11.2021 Allı 7043.
61. *Laccaria proxima* (Boud.) Pat.
19.11.2021 Allı 7045.

Hygrophoraceae
62. *Hygrocybe conica* (Schaeff.) P. Kumm.
19.12.2021, Allı 7048.
63. *Hygrophorus chrysodon* (Batsch) Fr.
20.12.2021, Allı 7049.

Hymenochaetaceae
64. *Fuscoporia torulosa* (Pers.) T. Wagner & M. Fisch.
Meşe ağacı gövdesi üzeri, 30.04.2015, Allı 6505.
65. *Trichaptum fuscoviolaceum* (Ehrenb.) Ryvarden
Kesik Çam kütüğü üzeri, 07.12.2020 Allı 7009.
Hymenogastraceae
66. *Galerina marginata* (Batsch) Kühner
Yere düşmüş, çam dalları üzeri, 20.12.2016, Allı 6765.
67. *Galerina patagonica* Singer
Çam kütüğü üzeri, 19.12.2021, Allı 7050.
68. *Hebeloma laterinum* (Batsch) Vesterh.
30.11.2018, Allı 6881.
69. *Hebeloma sarcophyllum* (Peck) Sacc.
30.11.2018, Allı 6870.
70. *Psilocybe coronilla* (Bull.) Noordel
07.12.2020 Allı 7011.

Inocybaceae
71. *Inocybe geophylla* P. Kumm.
20.12.2021, Allı 7042.
72. *Inocybe godeyi* Gillet
20.12.2016, Allı 6778.
73. *Inocybe rufuloides* Bon
10.06.2014, Allı 5581.
74. *Inocybe vaccina* Kühner
20.12.2021, Allı 7042.
75. *Inosperma cervicolor* (Pers.) Matheny & Esteve-Rav.
19.11.2021, Allı 7039.
76. *Pseudosperma rimosum* (Bull.) Matheny & Esteve-Rav
20.12.2021, Allı 7039.

Laetiporaceae
77. *Laetiporus sulphureus* (Bull.) Murrill
Badem ağacı gövdesi üzeri, 09.11.2018, Allı 6883; Badem ağacı gövdesi üzeri 16.11.2019, Allı 6930.
78. *Phaeolus schweinitzii* (Fr.) Pat.
Çam kökü üzeri, 06.04.2020, Allı 6938.

Lycoperdaceae
79. *Lycoperdon lividum* Pers**.**
25.02.2015, Allı 6385.
80. *Lycoperdon molle* Pers.
20.12.2021, Allı 7040.
81. *Lycoperdon perlatum* Pers.
04.12.2018, Allı 6888.

Marasmiaceae
82. *Marasmius oreades* (Bolton) Fr.
20.12.2016, Allı 6769.
83. *Marasmius rotula* (Scop.) Fr.
17.10.2014Allı 5783
84. *Marasmius wynneae* Berk. & Broome
20.12.2016, Allı 6768.

Mycenaceae
85. *Mycena epipterygia* (Scop.) Gray
Pinus brutia ağacı gövdesi üzeri, 30.11.2018, Allı 6885.
86. *Mycena pura* (Pers.) P. Kumm.
30.11.2018, Allı 6886.
87. *Mycena rosea* Gramberg
04.12.2018, Allı 6887.
88. *Mycena seynii* Quél.
Çam kozalağı üzeri, 18.11.2016, Allı 6755; 20.12.2016, Allı 6781.
89. *Mycena strobilicola* J. Favre & Kühner

Çam kozalağı üzeri, 20.12.2016, Allı 6782.

Omphalotaceae
90. *Gymnopus dryophilus* (Bull.) Murril
15.04.2018, Allı 6867.
91. *Gymnopus exsculptus* (Fr.) Murrill
Pinus brutia gövdesi üzeri, 30.11.2018, Allı 6878.
92. *Omphalotus illudens* (Schwein.) Bresinsky & Besl.
Meşe ağacı gövdesi üzeri, 25.08.2020, Allı 6988.

Physalacriaceae
93. *Armillaria mellea* (Vahl) P. Kumm.
Akçaağaç kütüğü üzeri, 30.11.2017, Allı 6839.
Pleurotaceae
94. *Hohenbuehelia tremula* (Schaeff.) Thorn & G.L. Barron
Çam gövdesi üzeri, 30.11.2018, Allı 6869.
95. *Pleurotus ostreatus* (Jacq.) P. Kumm.
Kesik kavak gövdesi üzeri,17.10.2014, Allı 5793.
96. *Strobilurus tenacellus* (Pers.) Singer
Çam kozalağı üzeri, 24.10.2018, Allı 6875.

Pluteaceae
97. *Volvopluteus gloiocephalus* (DC.) Vizzini, Contu & Justo
30.11.2018, Allı 6891.

Podoscyphaceae
98. *Abortiporus biennis* (Bull.) Singer
Zeytin ağacı kökü üzeri, 28.11.2021, Allı 7042a.

Polyporaceae
99. *Fomes fomentarius* (L.) Fr.
Akçaağaç gövdesi üzeri, 25.08.2020, Allı 6993.
100. *Lentinus tigrinus* (Bull.) Fr.
Ökaliptus ağacı gövdesi üzeri, 30.09.2017 Allı 6825.
101. *Ganoderma applanatum* (Pers.) Pat.
Meşe ağacı gövdesi üzeri, 25.08.2020, Allı 6989.
102. *Trametes versicolor* (L.) Lloyd
Söğüt ağacı gövdesi üzeri, 16.11.2016, Allı 6568.

Psathyrellaceae
103. *Candolleomyces candolleanus* (Fr.) D. Wächt. & A. Melzer
15.10.2014, Allı 5765.
104. *Coprinellus disseminatus* (Pers.) J.E. Lange
Söğüt ağacı gövdesi üzeri, 18.03.2017, Allı 6807.
105. *Coprinellus micaceus* (Bull.) Vilgalys, Hopple & Jacq. Johnson
18.03.2017, Allı 6808.
106. *Coprinellus xanthothrix* (Romagn.) Vilgalys, Hopple & Jacq. Johnson
20.11.2014, Allı 6202.
107. *Coprinopsis atramentaria* (Bull.) Redhead, Vilgalys & Moncalvo
26.09.2014, Allı 5609.
108. *Coprinopsis picacea* (Bull.) Redhead, Vilgalys & Moncalvo
25.10.2014, Allı 5821.
109. *Psathyrella prona* (Fr.) Gillet
15.10.2014, Allı 5761.

Rhizopogonaceae
110. *Rhizopogon luteolus* Fr.
20.12.2016, Allı 6772.
111. *Rhizopogon roseolus* (Corda) Th. Fr.
24.10.2014, Allı 5837.
Russulaceae
112. *Lactarius chrysophyllus* Z. Schaef.
01.11.2018, Allı 6881.
113. *Lactarius deterrimus* Gröger
01.11.2018, Allı 6882.
114. *Lactarius deliciosus* (L.) Gray
25.10.2014, Allı 5828.
115. *Lactarius semisanguifluus* R. Heim & Leclair
01.11.2018, Allı 6889.
116. *Russula delica* Fr.
01.11.2018, Allı 6890.
117. *Russula squalida* Peck
17.10.2014, Allı 5782.
118. *Russula torulosa* Bres.
16.11.2019, Allı 6934.
119. *Russula turci* Bres.
15.11.2019, Allı 6928.
120.*Russula vinosa* Lindblad
15.11.2019, Allı 6929.
Schizophyllaceae
121.*Schizophyllum commune* Fr.
Çam gövdesi üzeri, 08.02.2015, Allı 6366; 20.12.2016, Allı 6788; Ihlamur ağacı gövdesi üzeri, 04.04.2019, Allı 6896; Elma gövdesi üzeri, 06.04.2020, Allı 6944.

Sclerodermataceae
122.*Scleroderma verrucosum* (Bull.) Pers.
07.11.2020, Allı 7014.
123. *Pisolithus arhizus* (Scop.) Rauschert
17.11.2016, Allı 6751.

Stereaceae
124. *Stereum hirsutum* (Willd.) Pers.
Meşe ağacı gövdesi üzeri, 24.08.2020, Allı 6984.

Strophariaceae
125. *Deconica pratensis* (P.D. Orton) Noordel.
17.10.2014, Allı 5781.
126. *Hypholoma acutum* (Sacc.) E. Horak
Meşe ağacı üzeri, 15.10.2019, Allı 6922.
127. *Pholiota carbonaria* (Fr.) Singer

Çam ağacı kökleri üzeri, 15.10.2019, Allı 6917.
128. *Stropharia aeruginosa* (Curtis) Quél.
16.11.2019, Allı 6935.

Suillaceae
129. *Suillus bellini* (Inzenga) Kuntze
24.10.2018, Allı 6879.
130. *Suillus collinitus* (Fr.) Kuntze
24.10.2018, Allı 6880.
131. *Suillus granulatus* (L.) Roussel
24.10.2018, Allı 6875.

Tapinellaceae
132. *Tapinella panuoides* (Fr.) E.-J. Gilbert
Çam kütüğü üzeri, 19 Aralık 2020, Allı 7008

Thelephoraceae
133. *Phellodon niger* (Fr.) P. Karst.
20.03.2019, Allı 6895.
134. *Thelephora terrestris* Ehrh. ex Fr.
01.04.2020, Allı 6936.

Tremellaceae
135. *Tremella mesenterica* Retz.
Akçaağaç dalı üzeri, 04.05.2021, Allı 7016.

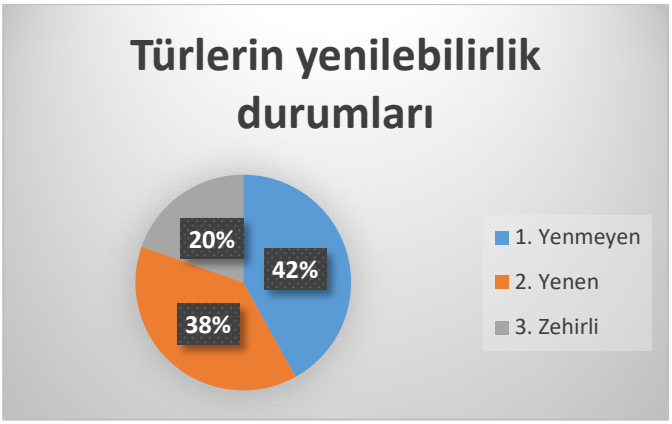
Tricholomataceae
136. *Tricholoma albobrunneum* (Pers.) P. Kumm.
27.11.2014, Allı 5842.
137. *Tricholoma batschii* Gulden
13.12.2014, Allı 6223.
138 *Tricholoma caligatum* (Viv.) Ricken
25.12.2020, Allı 7014.
139. *Tricholoma terreum* (Schaeff.) P. Kumm.
18.11.2016, Allı 6753; 07.12.2017, Allı 6857; 17.12.2021, Allı 7043.
140. *Tricholoma triste* (Scop.) Quél.
10.12.2014; Allı 6220.

Tubariaceae
141. *Cyclocybe cylindracea* (DC.) Vizzini & Angelini
Kesik kavak gövdesi üzeri,16.11.2019, Allı 6926.
142. *Tubaria furfuracea* (Pers.) Gillet
04.12.2018, Allı 6886.
143. *Tubaria romagnesiana* Arnolds
20.12.2016, Allı 6767.

Tartışma

Muğla Sıtkı Koçman Üniversitesi merkez kampüsü yerleşkesinde doğal olarak yetişen makromantarlar üzerinde yapılan bu çalışma ile 50 familyaya ait, 143 makromantar türü teşhis edilerek belirlenmiştir.

Tespit edilen toplam 143 türün 55 'i yenen, 60'ı yenmeyen ve 28'i zehirli olarak belirlenmiştir. Yenen türler toplam türlerin %38'ini, yenmeyenler %42'sini ve zehirli türler ise %20'sini oluşturmaktadır (Şekil 2).



Şekil 2. Tespit edilen türlerin yenilebilirlik durumları

Yenen türlerden; *Morchella elata, M. esculenta, M. eximia*, türleri Muğla ve civarında "kuzu göbeği" adı ile *Lactarius deliciosus*, *L. semisanguifluus* türleri "çıntar" adı ile *Russula delica* "akçıntar" adı ile *Lepista nuda* "mavi cincile" adı ile tanınır ve sevilerek tüketilirler. Hepsi çıntar olarak bilinen *Lactarius* spp. türleri sonbahar aylarında gerek akademik gerekse idari personel, bazende dışarıdan insanlar tarafından kampüs sınırları içerisinde bol miktarda toplanarak tüketilmektedir. Ayrıca yöresel pazarlarda da çok satılan ve sevilerek yenen çıntarın 2021 yılında kg fiyatı yöre pazarlarında ilk çıktığında 250-300 TL' iken yağışlara bağlı olarak miktarının artması ile bu rakam 50-70 TL ye kadar düştüğü tespit edilmiştir Kuzu göbeği olarak bilinen *Morchella* sp. türleri ise; ilkbahar aylarında mantar meraklısı üniversite personeli tarafından kampüs içerisinde toplamak için öğle aralarında bile aranırken aşırı ve bilinçsiz toplanması sonucu çok fazla miktarda bulunduğu söylenemez. *Pleurotus ostreatus* ise; "kavak mantarı" olarak çok az kişi tarafından bilinmekte ve tüketilmektedir.

Literatüre göre zehirli olarak bilinen (Bresinsky ve Besl 1990) *Gyromitra esculenta* bölgede "kuzugöbeği ebesi", *Sarcosphaera coronaria* ise "çanak" yöresel adları ile tanınmakta ve kampüs içerisinde toplanarak iyice pişirildikten sonra tüketilmektedir. *Gyromitra esculenta* da zehirli bileşikler monometilhidrazinlerdir. Çiğ olarak yendiğinde zehirlenme meydana gelmesinin yanı sıra, aşçılarda monometilhidrazinin kaynama noktasının düşük olması ve kolaylıkla buharlaşması nedeniyle pişirme sırasında kolaylıkla zehirlenmeler gelişebilir (Hoelzer, 1993). Sadece birkaç zehirli mantar için geçerli olan ve sıcaklıkla yapısı bozulabilen bir özelliğe sahip bu

mantarların çok iyi kaynatılması sonucu zehir yapısının bozulduğu ve insanları zehirlemediği düşünülmekte, diğer zehirli mantarlar için bu kesinlikle geçerli değildir.

Muğla'nın merkez ilçesi Menteşe ve üniversite kampüsü içerisinde doğal mantarlardan en bol olarak toplanan "çıntar" türleri halk tarafından çok sevilmekte ve mantardan farklı olarak nitelendirilmektedir. Yöre halkına göre; "çıntar ayrı, mantar ayrıdır. Çıntar yenir ama mantar yenmez! hatta mantar zehirlidir" şeklinde yaygın bir inanışa sahiptirler. Bu da halkın bölgede çıntar mantarı dışında mantar yememesine diğer doğal mantarlara şüpheli yaklaşmasına neden olmaktadır. Bunun sonucu olarak bölgemizde çok fazla mantar zehirlenme vakası olmamaktadır. Genel olarak zehirlenme vakaları bölgeye dışarıdan gelen insanların böyle bir ayrım yapmadan rastgele doğadan topladıkları mantarı bilinçsiz bir şekilde yemesi sonucu zehirlenmelerine hatta ölmelerine neden olmaktadır (Huddam ve ark., 2021).

Kampüs içerisinde belirlenen 143 makromantar içinde en fazla tür içeren familyalar sırasıyla; Agaricaceae 11, Russulaceae 9, Psathyrellaceae 7, Inocybaceae 6, Tricholomataceae, Hymenogastraceae, Mycenaceae ve Polyporaceae 4'er tür ile temsil edilmektedir. Bu familya üyelerinin fazla yayılış göstermesi özellikle bölgenin iklimsel özellikleri ve bitki örtüsünden kaynaklandığı düşünülmektedir. Diğer 42 familya ise; 4 ve 4 ün altında tür sayısına sahiptir.

Tespit edilen türlerin habitat ve substratlarının ülkemizde yapılan benzer çalışmalarda belirtilen türlerle uyum içinde olduğu görülmektedir.

Tablo 1'de bu çalışmada tespit edilen mantarlar (Muğla Sıtkı Koçman Üniversitesi kampüsü) çalışma alanına yakın bölgelerde yapılan benzer çalışmalarla karşılaştırılmıştır. Bunlar: Muğla ve tüm ilçelerini içeren bir çalışma (Güngör ve ark., 2016), Aydın ve tüm ilçelerini içeren bir çalışma (Allı ve ark., 2007), Honaz Dağı-Denizli (Gezer ve ark., 2007), Köyceğiz-Muğla (Demirel ve Allı, 2019), Datça Yarımadası-Muğla (Tırpan ve ark., 2018) makromantarları üzerine yapılan bir çalışmadır. Muğla ili genelinde yapılan diğer çalışmalar ile çevre illerde belirlenen makromantarlar üzerine yapılan çalışmalar ile Sorensen Benzerlik İndeks kullanılarak benzerlik bakımından karşılaştırılmıştır (Southwood, 1978). Buna göre; makromantarlar açısından en büyük benzerlik %42 ile Güngör ve ark. (2016) Muğla ve tüm ilçelerinde tespit ettikleri mantarların listesinin olduğu çalışma ile benzerlik gösterirken, en düşük benzerlik ise %40 ile Tırpan ve ark. (2018) Muğla ilinin Datça ilçesinde yapılan makrofungal çalışmada tespit edilmiştir. Bu benzerlik ve farklılıklarda çalışma alanlarındaki iklim ve bitki örtüsünün etkili olduğu söylenebilir. Araştırma bölgesi yüzölçümü olarak çok küçük olmasına rağmen içerisinde bulunan doğal orman formasyonu açısından zengin olması sebebiyle yakın bölgelerle karşılaştırıldığında küçüklüğüne rağmen makromantar çeşitliliği bakımından oldukça zengin olduğu söylenebilir. Bu çalışma ile Muğla Sıtkı Koçman Üniversitesi kampüsün de yetişen makromantarlar belirlenerek, Muğla ve Türkiye makromantarlarına katkı sağlanmaya çalışılmıştır.

Tablo 1. Belirlenen türlerin araştırma yöresine yakın bölgelerde yapılmış olan çalışmalarla benzerlik durumu

Çalışma Adı	Toplam takson sayısı	Benzer tür sayısı	Benzerlik oranı (%)
Muğla ve tüm ilçeleri (Güngör ve ark. 2016)	**211**	**76**	**0.42**
Aydın ve tüm ilçeleri (Allı ve ark. 2007)	**226**	**75**	**0.40**
Honaz Dağı-Denizli (Gezer ve ark. 2007)	**109**	**48**	**0.38**
Köyceğiz-Muğla (Demirel ve Allı 2019)	**125**	**47**	**0.35**
Datça Yarımadası-Muğla (Tırpan ve ark. 2018)	**99**	**39**	**0.32**
Sørensen-Dice Benzerlik İndeksi (**Bs**): **2C/A+B**. **A**: A alanındaki takson sayısı, **B**: B alanındaki takson sayısı, **C**: A ve B alanlarındaki ortak takson sayısı (Southwood 1978).			

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Metal and Radioactive Elements Uptake of Wild *Agaricus* and *Agrocybe* Species Growing in Samanlı Mountains (Türkiye)

Hasan Hüseyin DOĞAN[1*], Murad Aydın ŞANDA[2]

**Sorumlu yazar: hhuseyindogan@yahoo.com*

[1] Selcuk University Science faculty Biology Department, Campus, Konya/Türkiye
Orcid ID: 0000-0001-8859-0188/hhuseyindogan@yahoo.com
[2] Muş Alparslan University, Science and Letter Faculty, Molecular Biology and Genetic Department, Muş/Türkiye
Orcid ID: 0000- 0001-8843-4361/ muradsandak@gmail.com

Abstract: Twenty-two element contents were analyzed by ICP-AES equipment in five wild *Agaricus* and *Agrocybe* taxa [*Agaricus bresadolanus* Bohus, *A. sylvicola* (Vittad.) Peck, *A. xanthodermus* Genev., *Agrocybe paludosa* (J.E. Lange) Kühner & Romagn. ex Bon and *Agrocybe praecox* (Pers.) Fayod] from Samanlı Mountains of Türkiye. The element uptake was observed at the different levels in each *Agaricus* and *Agrocybe* species. The highest Pb and P concentrations were determined as 16.74 mg/kg and 1.501 mg/kg in *A. sylvicola* and *A. bresadolanus* respectively. Ag, Hg, and P concentrations were determined as 30685 µg/kg, 59781 µg/kg, and 501 mg/kg in A. bresadolanus respectively. *A. sylvicola* has the highest Ni, Cu, and Mn concentrations as 37.1, 43.63 and 1476 mg/kg respectively, whereas *A. praecox* has the highest Mo, Ni and P at 0.54 mg/kg, 10.20 mg/kg, and 27.9% respectively. *A. paludosa* has the highest Zn, Cd, and Ba concentrations of 336.8, 2.26, and 571.5 mg/kg. The highest K concentration was found in A. xanthodermus with 5.31 mg/kg.

According to WHO and FAO criteria, there is no important risk for the element uptake for human health if these species would be consumed. Additionally, some radioactive metals were found in mushroom species such as Sr, V, Th, Sc, Ga, and U. People should be careful against radioactive pollution if they consume mushrooms naturally.

Key words: *Agaricus*, *Agrocybe*, ICP-AES, element uptake, radioactivity, Türkiye.

Samanlı Dağları'nda (Türkiye) Yetişen *Agaricus* ve *Agrocybe* Türlerinin Metal ve Radyoaktif Element Alımı

Öz: Türkiye'nin Samanlı Dağlarında yetişen beş doğal *Agaricus* ve *Agrocybe* taksonunda [*Agaricus bresadolanus* Bohus, *A. sylvicola* (Vittad.) Peck, *A. xanthodermus* Genev., *Agrocybe paludosa* (J.E. Lange) Kühner & Romagn. ex Bon ve *Agrocybe praecox* (Pers.) Fayod] ICP-AES metodu ile yirmi iki element içeriği analiz edilmiştir. *Agaricus* ve *Agrocybe* türlerinin her birinde farklı seviyelerde element alımı gözlemlendi. En yüksek Pb ve P konsantrasyonları sırasıyla *A. sylvicola* ve *A. bresadolanus*'ta 16.74 mg/kg ve 1.501 mg/kg olarak belirlendi. *A. bresadolanus*'ta Ag, Hg ve P konsantrasyonları sırasıyla 30685 µg/kg, 59781 µg/kg ve 501 mg/kg olarak belirlendi. *A. sylvicola* sırasıyla 37.1, 43.63 ve 1476 mg/kg ile en yüksek Ni, Cu ve Mn konsantrasyonlarına sahipken, *A. praecox* 0.54 mg/kg, 10.20 mg/kg ve %27.9 ile en yüksek Mo, Ni ve P konsantrasyonlarına sahiptir. *A. paludosa* 336.8, 2.26 ve 571.5 mg/kg ile en yüksek Zn, Cd ve Ba konsantrasyonlarına sahiptir. En yüksek K konsantrasyonu 5.31 mg/kg ile *A. xanthodermus*'da bulunmuştur.

WHO ve FAO kriterlerine göre bu türlerin tüketilmesi durumunda element alımı için insan sağlığı açısından önemli bir risk bulunmamaktadır. Ayrıca Sr, V, Th, Sc, Ga ve U gibi bazı radyoaktif metaller mantar türlerinde bulunmuştur. İnsanlar, mantarları doğal yollarla tüketirken radyoaktif kirliliğe karşı dikkatli olmalıdır.

Anahtar kelimeler: *Agaricus*, *Agrocybe*, ICP-AES, element alımı, radyoaktivite, Türkiye.

Introduction

People have used macrofungi as food or treatments for some diseases for centuries. They can grow spontaneously in nature, and some species can be cultured. Naturally, grown species can be classified as poisonous, edible, or inedible. Toxins of the poisonous mushrooms can damage the intestine, the lungs, and the central nervous system (Seeger and Stijve, 1980). Edible macrofungi species have important vitamins and mineral substances for human health. While 92 % of the fresh mushrooms have water, 8 % of the remaining portion of them contains protein, fat, carbohydrate, vitamins, calcium, phosphorus, potassium, iron, copper, fiber, ash, etc (Matilla et al., 2002).

Macrofungal species are also a rich mineral resource. Especially, mushrooms can accumulate some essential minerals, and they can be beneficial for people with mineral deficiency. Minerals are grouped as macro (calcium, phosphorus, potassium, sulfur, chlorine, sodium, and magnesium) and micro minerals (iron, manganese, cobalt, copper, zinc, molybdenum, vanadium, chromium, tin, fluorine, silicon, selenium, and iodine). Micro mineral amounts in living organisms are extremely low due to the presence of trace elements. Despite iron, manganese, cobalt, copper, zinc, molybdenum, vanadium, chromium and tin are metals fluorine, silicon, selenium, and iodine are non-metals. Elements that have been classified as essential, beneficial, or detrimental are necessary for the survival and health of animals and humans (Doğan et al., 2006). Mushrooms are valuable health diets and have low in calories, and high in vegetable proteins, iron, zinc, chitin, fiber, vitamins, and minerals (Demirbaş, 2001). The contents of mushrooms range from crude protein 3.6-39.9 (% DM), crude fat content 0.5-6.3 (% DM), and carbohydrate 39-91 (% DM) (Vetter, 2019). Numerous data on the contents of major elements, and especially trace elements have been available in the literature (Kalač 2010; Kalač, 2012).

Wild-growing mushroom consumption is preferred over cultivated species in many central and Eastern Europe countries. Collection of the mushroom in nature has recently become a highly valued recreational activity in these countries as a lasting part of cultural heritage (Kalač, 2010). Mushrooms have also been picked up in Türkiye's forests [especially *Fagus orientalis* Lipsky. (Doğu kayını), *Carpinus betulus* L. (Gürgen), *Castanea sativa* Mill. (Kestane), *Abies* spp. (Göknar), *Quercus* spp. (Meşe), and *Pinus* spp. (Çam) forests from Marmara Region]. When collecting mushrooms from nature, attention should be paid to the metal contents and the mushrooms collected from contaminated areas should not be consumed. Some authors have reviewed the literature about the heavy metal concentration in mushrooms and have presented few data about the metal concentration in mushrooms from Agaricus genera (Tüzen et al., 1998; Michelot et al., 1998; Kalać and Svoboda, 2000; Cocchia et al., 2006; Tüzen et al., 2007; Melgar et al., 2009) and Agrocybe (Tüzen et al., 1998; Michelot et al., 1998; Kalać and Svoboda, 2000; Melgar et al., 2009). Although naturally grown mushrooms are consumed a lot in the research area, there is no study on the element contents. The main purpose of this study is to determine the harmful or beneficial aspects of some of the mushrooms in the region by doing an element analysis.

Material and Metod

Mushrooms were collected from the Samanlı Mountains, which are located on the northwest side of Türkiye. To identify the samples, the habitat and morphological characteristics of the mushrooms in the localities were noted and photographed. The spore prints of mushroom samples were obtained and spore measurements were determined in the laboratory. Some reagents such as Melzer's reagent, 5% KOH, HNO3, Aniline, etc were used as chemical substances. Samples were identified by using reference books (Moser 1983, Breitenbach & Kränzlin 2000). A voucher sample for each species is kept at Selcuk University, Mushroom Application and Research Centre, Konya/Türkiye.

Identified samples were cleaned, and cut into slices, and the samples were washed with deionized water. Each sample was dried at 50°C overnight and crushed in a mortar and pestle. Digestion of mushroom samples was performed using an oxi-acidic mixture of HNO_3: H_2SO4: H_2O_2 (4: 1 : 1: 12 mL for 2 to 4-g sample) and heating at 75°C for 3 h. After cooling, 20 mL of deionized water was added and the digest was again heated up to 150°C for 4 h and brought to a volume of 25 mL with deionized water. The metal content of the mushroom samples was determined by ICP-AES (Varian Vista Ax Model). The equipment automatically yielded triplicates for each sample, averaged the data, and calculated the relative standard deviations.

Localities, habitat, and collection numbers of the species are given in Figure 1 and Table 1.

In addition, the Turkish names of the species are given in Table 1 according to Sesli et al. (2020).

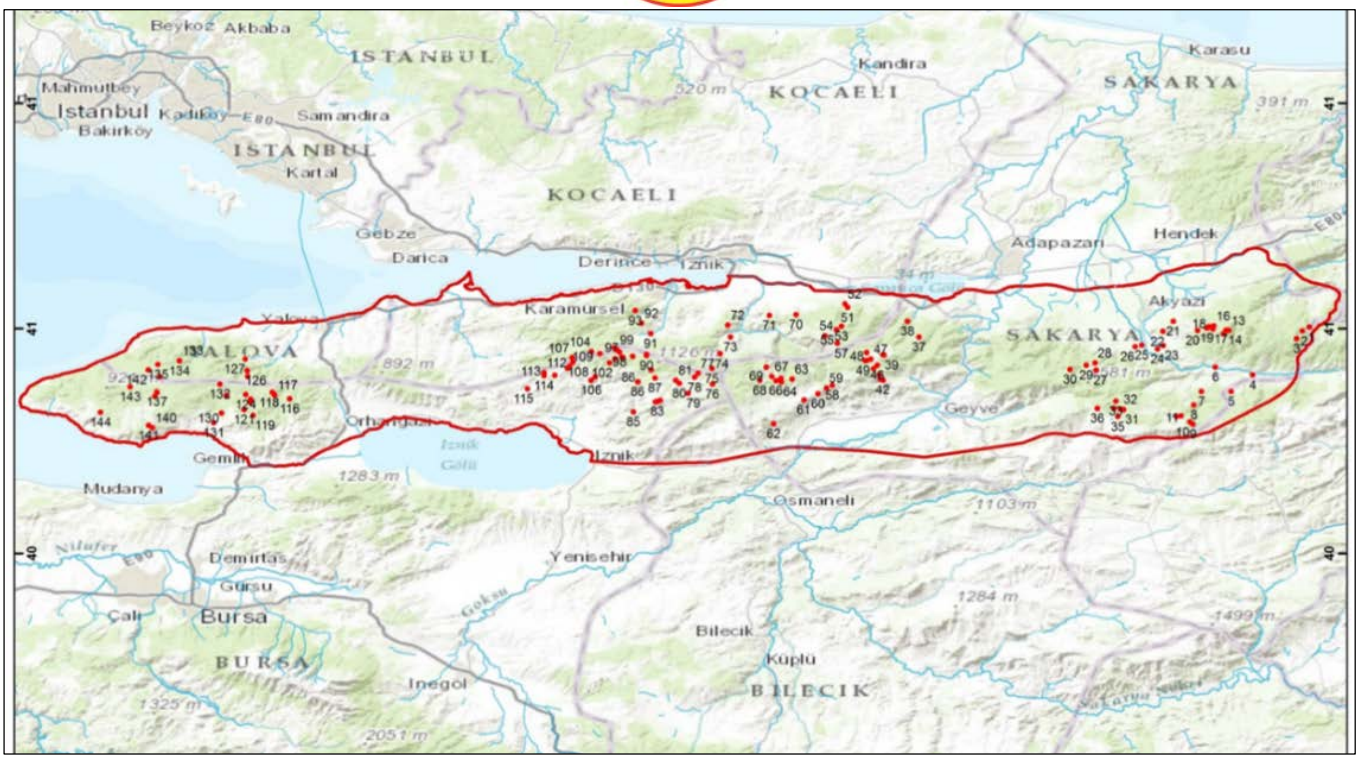

Figure 1. The localities in the study area.

Table 1. The localities and habitats of the mushroom samples.

Locality No	Taxa and Turkish names)	Province	District	Location	Habitat	Coordinate	Altitude
93	*A. sylvicola* (Boylu Kızıl)	Sakarya	Geyve	Şimşirlik boğazı	*Abies nordmanniana* subsp. *bornmuelleriana* and *Buxus sempervirens* forest	40°30'55N-30°33'54E	1250m
120	*A. sylvicola* (Boylu Kızıl)	Sakarya	Geyve	Şimşirlik boğazı	*A. nordmanniana* subsp. *bornmuelleriana, B. sempervirens* forest	40°30'55N-30°33'54E	1250m
22	*A. bresadolanus* (Halkalıkızıl)	Sakarya	Akyazı	Soğuksu	*A. nordmanniana* subsp. *bornmuelleriana* forest	40°39'06N-030°43'37E	930m
117	*A. xanthodermus* (Ağulu kızıl)	Kocaeli	Yuvacık	İnönü plateau	*A. nordmanniana* subsp. *bornmuelleriana, Quercus* sp. forest	40°34'12N-030°00'17E	1065m
107	*A. paludosa* (Yaş metelik)	Sakarya	Geyve	Karagöl plateau, Mahdumlar village	*A. nordmanniana* subsp. *bornmuelleriana, Carpinus orientalis, F. orientalis, B. sempervirens* forest	40°30'17N-030°34'39E	1150m
26	*A. paludosa* (Yaş metelik)	Sakarya	Geyve	Karagöl plateau, Mahdumlar village	*A. nordmanniana* subsp. *bornmuelleriana, C. orientalis, F. orientalis, B. sempervirens* forest	40°30'17N-030°34'39E	1150m
88	*A. paludosa* (Yaş metelik)	Sakarya	Geyve	Acıelma	*F. orientalis, C. orientalis* forest	40°35'49N-030°10'60E	1060m
161	*A. praecox* (Bahar meteliği)	Kocaeli	Suadiye	Altıoluk plateau, Kuzuyayla, in national park	*F. orientalis* forest	40°37'28N-030°07'06E	1325m
33	*A. praecox* (Bahar meteliği)	Sakarya	Akyazı	Dokurcun, Dikmentepe	*A. nordmanniana* subsp. *bornmuelleriana* forest	40°39'03N-030°53'28E	1350m

Results

Element concentrations of the species (*Agaricus bresadolanus*, *A. sylvicola*, *A. xanthodermus*, *Agrocybe paludosa*, and *A. praecox*) are given in Table 2.

Table 2. The element content of mushroom taxa in the research area (n=3, S.D. was not presented in the table).

		mg/kg	mg/kg	mg/kg	%	mg/kg	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Locality No	**Taxa**	**Cd**	**Pb**	**Ni**	**Fe**	**Zn**	**Ag**	**Co**	**Cu**	**Mo**	**As**
93	*A. sylvicola*	0.23	3.73	**37.1**	0.165	171.8	298	0.87	13.54	**0.33**	1.3
120	*A.sylvicola*	1.63	16.74	20.1	1.034	174.5	31	7.49	**43.63**	0.31	5.0
22	*A. bresadolanus*	0.45	1.26	10.2	0.205	90.5	**30685**	1.03	41.65	0.25	3.2
117	*A. xanthodermus*	0.18	2.08	3.1	0.046	47.7	95	0.31	5.08	0.25	0.4
107	*A. paludosa*	1.41	1.18	8.4	0.090	**336.8**	53	0.43	17.51	0.11	**405.4**
26	*A. paludosa*	0.22	0.81	4.3	0.025	68.4	2838	0.25	19.30	0.13	6.4
88	*A. paludosa*	**2.26**	1.08	27.3	0.223	73.9	27868	1.93	**72.31**	0.12	0.5
161	*A.praecox*	1.27	12.40	10.5	**1.319**	61.9	236	**10.20**	32.67	**0.54**	3.9
33	*A. praecox*	0.18	**36.61**	1.80	58.8	68	21.1	0.87	338	0.153	1.6

		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	**%**	%	%	mg/kg
Locality No	**Taxa**	**Th**	**Sr**	**Sb**	**Bi**	**Mn**	**K**	**S**	**Ca**	**P**	**V**
93	*A. sylvicola*	0.19	11.7	0.09	0.03	77	2.27	0.12	0.34	0.707	3
120	*A.sylvicola*	1.17	**12.5**	**0.36**	**0.24**	**1476**	3.22	0.12	**0.47**	0.311	22
22	*A. bresadolanus*	0.04	2.1	0.03	<0.02	135	5.14	0.36	0.06	**1.501**	4
117	*A. xanthodermus*	0.11	2.1	0.03	<0.02	163	**5.31**	0.08	0.05	0.490	3
107	*A. paludosa*	0.16	2.8	<0.02	0.03	50	3.11	0.18	0.12	0.403	<2
26	*A. paludosa*	0.02	1.9	<0.02	<0.02	67	2.74	0.14	0.07	0.430	<2
88	*A. paludosa*	0.05	9.4	0.04	<0.02	126	4.10	**0.45**	0.11	0.594	7
161	*A.praecox*	**2.20**	7.3	0.27	0.09	889	2.21	0.08	0.18	0.325	**28**
33	*A. praecox*	0.17	5.2	0.17	<0.02	-	2.74	0.26	0.17	0.745	<2

		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	mg/kg	µg/kg
Locality No	**Taxa**	**La**	**Cr**	**Mg**	**Ba**	**Ti**	**B**	**Al**	**Na**	**U**	**Au**
93	*A. sylvicola*	0.76	4.3	0.104	25.7	47	**8**	0.10	0.004	0.25	<0.2
120	*A.sylvicola*	**10.01**	19.1	**0.282**	91.9	**120**	3	**1.02**	0.004	0.20	**4.0**
22	*A. bresadolanus*	0.28	2.4	0.174	6.0	23	2	0.19	**0.026**	0.02	3.0
117	*A. xanthodermus*	0.31	6.1	0.138	7.3	19	4	0.05	0.006	0.06	<0.2
107	*A. paludosa*	0.56	2.5	0.093	30.1	17	2	0.07	0.007	0.02	<0.2
26	*A. paludosa*	0.10	3.2	0.092	17.0	3	4	0.02	0.014	<0.01	2.0
88	*A. paludosa*	0.25	6.7	0.139	**571.5**	95	<1	0.13	0.002	0.01	0.2
161	*A.praecox*	5.41	**27.9**	0.130	43.0	115	3	0.93	0.003	**0.47**	1.8
33	*A. praecox*	0.45	6.0	0.163	46.4	8	5	0.09	0.011	0.02	0.3

		mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	mg/kg	mg/kg
Locality No	**Taxa**	**W**	**Sc**	**Tl**	**Hg**	**Se**	**Te**	**Ga**
93	*A. sylvicola*	0.1	0.4	0.04	64	0.4	<0.02	0.4
120	*A.sylvicola*	<0.1	2.6	0.11	70	0.3	**0.14**	2.2
22	*A. bresadolanus*	<0.1	0.4	0.08	**5978**	**7.5**	<0.02	0.5
117	*A. xanthodermus*	<0.1	0.3	**0.34**	197	0.1	0.06	0.2
107	*A. paludosa*	<0.1	0.3	0.03	28	0.2	<0.02	0.2
26	*A. paludosa*	<0.1	0.2	<0.02	778	4.7	<0.02	<0.1
88	*A. paludosa*	<0.1	0.8	<0.02	519	0.8	<0.02	0.4
161	*A.praecox*	0.1	**2.7**	0.10	626	1.1	<0.02	**2.8**
33	*A. praecox*	<0.1	0.3	<0.02	128	0.1	<0.02	0.3

Discussions

According to Table 2, the highest element concentrations (14 different elements) was observed on *Agaricus sylvicola*, these elements are Ni with 37.1 mg/kg, Cu with 43.63 mg/kg, Sr with 12.5 mg/kg, Sb with 0.36 mg/kg, Bi with 0.24 mg/kg, M with 1476 mg/kg, Ca with 0.47 %, La with 10.01 mg/kg, Mg with 0.282 mg/kg, Ti with 120 mg/kg, B with 8 mg/kg, Al with 1.02 %, Au with 4 µg/kg and Te with 0.14 Mg/kg. Second is *Agrocybe praecox* with 10 elements, they are Pb with 36.61 mg/kg,

Fe with 1.319 %, Co with 10.20 mg/kg, Mo with 0.54 mg/kg, Th with 2.20 mg/kg, V with 28 mg/kg, Cr with 27.9 mg/kg, U with 0.47 mg/kg, Sc with 2.7 mg/kg, Ga with 2.8 mg/kg. The third are *Agaricus bresadolianus* and *Agrocybe paludosa* with 5 elements for each. These elements are Ag with 30685 µg/kg, P with 1.501%, Na with 0.026%, Hg with 5978 µg/kg, Se with 7.5 mg/kg for *Agaricus bresadolianus*; Cd with 2.26 mg/kg, Zn with 336.8 mg/kg, As with 405.4 mg/kg, S with 0.45 %, Ba with 571.5 mg/kg for *Agrocybe paludosa*. Last, *Agaricus xanthodermus* has the two highest elements; they are K with 5.31 mg/kg and Tl with 0.34 mg/kg.

The highest Ni was observed as 37.1 mg/kg in *A. sylvicola*. There is evidence that nickel is an essential trace element in several animal species, plants, and prokaryotic organisms. Nickel appears to be essential for humans, although no data are available concerning nickel deficiency. Allergic skin reactions are the most common health effect of nickel, affecting about 2% of the male and 11% of the female population. Nickel content in consumer products, possibly in food and water is critical for the dermatological effect. The respiratory tract is also a target organ for allergic manifestations of occupational nickel exposure. Work-related exposure in the nickel-refining industry has been documented to cause an increased risk of lung and nasal cancers. Inhalation of a mixture of oxidic, sulfidic, and soluble nickel compounds at higher than 0.5 mg/m^3 concentrations, which is often considerably higher, for many years has been reported. (Anonymous, 1990).

Foods normally are the major source of Cd intake. Available data indicate that the current intake of cadmium from the foods is most commonly 10–35 µg/d (WHO, 2000). The bioavailability of Cd can be markedly affected by nutritional factors. Low iron status, as determined in serum ferritin levels that are prevalent among women, increases the uptake of cadmium from the gastrointestinal tract. Besides, if Cd binds to phytates, metallothionein, and other proteins, the bioavailability of Cd from some grains, seeds, and foods may be reduced. Usually, people cannot get enough cadmium from water and food sources. Although water is not a major contributor to Cd intake for most individuals, elevated natural Cd levels in water can occur, and resultant Cd intakes can be as high as the dietary contribution. Estimates of mean Cd intake from national food surveys and total diet studies generally ranged from 0.1 to 0.5 µg/kg body weight per day. The estimates derived from the WHO regional diets, based on food balance sheets, range from 0.35 to 0.63 µg/kg body weight per day (WHO, 2000). Estimates of Cd intake (µg/kg body weight per day, assuming a body weight of 60 kg) in the WHO GEMS/Food regional diets for mushrooms is 0.001 (in Europe) and 0 (Middle East, Far East, Africa, and Latin America) (WHO, 2000). The WHO mentions maximum permissible levels in raw plant materials for cadmium as 0.30 mg/kg. The Cd concentrations were observed as 2.26 mg/kg in *Agrocybe paludosa*. This is higher than limit values when we compare with WHO data. Nevertheless, there are some similar data for the macrofungi; the highest Cd concentration among *Agrocybe* taxa was reported as 3.35 mg/kg in *A. praecox* (Michelot et al., 1998). Among *Agaricus* taxa, the highest Cd value was reported in *A. bresadolianus* (Michelot et al., 1998).

Pb has no beneficial role in human metabolism, producing progressive toxicity. Pb is the most toxic heavy metal, and the inorganic forms are absorbed through ingestion by water and food, and inhalation. An especially serious effect of lead toxicity is its teratogenic effect. Pb poisoning also causes inhibition of the synthesis of hemoglobin dysfunctions in the kidneys, joints, reproductive system, cardiovascular system, and chronic damage to the nervous system (Duruibe et al., 2007). The EU maximum permitted level for lead in cultivated mushrooms is 0.3 mg/kg wet weight (European Commission, 2001). Pb was determined as 36.31 mg/kg in *A. praecox* and this level is high according to the EU level.

Iron is the most commonly used element with 4.2% in plants, animals, and people after aluminum. Although it is normally in an insoluble form, it can be a soluble form of iron by many natural reactions and contaminate groundwater (Gray, 1996). The tolerable value is 50-100 mg/kg daily amount in normal people. The lethal dose for an adult human is 100 grams (WHO-FAO, 1996). Fe was determined from some mushrooms in Türkiye by different researchers and it was found as; 341.98±2.58 mg/kg in *Tricholoma terreum*, 84.51 ±5.73 mg/kg in *Coprinus micaceus*, 451.3±4.8 mg/kg in cultured *Pleurotus ostreatus* and 57.1±1.1 mg/kg in naturel *P. ostreatus*, and 264.57 ±17.27 mg/kg in *Morchella esculenta* (Akgül et al., 2016; Sevindik et al., 2016; Eraslan et al., 2021). There is no risk in terms of the highest iron content (1.319%) determined in *A. praecox*.

90% of zinc in the soil is stored in plants. Zinc is an essential mineral for the organism. Zinc has roles in carbohydrate, protein, lipid, nucleic acid, HEM synthesis, gene expression, reproduction, growth, and embryogenesis. It also plays a critical role in the structural and functional integrity of the cells (Belgemen and Akar, 2004). The maximum daily dose in the US is 15 mg/kg for adult men and 12 mg/kg for women (WHO-FAO, 1996). The Zn in *A. bresadolianus* was determined as 336.8 mg/kg and this amount is higher than the literature. Similar results have been obtained in previous studies. These are 107.11±7.82 mg/kg in *Tricholoma terreum*, 51.01±7.42 mg/kg in *Coprinus micaceus*, 134.9±2.1 mg/kg in cultured *Pleurotus ostreatus* and 45.9±0.9 mg/kg in naturel *P. ostreatus* (Akgül et al., 2016; Sevindik et al., 2016). Nevertheless, Zn was found in more lees than the other species with a value of 7.82 ±0.34 in *Morchella esculenta* (Eraslan et al., 2021).

According to WHO, EU standards, and the regulation issued by the Ministry of Health in 2005, the drinking water Hg limit is 1 ppb (µ/l). Airborne particles exceeding 10 mg/m^3 are dangerous for health. Chemical pneumonia may occur at concentrations above 1 mg/m^3. The maximum amount of mercury that can be found in foods was determined as 0.05 mg/kg by FAO/WHO. The weekly tolerable amount (PTWI) according to WHO standard is 0.0016 mg/kg (WHO-FAO 1996). The highest mercury value in *A. paludosa* is 5978 µg/kg and there is no health risk.

Although the average Al content in healthy human tissues in the UK is less than 0.5 µg/g, it is observed as high as 2.6 µg/g in the liver, 18.2 µg/g in the lung, 32.5 µg/g in the lymph nodes and 73.4 µg/g in the bones (WHO 1989; WHO-FAO, 1996). Naturally, occurring aluminum, as well as aluminum salts used as coagulants in drinking water treatment, are the primary sources of aluminum in drinking water. The presence of aluminum at concentrations over 0.1–0.2 mg/L often leads to consumer complaints because of the deposition of aluminum hydroxide floc and the exacerbation of discoloration of water by iron (WHO 2017). Al was determined as 1.02 % in *A. sylvicola*, this level is tolerable.

Besides, some radioactive metals such as Sr, V, Th, Sc, Ga, and U were observed in mushroom species. Overall, radioactive uptake of *A. praecox* is higher than other species with the rates of 28 mg/kg for V, 2.20 mg/kg for Th, 2.7 mg/kg, for Sc, 2.8 mg/kg for Ga, and 0.47 mg/kg for U. Sr (12.5 mg/kg) was only found more in *Agaricus sylvicola*. Radionuclides are naturally present in the environment. They may also enter the environment because of human activities. Natural sources of radiation are responsible for the large majority of radiation exposure (greater than 98%), excluding medical exposure. Additional exposure can result from human activities associated with radioactive materials (Health Canada, 2009). Guidance levels for common natural and artificial radionuclides are 10 Bq/l (Uranium-238), 1 Bq/l (Uranium-234), 1 Bq/l (Thorium-230). The provisional guideline value for the total content of uranium in drinking water is 30 µg/L based on its chemical toxicity, which is predominant compared with its radiological toxicity (WHO, 2017). Samanlı Mountains are very close to industrial areas in Kocaeli and Sakarya regions. Therefore, the risk of chemical, biological and radioactive contamination is very high in regions close to industrial zones.

People should be careful about radioactive and heavy metal pollution when they consume mushrooms naturally.

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Assessment of Cytotoxic Effect of *Porodaedalea pini* Mushroom on Prostate Cancer

Ebru DEVECİ[1*], Gülsen TEL-ÇAYAN[2], Mehmet Emin DURU[3]

**Sorumlu yazar: edeveci@ktun.edu.tr.*

[1] Chemistry and Chemical Processing Technology Department, Technical Sciences Vocational School, Konya Technical University, Konya, Türkiye
Orcid ID: 0000-0002-2597-9898/ edeveci@ktun.edu.tr.
[2] Department of Chemistry and Chemical Processing Technologies, Muğla Vocational School, Muğla Sıtkı Koçman University, Muğla, Türkiye
Orcid ID: 0000-0002-1916-7391/ gulsentel@mu.edu.tr.
[3] Department of Chemistry, Faculty of Sciences, Muğla Sıtkı Koçman University, Muğla, Türkiye
Orcid ID: 0000-0001-7252-4880/ eminduru@mu.edu.tr.

Abstract: *Phellinus* species are in the classification of valuable mushrooms among medicinal mushrooms and have been the source of traditional medicine for centuries. In this study, the hexane (PPH), methanol (PPM) and water (PPW) extracts, fractions and isolated compounds from *Porodaedalea pini* (Çamkavı mantarı) were screened for their cytotoxic effects on PC3 (prostate cancer) and 3T3 (murine fibroblast) cell lines by MTT assay. PPH was found to have moderate cytotoxicity on PC3 cell with the IC_{50} values of 33.84±0.01 µg/mL. The fatty acid profile of PPH was identified by GC-FID (gas chromatography-flame ionization dedector) and GC-MS (gas chromatography-mass spectrometry) and the main fatty acids were recorded as palmitic (41.40±0.03%), linoleic (21.53±0.01%), oleic (12.06±0.01%), and stearic (8.20±0.01%) acids. PPM and PPW were fractioned by using liquid-liquid extractions. Among all fractions, the 2-butanol fraction of the methanol extract (PPM-B) indicated the best cytotoxicity on PC3 and 3T3 cell lines. Also, among the isolated compounds (dioctyl phthalate (**1**), ergosterol peroxide (**2**) and pinoresinol (**3**)) from PPM, ergosterol peroxide (**2**) was found as moderate cytotoxic on PC3 with the IC_{50} value of 95.47±1.01 µg/mL. This study, in which the effect of *P. pini* on PC3 cell was examined for the first time, proved its medicinal importance by revealing the cytotoxic properties of the species.

Key words: *Porodaedalea pini,* Prostate cancer, Extract, Fatty acid, Isolation

Porodaedalea pini Mantarının Prostat Kanseri Üzerindeki Sitotoksik Etkisinin Değerlendirilmesi

Öz: *Phellinus* türleri şifalı mantarlar arasındaki değerli mantarlar sınıfında yer almaktadır ve yüzyıllardır geleneksel tıbbın kaynağı olmuştur. Bu çalışmada, *Porodaedalea pini* (Çamkavı mantarı)'den elde edilen hekzan (PPH), metanol (PPM) ve su (PPW) ekstrelerinin, fraksiyonlarının ve izole edilmiş bileşiklerin PC3 (prostat kanseri) ve 3T3 (fare fibroblast) hücre hatları üzerindeki sitotoksik etkileri MTT testi kullanılarak taranmıştır. PPH'ın 33.84±0.01 µg/mL olan IC_{50} değeri ile PC3 üzerinde orta derecede sitotoksisiteye sahip olduğu bulunmuştur. PPH'ın yağ asidi profili GC-FID (gaz kromatografisi-alev iyonizasyon dedektörü) ve GC-MS (gaz kromatografisi-kütle spektrometresi) ile belirlenmiş ve majör yağ asitleri palmitik (%41.40±0.03), linoleik (%21.53±0.01), oleik (%12.06±0.01) ve stearik (%8.20±0.01) asit olarak kaydedilmiştir. PPM ve PPW ekstreleri, sıvı-sıvı ekstraksiyon tekniği kullanılarak fraksiyonlandırılmıştır. Tüm fraksiyonlar arasında metanol ekstresinden elde edilen 2-bütanol fraksiyonu (PPM-B) PC3 ve 3T3 hücre hatlarında en iyi sitotoksisiteyi göstermiştir. Ayrıca, PPM'den izole edilen bileşiklerden (dioktil ftalat (**1**), ergosterol peroksit (**2**) ve pinoresinol (**3**)), ergosterol peroksit (**2**) 95.47±1.01 µg/mL olan IC_{50} değeri ile PC3 hücre hattında orta derecede sitotoksik olarak bulunmuştur. *P. pini*'nin prostat kanseri üzerindeki etkisinin ilk kez incelendiği bu çalışmada, türün sitotoksik özellikleri ortaya çıkartılarak tıbbi önemi kanıtlanmıştır.

Anahtar Kelimeler: *Porodaedalea pini,* Prostat kanseri, Ekstre, Yağ asidi, İzolasyon

Introduction

Cancer still maintains its importance as the leading cause of death worldwide. Factors such as morbidity, poor prognosis, recurrence and survival rate of the disease are encountered as challenges in traditional non-surgical treatment procedures such as radiotherapy and chemotherapy (Zhang et al., 2020). Survival in cancer patients, especially in advanced phases, remains at low levels in proportion to factors such as high toxicity, drug resistance and other long-term side effects. Therefore, the tendency of scientists to search for more effective approaches and discover novel anticancer drugs in this direction has gained momentum (Tilaoui et al., 2021).

Prostate cancer is the second most common cancer in men, especially affecting older men: more than 80% of cases are diagnosed after age 65 (Daniyal et al., 2014). Studies based on the number of new cases rank prostate cancer as the sixth most prevalent cancer in the world. It is registered as the most common type of cancer in men in North America, parts of Africa and Europe, and as the second leading cause of cancer death in men in the United States (Grönberg, 2003; Hsing and Chokkalingam, 2006). However, only 10% of men with prostate cancer die from the disease. This is the paradox of prostate cancer: at autopsy of men aged 70-79, prostate cancer is 39%, increasing to 43% by age 80. Identified risk probabilities of prostate cancer are race, age, and positive family history. Other risk factors such as hormones, occupation, dietary factors, obesity, physical activity, sexual activity, smoking, genetic susceptibility and vasectomy have also been connected with prostate cancer risk, but their role in the aetiology remains unclear. It is estimated that 42% of prostate cancer risk is due to genetic influences, including individual and combined effects of rare, highly penetrant genes, more commonly poorly penetrating genes, and genes acting in concert with each other. Prostate cancer pathogenesis probably involves interaction between environmental and genetic factors (Hsing and Chokkalingam, 2006; Rawla, 2019).

Nature has been a significant source of inspiration for medicine since ancient times. Nature produces a wide variety of biologically active constituents with amazing therapeutic potential as well as resources related to cancer treatment (Majolo et al., 2019). The fact that natural products dominate a wide range of traditional and folk medicine applications in the treatment of many diseases and are the source of several compounds commonly used in cancer chemotherapy has generally allowed them to lead to potential new compounds. First-generation chemotherapeutics are more active against rapidly proliferating cancer cells, as well as act on therapeutic interactions that are not specific to cancer. This treatment causes a variety of harmful side effects that can have consequences in anticancer chemotherapy, from overdose to patient death. Newer methods for cancer treatment include targeted therapies that are specific to the properties of cancer and cause harmless or minimal damage to healthy tissues (Hanahan and Weinberg, 2011). Therefore, the search for compounds that can act selectively on cancer cells is a top priority issue in this field. It is therefore a very important responsibility to uncover the treasury of natural products for the discovery of a variety of highly specific agents to make modern oncology more powerful.

Cancer mycotherapy is documented as a promising scientific arena that studies anticancer substances derived from mushrooms. Around the world, mushrooms have become a fundamental part of traditional medicine, thanks to their valuable bioactive properties (Xu et al., 2012). The concept of mushroom therapy has been officially introduced in Traditional Chinese Medicine, as it is recognized as the most effective natural remedies for various kinds of cancer (Hao and Jiang, 2015). Since medicinal mushrooms are producers of hundreds of compounds (heteropolysaccharides, phenolic acids, α-glucans, proteins, β-glucans, fatty acids, complexes of polysaccharides with proteins, terpenoids, nucleoside antagonists, sesquiterpenes, lanostanoids, and sterols), they can synergistically affect more than one cancer-related pathway during treatment. Therefore, investigation of complex anticancer effects contributed by the molecular combinations of extracts and fractions, as well as pure mushroom-derived compounds, is among the important studies focused on (Popovic et al., 2013).

Phellinus species belong to the family of medicinal mushrooms and have been recognized for centuries in traditional medicine of the Far East. It has been used as an effective remedy for bleeding, stomach and intestinal ailments, and diarrhea. In mycochemical studies, it was emphasized that this species showed biological properties such as mainly antiviral, antioxidant, antiangiogenic, and anticancer associated with the presence of steroids, polysaccharides, terpenoids, and phenolic compounds (Sulkowska-Ziaja et al., 2021). *Porodaedalea pini* (Çamkavı mantarı) mushroom, a member of the *Phellinus* family, is a species that usually grows on pine trees and is widely distributed in the northern hemisphere (Sesli et al., 2020). In the studies, it has been reported that the extracts (methanol, ethanol, water and polysaccharide extracts) and pure compounds (steroids, terpenes and phenolic compounds) obtained from *P. pini* have antioxidant, anti-cancer, anti-viral and anti-inflammatory properties (Deveci et al., 2019a; Deveci et al., 2021; Hong et al., 2012; Lee et al., 2010).

The proportion of studies focusing on mushrooms has increased exponentially in recent years (Blagodatski et al., 2018). This study adds the first information to the literature by investigating the cytotoxic effects of *Porodaedalea pini* on PC3 (prostate cancer) and 3T3 (murine fibroblast) cell lines. The cytotoxic effects of the extracts, fractions and isolated compounds were elucidated with the chemical profile of the most active extract.

Material and Metod

Mushroom Material

Porodaedalea pini (Brot.) Murrill. (Çamkavı mantarı) was collected from Muğla, Türkiye in November-December 2014 and January 2015. The voucher specimen was stored with Fungarium No: AT-2446 in the Research and Application Center for Mushrooms, Mugla Sitki Kocman University.

Extraction and isolation

The powdered aerial parts of *P. pini* were macerated with two different solvents (*n*-hexane and methanol) at room temperature, respectively. Solvents were removed by using a rotary evaporator to get hexane (PPH) and methanol (PPM) extracts. Then the mushroom residue was extracted with water at 80°C for one day and lyophilized to obtain the water extract (PPW).

A part of the methanol extract (PPM) was dissolved in water and liquid-liquid extractions were performed with ethyl acetate and 2-butanol saturated with water, respectively. Thus, ethyl acetate fraction (PPM-EA), 2-butanol fraction (PPM-B) and water fractions (PPM-W) were obtained from the methanol extract. Similarly, the water extract (PPW) was dissolved in water again and a liquid-liquid extraction was performed with 2-butanol saturated with water. Thus, 2-butanol (PPW-B) and water (PPW-W) fractions were obtained from the water extract. All extracts and fractions were stored at +4°C until analysis.

The methanol extract (PPM) was chromatographed by using silica gel column with hexane:$CHCl_3$, $CHCl_3$:acetone, acetone:methanol and methanol to afford twenty-three fractions. 4th fraction (PPM4) was re-fractionated by using silica gel column with the gradient solvent system of hexane:ethyl acetate to give fifteen sub-fractions. Sub-fraction 4th (PPM4-4) was subjected to the silica gel column chromatography using hexane:ethyl acetate (95:5) solvent system to yield compound **1**. Compound **2** was seperated from sub-fraction 9th (PPM4-9) by silica gel column chromatography using hexane:ethyl acetate (85:15) solvent system. Fraction 13th (PPM13) was chromatographed by using silica gel column with gradient solvent system of hexane:ethyl acetate to obtain four sub-fractions. Compound **3** was purified by recycling HPLC (C_{18} column and methanol:water (70:30)). Compounds were identified as dioctyl phthalate (**1**), ergosterol peroxide (**2**) and pinoresinol (**3**) based on their spectroscopic data (IR, ^{1}H-NMR, ^{13}C-NMR and MS) which were in agreement with those published previously. Details about the isolation and characterization of the compounds can be found in our previous published research (Deveci et al., 2019b).

Fatty acid profile

Fatty acids of the hexane extract of *P. pini* (PPH) were investigated by using the transesterification procedure and the analysis was performed by GC-FID and GC-MS as previously reported by Çayan et al. (2020).

A flame ionization detector (FID) and a DB-1 fused silica capillary non-polar column (30m x 0.25 id., film thickness 0.25 µm) were used for GC (Shimadzu GC17 AAF, V3, 230 V series (Japan)) analyses of the methyl derivatives of fatty acids. Injector and detector temperatures were 250 and 270°C, respectively, carrier gas was He at a flow rate of 1.4 mL/min; sample size, 1.0 µL; split ratio, 50:1. The initial oven temperature was held at 100°C for 5 min, then increased up to 238°C with 3°C/min increments and held at this temperature for 9 min. The relative percentages of the fatty acid methyl derivatives were determined with GC solution computer program. An ion trap mass spectrometer (MS) and a DB-1 MS fused silica non-polar capillary column (30 m x 0.25 mm ID, film thickness 0.25 µm) were used for the GC-MS (Varian Saturn 2100 (USA)) analyses of the methyl derivatives of fatty acids. For GC-MS detection, an electron ionization system with ionization energy of 70 eV was used. Carrier gas was helium (15 psi) at a flow rate of 1.3 mL/min. Injector and MS transfer line temperatures were set at 220°C and 290°C, respectively. The oven temperature was held at 100°C for 5 min, then increased up to 238°C with 3°C/min increments and held at this temperature for 9 min. Diluted samples (1/25, w/v, in *n*-hexane) of 0.2 µL were injected manually in the split mode. Split ratio was 50:1. EI-MS were taken at 70 eV ionization energy. Mass range was from m/z 28 to 650 amu. Scan time 0.5 sec with 0.1 inters scan delays. The library search was carried out using NIST and Wiley 2005 (Gas Chromatography-Mass Spectrometry) GC-MS libraries. FAME (fatty acid methyl ester) mixture (Supelco™ 37, Catalog no: 47885-U) were identified by comparing their retention times with those of the pure FAMEs standards.

The fatty acid profile was determined by three parallel measurements. Results were given as relative percentage (%) of each fatty acid.

Determination of the cytotoxicity

RPMI1640 media containing 10% FBS (fetal bovine serum) was used for the culture of PC3 (prostate cancer) cells and Dulbecco's Modified Eagle Medium containing 5% FBS (fetal bovine serum), penicillin (100 IU/mL) and streptomycin (100 µg/mL) for 3T3 (murine fibroblast cell line). Both cell cultures were incubated at 37°C in a humidified in the atmosphere of 5% CO_2 After adding 5x10^4 cells with the respective growth medium to the 96-well plate, they were left to incubation in 5% CO_2 at 37°C for 24 h until adhered to the bottom. Sample solution including the extracts, fractions and isolated compounds of different concentration (1-200 µg/mL) was added to each well. Viability and proliferation of the cells were tested according to the previously described MTT (3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide) assay (Deveci et al., 2019c). The results were read at 540 nm. Doxorubicin was used as standard for

PC3 and cycloheximide for 3T3 cell lines and the cell viability values were expressed as 50% inhibition concentration (IC_{50}).

Statistical analysis

All results were the average of three parallel sample measurements and given as the mean ± S.D. (standard error). Student's *t* test was used to analyse significant differences and *p* values <0.05 were accepted as significant.

Results

Fatty acid profile

Fatty acid profile of *P. pini* was investigated by GC-FID and GC-MS and all identified fatty acids were listed in Table 1. GC chromatogram of *P. pini* hexane extract (PPH) was presented in Figure 1. The dominant fatty acids were detected as palmitic (41.40±0.03%), linoleic (21.53±0.01%), oleic (12.06±0.01%), and stearic (8.20±0.01%) acids among the eleven identified fatty acids. The total fatty acid contents for SFAs, MUFAs, and PUFAs were calculated as 54.98, 18.49, 26.24%, respectively.

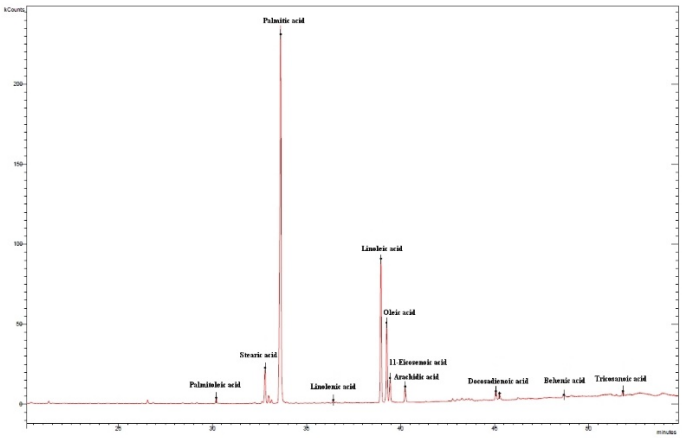

Figure 1. GC chromatogram of *P. pini* hexane extract (PPH).

Cytotoxic activity

The extracts, fractions and isolated compounds obtained from *P. pini* were investigated against PC3 and 3T3 cell lines using MTT assay. Firstly, the cytotoxic activities of the hexane (PPH), methanol (PPM) and water extracts (PPW) obtained from *P. pini* and the fractions obtained from these extracts using liquid-liquid extraction on PC3 and 3T3 cells were determined. The results were summarized in Table 2. The hexane extract (PPH) showed the best cytotoxicity on PC3 (IC_{50}: 33.84±0.01 µg/mL), while methanol extract (PPM) exhibited moderate cytotoxic activity on 3T3 (IC_{50}: 38.05±0.14 µg/mL). The National Cancer Institute and Geran protocol described the cytotoxicity of the extracts as high ($IC_{50} \leq 20$ µg/mL), moderate (IC_{50}: 21-200 µg/mL), weak (IC_{50}: 201-500 µg/mL), and not ($IC_{50} \geq 501$ µg/mL) cytotoxic (Nguyen et al., 2020).

Table 1. The fatty acid profile of *P. pini*[a]

Fatty Acids	%
Palmitic acid (C16:0)	41.40±0.03
Palmitoleic acid (C16:1 ω-7)	3.05±0.02
Stearic acid (C18:0)	8.20±0.01
Oleic acid (C18:1 ω-9)	12.06±0.01
Linoleic acid (C18:2 ω-6)	21.53±0.01
Linolenic acid (C18:3 ω-3)	1.99±0.01
Arachidic acid (C20:0)	2.47±0.02
11-Eicosenoic acid (C20:1 ω-9)	3.38±0.01
Behenic acid (C22:0)	1.06±0.01
Docosadienoic acid (C22:2 ω-6)	2.72±0.03
Tricosanoic acid (C23:0)	1.85±0.02
Total saturated fatty acids (SFAs)	54.98
Total monounsaturated fatty acids (MUFAs)	18.49
Total polyunsaturated fatty acids (PUFAs)	26.24
Total unsaturated fatty acids (UFAs)	44.73
Undetected fatty acids	0.29

[a] Fatty acid profile represent the means ±S.D. of three parallel sample measurements (p<0.05).

According to this comparison, the methanol extract (PPM) was moderately cytotoxic against PC3 with IC_{50} value of 88.77±0.78 µg/mL, while water extract (PPW) was determined as weak active. Among the all fractions, PPM-B was recorded as a moderate cytotoxic fraction against PC3. Secondly, a portion of the methanol extract (PPM) was purified as a result of a combination of different chromatographic techniques as described in our previous study (Deveci et al., 2019b). The chemical structures of the compounds isolated were presented in Figure 2. Among the isolated compounds, only ergosterol peroxide (**2**) (IC_{50}: 95.47±1.01 µg/mL) showed moderate cytotoxicity on PC3 (Table 2).

Discussions

Fatty acids cause changes in metabolism by affecting gene expression, hormonal responses and the properties of cells, and also take part in the production processes of biologically active compounds. On these occasions, fatty acids act on physiological functions, health and disease risk (Calder, 2015). It has been proven that fatty acids (especially ω-3 and ω-6) enhance and even protect the effect of medical treatment for important diseases such as diabetes, cardiovascular diseases and cancer (Çakmakçı and Tahmas-Kahyaoğlu, 2012). GC-FID is a traditional technique used in the analysis of fatty acids due to its high accuracy, sensitivity and suitability. GC-MS is used for the determination of fatty acids for more precise quantitative determination. Incorporating the high resolution of GC and the high sensitivity of MS to separate and identify complex components, this technique is an effective tool for qualitative and quantitative analysis of fatty acids. In this context, it is recommended in the literature to use both techniques together for the identification of fatty acids (Chiu and Kuo, 2020; Wu et al., 2017).

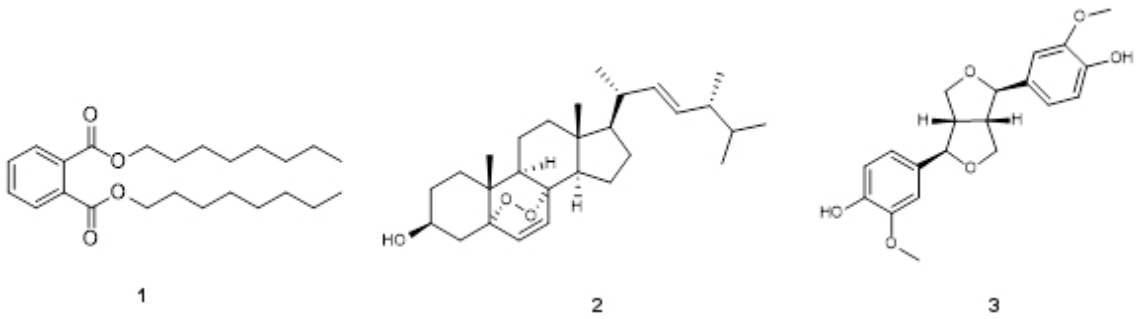

Figure 2. Chemical structures of the compounds isolated from *P. pini* methanol extract (PPM). 1: dioctyl phthalate, 2: ergosterol peroxide, 3: pinoresinol

Many extensive *in vitro* and *in vivo* studies have examined the association and risk of fatty acids with various types of cancer species such as breast, prostate, and colorectal cancer (Chen and Huang, 2019).In this study, fatty acid profile of *P. pini* hexane extract (PPH) was investigated due to have the highest cytotoxicity on PC3 cell line and the main fatty acids were detected as palmitic (41.40±0.03%), linoleic (21.53±0.01%), oleic (12.06±0.01%), and stearic (8.20±0.01%) acids by GC-FID and GC-MS. According to the study of Reis et al. (2014) the main fatty acids were consisted of palmitic (26.8±0.2%), linoleic (25.3±0.2%), oleic (13.5±0.1%) and stearic (12.3±0.1%) acids in *P. linteus*. The most abundant fatty acids of *P. pini* were described as linoleic (41.9%), palmitic (19.2%) and oleic (14.4%) acids (Olennikov et al., 2014). In our previous study, the main fatty acids of *P. igniarius* were linoleic (48.27±1.19%), palmitic (28.09±1.02%) and stearic (7.42±0.11%) acids (Çayan et al., 2020). Palmitoleic (0.00461-0.10032 mg/g), linoleic (0.1629-1.6483 mg/g), oleic (0.01644-0.10889 mg/g), hexadecanoic (0.3952-1.2403 mg/g), and stearic (0.1464-0.3821 mg/g) acids were identified in six *Phellinus* species (*P. linteus, P. baumii, P. pomaceus, P. pini, P. robustus, Phellinus sp*.) (Deng et al., 2011).

Treatment of prostate cancer is performed using surgery, radiotherapy, hormonal therapy, neoadjuvant hormone therapy and androgen withdrawal therapy approaches (Sumanasuriya and De Bono, 2018). The method to be used for the treatment of prostate cancer varies according to the stage of cancer. For this reason, patients in whom the cancer process progresses become resistant to treatment and treatment options become difficult. Antiandrogen manipulation, estrogen therapy, use of chemotherapeutic drugs such as gemcitabine, doxorubicin and paclitaxel are common in advanced prostate cancer patients (Kroon et al, 2014). However, the acquired drug resistance of these treatment methods and the inadequacy of the dose to be used or the dose-dependent side effects are not sufficient for prostate treatment, but often only increase the survival rate of the patient. For this purpose, studies on the characterization of new strategies, comprising of the use of natural compounds in combination therapies, have gained momentum in the light of the results focusing on the toxic effects of chemotherapy in general. The main goal of incorporating natural compounds into cancer chemotherapies is to expand the therapeutic window of chemotherapeutic drugs and reduce the formation of chemotherapy resistance (Lin et al., 2020).

Table 2. Cytotoxic activity of the extracts, fractions and isolated compounds from *P. pini*[a]

		PC3	3T3
Extracts	PPH	33.84±0.01	40.26±0.45
	PPM	88.77±0.78	38.05±0.14
	PPW	>200	>200
Fractions	PPM-EA	>200	95.65±3.36
	PPM-B	95.01±1.08	>200
	PPM-W	>200	52.05±0.18
	PPW-B	>200	>200
	PPW-W	>200	>200
Isolated compounds	Dioctyl phthalate (**1**)	>200	NT[b]
	Ergosterol peroxide (**2**)	95.47±1.01	NT[b]
	Pinoresinol (**3**)	>200	NT[b]
Standards	Doxorubicin	1.38±0.16	NT[b]
	Cycloheximide	NT[b]	0.07±0.12

[a] IC_{50} values (µg/mL) represent the mean ±S.D. of three parallel sample measurements (p<0.05).
[b] NT: not tested.

PC3 cell, which is considered a classical prostate cancer cell line, is used as an androgen-independent prostate cancer model. This cell line has a high metastatic potential compared to other prostate cancer cell line models (Kamalidehghan et al., 2018). Therefore, the extracts, fractions and isolated compounds obtained from *P. pini* were investigated against PC3 and 3T3 cell lines by MTT assay.

The cytotoxic activities of the hexane (PPH), methanol (PPM) and water extracts (PPW) obtained from *P. pini* and the fractions obtained from methanol and water extracts using liquid-liquid extraction on PC3 and 3T3 cells were determined. The hexane extract (PPH) containing palmitic acid as the main fatty acid showed the best cytotoxicity on the PC3 cell line. *In vitro* and *in vivo* studies have shown that palmitic acid inhibits growth in prostate cancer cells and causes inhibition of cell metastasis by blocking key molecules of the PI3K/Akt pathway (Zhu et al., 2021). The methanol extract (PPM) was moderately cytotoxic against PC3 while water extract (PPW) was determined as weak active. Among all fractions, the 2-butanol fraction of the methanol extract (PPM-B) was recorded as a moderate cytotoxic fraction against PC3. The fractionation with ethyl acetate and butanol derivatives, respectively, is a frequently used separation technique in bioactivity determination studies. The strong anti-angiogenic effect of the butanolic fraction obtained from *P. linteus* mushroom has been proven (Kim et al., 2004). We previously reported the organic acid and phenolic compounds of *P. pini* as *p*-hydroxybenzoic acid (32.40 μg/g), *p*-coumaric acid (5.46 μg/g), caffeic acid (4.07 μg/g), ellagic acid (0.32 μg/g), fumaric acid (0.14 μg/g), vanillin (0.07 μg/g), and coumarin (0.01 μg/g) by using HPLC-DAD (Deveci et al., 2019b). The cytotoxic effects of the extracts may be due to the combined effects of fatty acids and phenolic and organic acid compounds.

Dioctyl phthalate (**1**), ergosterol peroxide (**2**) and pinoresinol (**3**) purified from the methanol extract (PPM) were investigated for the cytotoxicity on the PC3 cell line. Among the isolated compounds, only ergosterol peroxide (**2**) showed cytotoxicity on PC3. It has been proven that sterols promote the growth and apoptosis of cancer cells through the activation of caspase enzymes and inhibit the development of various cancers. The increased activity of caspase enzymes has been attributed to the fact that sterols cause changes in membrane structure and functions as a result of binding to the cell membrane, and this change increases the caspase enzyme activities of proteins included in extracellular and intracellular signal transmission pathways. These two combined pieces of evidence support the anti-cancer effects of sterols, arguing that their inclusion in the diet is an important strategy in the prevention/treatment of cancer (Woyengo et al., 2009).

In a previous study, the inhibition rates of the isolated compounds ergosterol, baicalein, ergosta-7,22-dien-3*β*-yl, 24-ethylcholesta-5,22-dien-3*β*-ol pentadecanoate, 3,4-dihydroxy benzaldehyde, and inoscavinA from *P. baumii* on LNCaP (prostate cancer) were found as ~10, 10, 80, 85, 85, 20%, respectively at 100 μg/mL concentration (Zhang et al., 2017). In a different study, the mechanism of action of ProstaCaid™, which consists of 33 different comprehensive polyherbal and nutritional preparations, including mycelium of *P. linteus* mushroom, is used as a nutritional supplement in prostate cancer patients, on prostate cancer was revealed. PC3 cells were inhibited in a dose- and time-dependent manner with IC_{50} values of 56.0, 45.6 and 39.0 μg/mL for 24, 48 and 72 h, respectively and the proliferation was inhibited through modulation of the genes expression (Jiang et al., 2011). It was also reported that *P. linteus* blocked the growth of prostate cancer cells and induced apoptosis *in vitro* (Guo et al., 2007; Tsuji et al., 2010; Zhu et al., 2007). The sulforhodamine B-based assay was used to test the cytotoxic activity of ergosterol peroxide (isolated from *Hericium novae-zealandiae* mushroom) against DU145 (IC_{50}: 21±3 μM), PC3 (IC_{50}: 42±3 μM), LNCaP (IC_{50}: 15±2 μM) prostate cancer cell lines (Chen et al., 2019). The resazurin reduction test was used to determine the cytotoxicity of ergosterol peroxide (IC_{50}: 38.19±1.67 μM) isolated from *Inonotus obliquus* on PC3 by Ma et al. (2013). The cell growth values of pinoresinol on PC3 (143±55%) and LNCaP (55±9%) prostate cancer cell lines at 100 μM concentration were reported by using MTT assay (Sepporta et al., 2013). Chin et al. (2006) calculated the ED_{50} value of pinoresinol as 0.5 μg/mL against LNCaP (prostate cancer) by the sulforhodamine B-based assay. The differences between the findings can be explained by the effect of a wide variety of variables as follows: method differences, researcher's knowledge and experience, cell type used, ambient temperature, test reagent content and media composition (Tokur and Aksoy, 2017).

This study presents a detailed assessment in terms of comparing the effects of *P. pini* mushroom extracts, fractions and isolated compounds on PC3 and 3T3 cell lines for the first time. The strong cytotoxicity of the hexane extract against PC3 may be related to the contents of palmitic, linoleic, oleic and stearic acids detected by GC-FID and GC-MS. These results demonstrated that it is possible to evaluate *P. pini* (especially hexane extract) as a new agent in prostate cancer. However, it is still necessary to purify cytotoxic compounds with advanced chromatographic techniques and to complete the findings with *in vivo* studies.

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Research Article
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A New Species Record from the Order of Pezizales; *Coprotus disculus*

İsmail ACAR[1], Luis Quijada[2]

**Sorumlu yazar: iacar2011@gmail.com*

[1]Van Yüzüncü Yıl University, Başkale Vocational High School, Department of Organic Agriculture, Van, Türkiye
Orcid No:0000-0002-6049-4896 / iacar2011@gmail.com
[2]Department of Organismic and Evolutionary Biology, The Farlow Reference Library and Herbarium of Cryptogamic Botany, Harvard University, 22 Divinity Avenue, Cambridge, MA 02138, USA;
Orcid No:0000-0003-1666-6758 luis_quijada@fas.harvard.edu

Abstract: The article reports new data on the occurrence of *Coprotus disculus* Kimbr., Luck-Allen & Cain collected in Hakkâri Province, Türkiye. The species was identified based on morphological data. The second record of the genus in Türkiye is reported. Macroscopic and microscopic characters and photographs are given, along with the collection information.

Key words: *Ascomycota*, Coprophilous, Fungi, *Pezizomycetes*, Türkiye.

Pezizales Ordosundan Yeni Bir Tür Kaydı; *Coprotus disculus*

Öz: Makale, Türkiye'nin Hakkâri ilinde toplanan *Coprotus disculus* Kimbr., Luck-Allen ve Cain'in oluşumu hakkında yeni verileri rapor ediyor. Türler morfolojik verilere göre tanımlanmıştır. Türkiye'de cinsin ikinci kaydı verilmiştir. Koleksiyon bilgileri ile birlikte makroskobik ve mikroskobik karakterler ve fotoğraflar verilmiştir.

Anahtar kelimeler: *Ascomycota*, Gübre Seven, Fungi, *Pezizomycetes*, Türkiye.

Introduction

An overview of the nomenclature, taxonomy, and systematics of the genus *Coprotus* Korf was recently published by Kušan et al., (2018). The genus was validly published in 1967 (Kimbrough & Korf, 1967). Species of the genus occur on herbivore dung and are characterized by small, sessile, translucent, or whitish to yellow oblate to lenticular or discoid apothecia, with a reduced excipulum composed of angular to globose cells; operculate inamyloid 8-multispored asci; filiform, slightly to strongly curved paraphyses that can have carotenoid or lack pigmentation; and smooth ascospores without lipid bodies and containing de Bary bubbles in anhydrous conditions (Kimbrough et al., 1972, Melo et al., 2015, Kušan et al., 2018). The species of the genus are widespread and have been reported from all continents but Antarctica, although most of the reports are from North America (Melo et al., 2015). It was previously placed in Ascodesmiaceae and recently included in the new family *Coprotaceae* U. Lindemann & Van Vooren (Van Vooren, 2021). The family only has two genera: *Coprotus*, with 27 species, and *Boubovia* Svrček, with 7 species (Index Fungorum accessed 10 May 2022). Although the species have been traditionally considered saprobic on dungs and plant/woody debris, they have rarely been isolated from soil (Van Vooren, 2021). *Coprotus* does not show seasonal preference and apothecia are produced when temperature and moisture are adequate (Kimbrough et al., 1972). Recent studies based on DNA sequence analyses have shown that the genus occurs as endophytic and endolichenic in multiple hosts. The endophyte lifestyle is common and broadens the known ecology of the species (Healy et al., 2022).

Studies on *Ascomycetes* in Türkiye have gained quite a momentum in recent years (Acar & al., 2018, 2020; Işık & Türkekul 2018a, b; Kaya & Uzun 2018; Uzun & Kaya 2018, 2019, 2020; Kaya et al., 2018; Kabaktepe et al., 2019; Keleş, 2019; Sadullahoğlu & Uzun, 2020; Acar 2021; Çetinkaya & Uzun, 2021; Kaplan & al., 2021; Kesici & Uzun 2021). Despite this activity there have been no reports of the species of *Coprotus* in the checklist of Turkish fungi (Sesli et al., 2020). However, Akçay et al.

reported the first record of the genus in August 2022. Thus, our report of *Coprotus disculus* is an addition to the fungal diversity of Türkiye and the second time that the is reported in the country.

Material and Metod

Fresh *Coprotus* ascomata were collected from Hakkâri Province in Türkiye in 2018. The samples were photographed with a Canon (EOS 60D) camera equipped with a Tokina 100 mm macro lens in the field. Macroscopic characters were recorded from fresh materials. Microscopic characters were observed in water with a Leica DM500 research microscope under oil immersion, at least 30 asci and ascospores were measured using the Leica Application Suite (version 3.4.0) program. The following references were used to identify and compare our collection with other species in the genus (Kimbrough et al., 1972; Doveri, 2007; Melo et al., 2015; Kušan et al., 2018). The specimen studied is deposited in the Fungarium of the Van Flora Application and Research Center of Van Yüzüncü Yıl University (VANF).

Results

Coprotus disculus Kimbr., Luck-Allen & Cain, Can. J. Bot. 50(5): 962 (1972) Figure 1-2

Apothecia 0.4–1 mm diam, scattered to subgregarious, superficial, sessile, translucent to white to yellowish, lenticular to discoid, at maturity white or becoming pale yellow, dirty white to light grey when dry. **Asci**: 75–120 × 9–16 µm, 8–spored, cylindrical, operculate, opens irregularly, rounded at apex. **Ascospores**: 11.3–14.2 × 5–8.3 µm, hyaline, ellipsoid to somewhat narrowing toward to apex, non-apiculate, usually uniseriate, irregular, sometimes biseriate. **Paraphyses**: 3–4 µm wide, filiform, hyaline, septate and without inclusions, slightly enlarged and curved at the apex. **Excipulum** of a *textura angularis* to *t. globulosa*; cells thin-walled, hyaline, toward the base globose, up to 18 µm diam, cortical cells at margin and flanks 7.8–12.2 × 6.5–10.5 µm.

Specimen Examined: **TÜRKİYE, Hakkâri,** Şemdinli, Derya village input, 37° 21′271"N, 44° 31′282"E, 1525 m, on the dung of cow, 28.03.2018, VANF Acar. 1014.

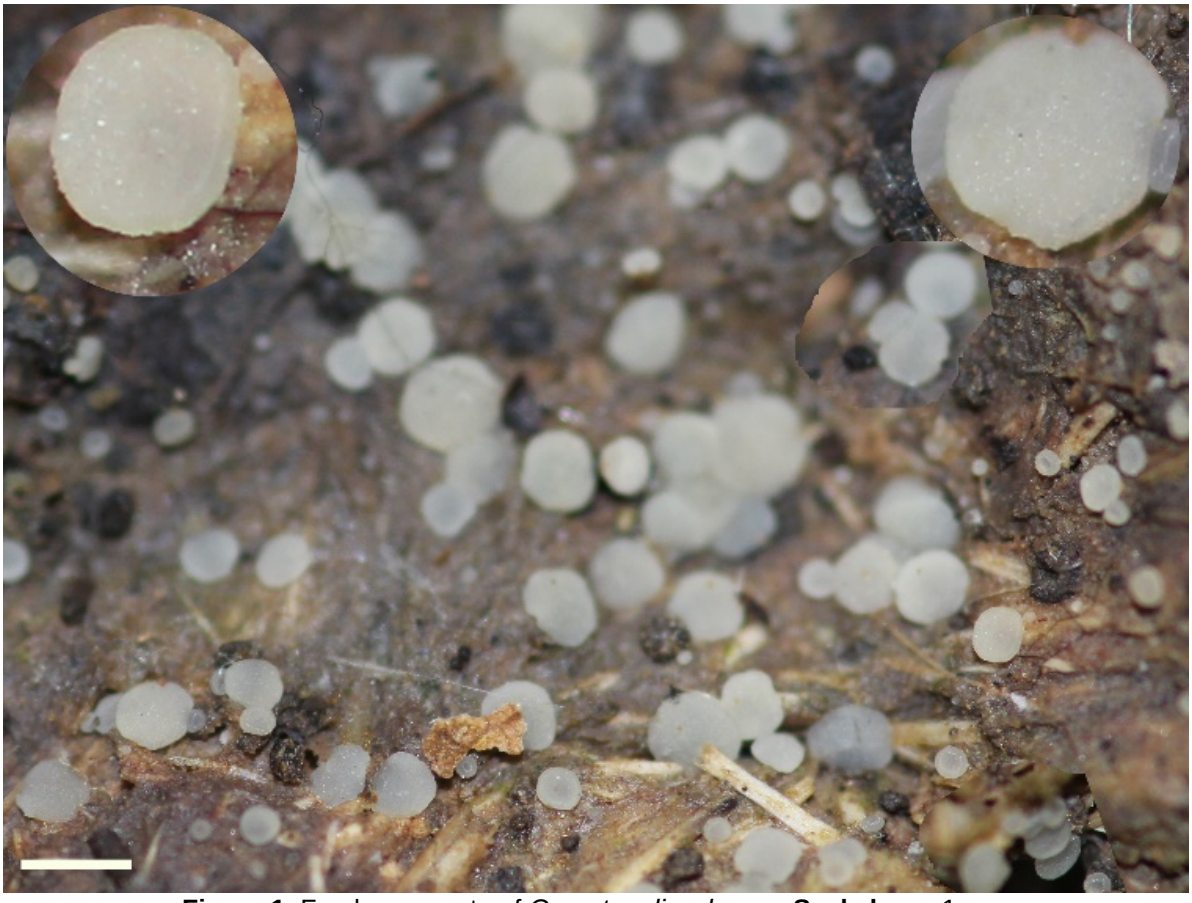

Figure 1. Fresh ascomata of *Coprotus disculus.* **Scale bar =** 1 mm

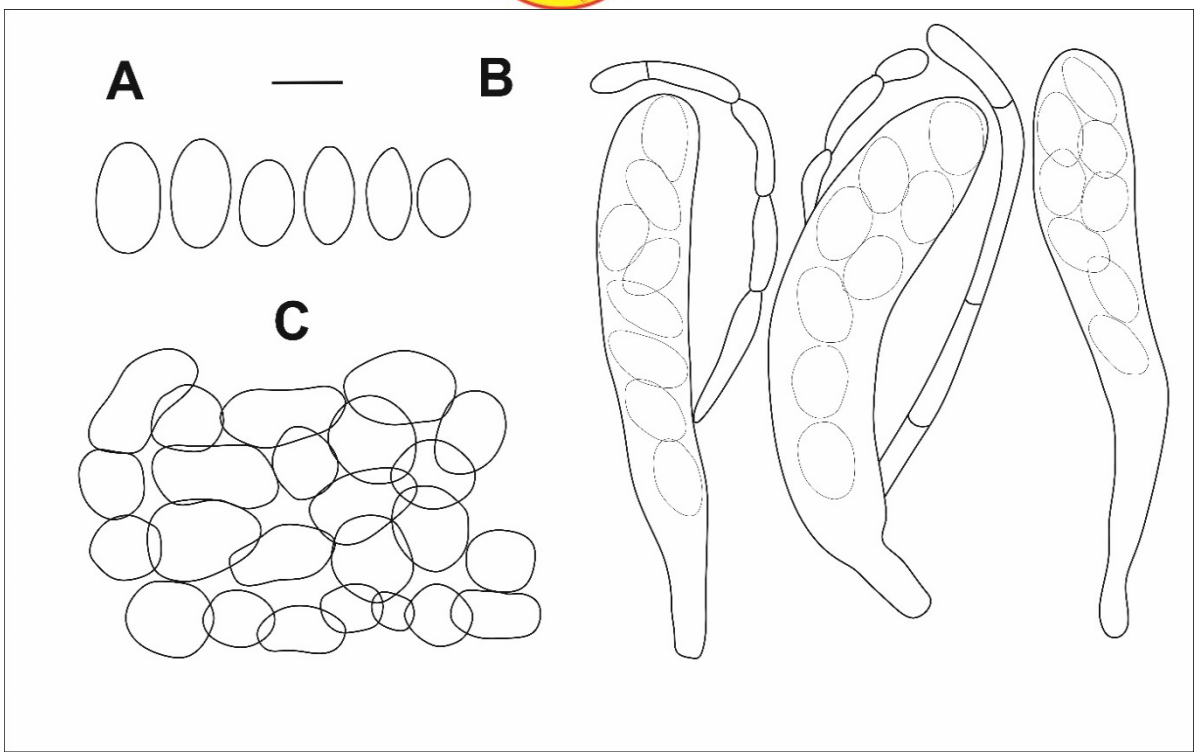

Figure 2. Drawing showing the micromorphology features of *Coprotus disculus*. **A.** Ascospores, **B.** Asci and Paraphyses, **C.** Ectal excipulum. Scale bar: 10 µm

Discussions

In the Kimbrough's monograph of the genus *Coprotus* (Kimbrough et al., 1972), he included 18 species and divided them into 2 groups. The first group are species with apothecia and paraphyses containing carotenoid pigments, the second group contains species with whitish apothecia, becoming pale yellow with age or drying, and paraphyses lacking carotenoids (Doveri, 2012). Our collection belongs to the latter.

Coprotus disculus has been reported from deer, horse, cow, goat and rodent dungs from Africa, North America, Europe and South America (Kimbrough et al. 1972; Melo et al., 2015). The original description describes asci measuring 75–90 × 10–15 µm and ascospores 12–13.5 × 5– 8 µm (Kimbrough et al. 1972). The last description we were able to find is from goat dung in Brazil, and has similar values for asci and ascospores, respectively 80–90 × 12.5–14 µm and 12.5–13.5 × 5– 8 µm (Melo et al., 2015). Although asci in our sample were longer, 75–120 × 9–16 µm, the measurements are overlapped and the ascospore range, 11.3–14.2 × 5–8.3 µm, as well as all other morphological features fit well with previous reports (Kimbrough et al., 1972; Melo et al., 2015). *Coprotus disculus* is differentiated from several species in the genus by its whitish apothecia without carotenoid pigments in the paraphyses, that is in group two mentioned above. The most similar species with colourless apothecia, 8-spored asci and similar ascospores measures are *C. leucopocillum* and *C. dextrinoideus* (Kimbrough et al., 1972). Our collection from Türkiye has asci of similar length as *C. leucopocillum* and *C. dextrinoideus* (80–110 µm, 80–125 µm), but both species have wider asci (15–22 µm vs 18–24 µm) than *C. disculus*. Furthermore, ascospores are bigger in *C. leucopocillum* (14–18 × 7.5–11.5 µm), and although ascospores length is similar between in *C. dextrinoideus* and *C. disculus* (11–13 µm vs 11.3–14 µm), the ascospores of the former are broader (7.5–10 µm vs 5–8.3 µm). Therefore, even if we found morphological variation in asci length in comparison to previous reports, we believe that *C. disculus* is the appropriate identification of our collection.

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Research Article
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Pseudohydropus floccipes (Fr.) Vizzini & Consiglio, A New Record for Turkish Mycobiota

Yasin UZUN[1], Ali KELEŞ[2], Abdullah KAYA[3*]

**Sorumlu yazar: kayaabd@hotmail.com*

[1]Karamanoğlu Mehmetbey University, Ermenek Uysal and Hasan Kalan Health Services Vocational School, Department of Pharmacy Services, 70400 Karaman, Türkiye
Orcid ID: 0000-0002-6423-6085 / yuclathrus@gmail.com
[2]Yüzüncü Yıl University, Education Faculty, Dept. of Mathematics and Science Education, 65080 Van, Türkiye
Orcid ID: 0000-0002-9087-0805 / alikeles61@yahoo.com
[3]Gazi University, Science Faculty, Department of Biology, 06560 Ankara, Türkiye
Orcid ID: 0000-0002-4654-1406 / kayaabd@hotmail.com

Abstract: *Pseudohydropus floccipes* (Fr.) Vizzini & Consiglio is reported as a new record from Türkiye, based on the identification of the samples collected from Rize province. It is the first member of the genus *Pseudohydropus* Vizzini & Consiglio determined in Türkiye. A brief description of the species is provided together with the photographs, related to the macroscopy and microscopy.

Key words: Biodiversity, New record, *Porotheleaceae*, Türkiye

Pseudohydropus floccipes (Fr.) Vizzini & Consiglio, Türkiye Mikobiyotası İçin Yeni Bir Kayıt

Öz: *Pseudohydropus floccipes* (Fr.) Vizzini & Consiglio Rize'den toplanan örneklerin teşhis edilmesiyle, Türkiye'den yeni kayıt olarak rapor edilmiştir. Bu *Pseudohydropus* Vizzini & Consiglio cinsinin Türkiye'de belirlenen ilk üyesidir. Türün kısa bir betimlemesi, makroskobi ve mikroskobisine ilişkin fotoğrafları ile birlikte verilmiştir.

Anahtar kelimeler: Biyoçeşitlilik, *Porotheleaceae*, Yeni kayıt, Türkiye

Introduction

The genus *Pseudohydropus* Vizzini & Consiglio was proposed by Consiglio et al. (2021), including the taxa, generally characterized by mycenoid habit; sinuate, adnexed to adnate lamellae with a decurrent tooth; white spore-print; globose to largely ellipsoid, colourless, inamyloid, non-dextrinoid basidiospores. sarcodimitic stipe trama. While proposing the new generic name, two new combinations, *Pseudohydropus floccipes* (Fr.) Vizzini & Consiglio (Basionym: *Agaricus floccipes* Fr.) and *Pseudohydropus globosporus* (A.C. Cooper, Desjardin & B.A. Perry) Vizzini & Consiglio (Basionym: *Hydropus globosporus* A.C. Cooper), and two newly erected species, *Pseudohydropus commenticius* J.A. Cooper and *Pseudohydropus parafunebris* J.A. Cooper were included in it (Consiglio et al., 2021). Among them, *Pseudohydropus floccipes* was first introduced as *Agaricus floccipes* by Fries in 1838. Later on it was presented within the genera *Collybia, Hemimycena, Hydropus, Marasmiellus* and *Mycena* with the same epithet. Though IndexFungorum currently list this taxon as *Hydropus floccipes* (Fr.) Singer, Consiglio et al. (2021) proposed a new combination transferring the taxon to a newly erected genus, *Pseudohydropus* Vizzini and Consiglio.

The current Turkish fungal checklist (Sesli et al., 2020) and subsequent contributions (Akçay, 2020; Keleş, 2020; Sesli, 2020; Uzun et al., 2020; Acar et al., 2021; Demirak and Türkekul, 2021; Doğan et al., 2021; Kaygusuz et al., 2020, 2021; Keleş and Kaya, 2021) revealed that *Pseudohydropus floccipes* has not been reported from Türkiye before. A brief description of the species is provided together with its distribution and photographs related to its macro and micromorphologies. The work aims to contribute to the mycobiota of Türkiye by adding a new record.

The study aims to make a contribution to the macrofungal biodiversity of Türkiye.

Material and method

The fruit bodies of *Pseudohydropus floccipes* were collected from Ardeşen district o Rize province, in 2017, during a field study. Fruit bodies were photographed at their natural habitats, and characteristics related to its ecology, morphology and geopraphy. Then the samples were transferred to the fungarium. After letting them dry in an air conditioned room, they were prepared as fungarium material. Microscopic investigation were based on dry samples, and performed under a trinocular light microscope. Photographs related to micromorphology were obtained with the aid of a digital camera. The sample was identified with the help of (Moser, 1968; Machol and Singer, 1977; Singer, 1982; Hausknecht et al., 1997; Bas, 1999; Pérez-de-Gregório, 2001; Esteve-Raventós et al., 2002; Seok et al., 2005; Buczacki et al., 2012; Consiglio et al., 2021).

The specimen is kept at Karamanoğlu Mehmetbey University, Science Faculty, Department of Biology.

Results

Fungi R.T. Moore

Basidiomycota R.T. Moore

Agaricales Underw.

Pseudohydropus floccipes (Fr.) Vizzini & Consiglio, RdM 64 (2): 99-190 (2021)

Syn: [*Agaricus floccipes* Fr., *Collybia floccipes* (Fr.) Gillet, *Hemimycena floccipes* (Fr.) Singer, *Hydropus floccipes* (Fr.) Singer, *Hydropus floccipes* var. *luteipes* A. Ortega & M. Zea, *Hydropus floccipes* f. *luteipes* (A. Ortega & M. Zea) Pérez-De-Greg., *Marasmiellus floccipes* (Fr.) Singer, *Mycena floccipes* (Fr.) Kühner]

Macroscopic and microscopic features: Pileus 7-23 mm in diam., conical to campanulate when young, convex, broadly convex to almost applanate at maturity some with an obtuse umbo, margin acute, surface smooth, brown to grey-brown when young, pale grey-brown to brown-beige when mature, mostly lighter towards the margin and darker at the center or towards the center, some with slightly hygrophanous appearance. Flesh thin, concolorous with the surface. Lamellae white, distant, adnexed. Taste mild, odor indistinct. Stipe (18-) 20-55(-60) × 0.9-2 mm, cylindrical, equal or slightly tapering tapering towards the apex or base, surface smooth, whitish to pale greyish, context concolorous to somewhat hyaline, some whitish hairy at the base.

Figure 1. Basidiocarps of *Pseudohydropus floccipes.*

Basidiospores 5.6-7.8 × 5.5-7.5 µm, globose to subglobose, hyaline, inamyloid, smooth. Basidia 25.5-32 × 6-7 µm, clavate 4-spored, with basal clump. Cheilocystidia 40-95 × 9-23 µm, subcylindrical to clavate, with rounded apex. Pleurocystidia 45-103 × 11-20 µm, subcylindric to sublageniform.

Pseudohydropus floccipes grows as solitary or gregariously on bark of stumps and trunks of deciduous and coniferous trees, from spring to autumn (Hauskneckht et al., 1997; Seok et al., 2005; Consiglio et al., 2021).

Specimen examined: Rize, Ardeşen, Sinan village, 41°06′N-41°05′E, 460 m, 12.08.2017, on *Fagus* sp. stump covered by mosses, Yuzun 5775.

Discussions

Pseudohydropus floccipes was reported for the first time from Türkiye. It is also new for Türkiye at generic level. Macroscopic and microscopic characteristics of Turkish collection are generally in aggreement with those presented before (Moser, 1968; Hauskneckht et al., 1997; Seok et al., 2005; Buczacki et al., 2012; Consiglio et al., 2021). The usual substrate of *P. floccipes* is reported as *Quercus* L. sp. (Consiglio et al., 2021), but our collection was made on *Fagus* sp. It is reported to be a quite rare but widespread species in Northern Hemisphere, Europe, North Africa, Asia and America (Consiglio et al., 2021).

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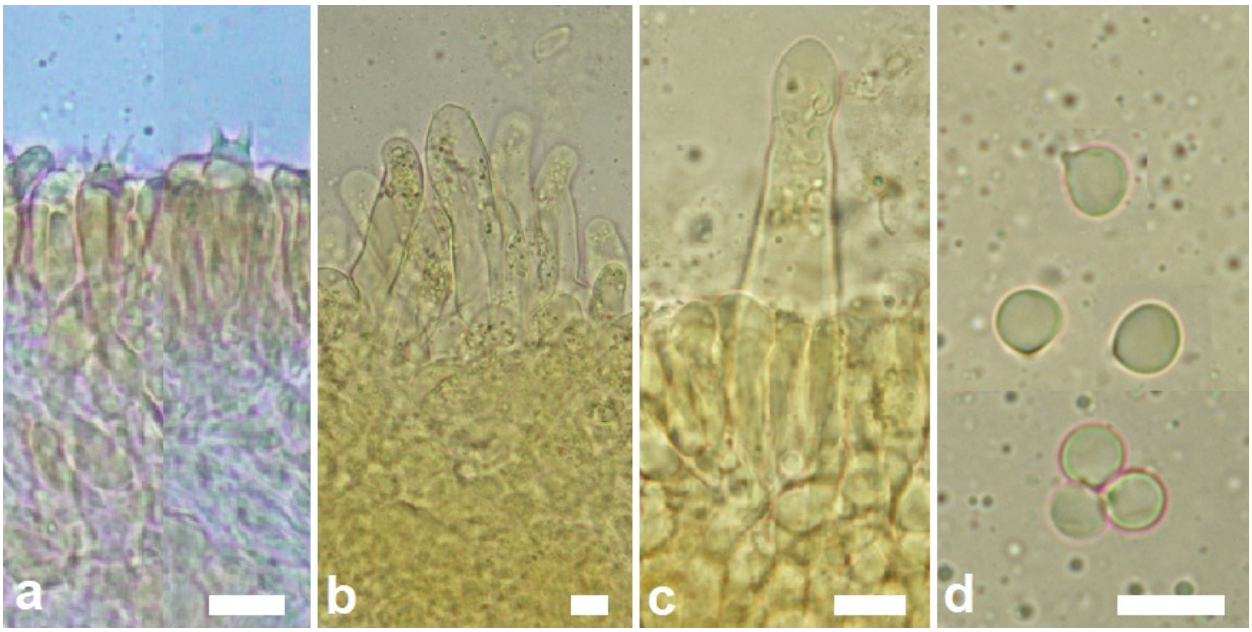

Figure 2. Basidia (a), cheilocystidia (b), pleurocystidium (c) and basidiospores of *Pseudohydropus floccipes* (bars: 10 µm).

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Research Article
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Pisolithus albus, A New Record For Turkish Gastroid Fungi

Ilgaz AKATA[1*], Deniz ALTUNTAŞ[2]
Beste Gizem ÖZBEY SARIDOĞAN[1], Ergin ŞAHİN[3,4]

**corresponding author: akata@science.ankara.edu.tr*

[1*] Ankara University, Faculty of Science, Department of Biology, Ankara, Türkiye
Orcid No/Orcid ID: 0000-0002-1731-1302/ akata@science.ankara.edu.tr
Orcid No/Orcid ID: 0000-0002-9777-6598/ bozbey@ankara.edu.tr
[2] Ankara University Graduate School of Natural and Applied Sciences, Ankara, Türkiye
Orcid No/ Orcid ID: 0000-0003-0142-6188/ denizaltuntas91@gmail.com
[3] Dokuz Eylül University, Faculty of Science, Department of Biology, İzmir, Türkiye
[4]Dokuz Eylül University, Fauna and Flora Research and Application Center, İzmir, Türkiye
Orcid No/ Orcid ID: 0000-0003-1711-738X/ ergin.sahin@deu.edu.tr

Abstract: Fungal specimens were sampled from the Bodrum district of Muğla province / Türkiye on September 21, 2020, and they were scrutinized by performing both morphological and rDNA sequence-based phylogenetic analyses. Considering the micro- and macromorphological data and the high (>99%) sequence similarity between the sampled specimen (ANK Akata & Altuntaş 699) and *Pisolithus albus* (Cooke & Massee) Priest., the collected specimen was identified as *P. albus*. As a result of this study, *P. albus* was reported as a new record for Turkish Gastroid fungi. A brief description of the lately recorded species was stated along with its macro-photograph, and illustration of spores and discussed briefly.

Key words: *Pisolithus albus*, Gastroid fungi, New record, Türkiye

Pisolithus albus, Türkiye Gastroid Mantarları İçin Yeni Bir Kayıt

Öz: 21 Eylül 2020 tarihinde Muğla ili Bodrum ilçesinden mantar örnekleri toplanmış ve hem morfolojik hem de rDNA dizi tabanlı moleküler filogenetik analizler uygulanarak detaylı bir şekilde incelenmiştir. Toplanan örnek (ANK Akata & Altuntaş 699) ile *Pisolithus albus* (Cooke & Massee) Priest. arasındaki yüksek (>%99) dizi benzerliği ve mikro- ve makromorfolojik veriler göz önüne alındığında, toplanan örnek *P. albus* olarak tanımlanmıştır. Bu çalışma sonucunda *P. albus* Türkiye Gastroid mantarları için yeni kayıt olarak rapor edilmiştir. Yeni kaydedilen türün kısa bir tanımı, makro fotoğrafı ve sporların gösterimi ile birlikte sunulmuş ve kısaca tartışılmıştır.

Anahtar kelimeler: *Pisolithus albus*, Gastroid mantarlar, Yeni kayıt, Türkiye

Introduction

Pisolithus is a genus of the gastroid family *Sclerodermataceae* within the order *Boletales* (*Basidiomycota*). Its members have a wide distribution ranging from temperate to tropical regions and they are ectomycorrhizal species associated with some woody plants. The members have been reported in different environments such as forests, damaged areas, eroded soils, plantations, mining, and roadsides. They are also known to be highly effective in promoting plant growth in dry habitats with high soil temperatures (Moyersoen et al. 2004; Lebel et al., 2018).

According to the index fungorum, the genus contains 16 species (*P. kisslingii* E. Fisch., *P. arhizus* (Scop.) Rauschert, *P. aureosericeus* M.P. Martín, Kaewgraj., *P. abditus* Kanch., Sihan., Hogetsu & Watling, *P. hypogaeus* S.R. Thomas, Dell & Trappe, *P. indicus* Natarajan & Senthil., *P. marmoratus* (Berk.) E. Fisch., *P. orientalis* Watling, Phosri & M.P. Martín, Pennycook & Beever, *P. capsulifer* (Sowerby) Watling, Phosri & M.P. Martín, *P. aurantioscabrosus* Watling, Phosri & Watling, *P. microcarpus* (Cooke & Massee) G. Cunn., *P. calongei* M.P. Martín, Phosri & Watling, *P. croceorrhizus* P. Leonard & McMull.-Fish, *P. tympanobaculus* T. Lebel & M.D. Barrett and *P. thermaeus* T. Lebel, *P. albus* (Cooke & Massee) Priest.). forming an ectomycorrhizal association with broadleaved and coniferous trees (Martin et al., 2002).

P. albus is prevalent in dry or dispersed areas such as sandy and gravelly soils, and develops in ectomycorrhizal associations with *Acacia* Wılld., *Corymbia* K. D. Hill & L. A. S. Johnson and native *Eucalyptus* L'Hér. members in Australia, endemic species *Kunzea tenuicaulis* de Lange in New Zealand, native

species *of Acacia, Arillastrum* Pancher ex Baill., *Melaleuca* L., *Sannantha* Peter G. Wilson, Babingtonia Lindl. and *Tristaniopsis* Brongn. & Gris in New Caledonia, plantation *Acacia* and *Eucalyptus* species in China, India, Morocco, Malaysia, Thailand, Spain and Senegal, plantation of *Eucalyptus* members in Burkina Faso, Chad, Tunisia, Niger, Côte d'Ivoire, Morocco, Madagascar and Italy (Gargano et al. 2018, Hosaka, 2009; Jaouani et al., 2015; Lebel et al., 2018).

Considering the current literature on Turkish mycobiota (Sesli and Denchev, 2014; Sesli et al, 2020), the sole member of the genus *Pisolithus* that has thus far been reported from Türkiye is *P. arhizus*, and to the best of our knowledge, there is no record related to *P. albus*.

Material and Method

Morphological study

Pisolithus specimens were sampled from Bodrum (Muğla-Türkiye) amid fieldwork conducted on September 21, 2020. Macroscopic and ecological features of the specimens were noted at their site of collection. Necessary macroscopic and microscopic data were obtained by standard techniques. Identification of the specimens was performed with the guidance of the literature (Gargano et al., 2018; Jaouani et al., 2015; Lebel et al., 2018). Herbarium materials were prepared from the identified specimens and kept at Ankara University Herbarium (ANK).

ITS rDNA Sequence Analyses

The nuclear DNA of ANK AKATA & Altuntaş 699 was enriched by employing the CTAB method as previously described (Rogers and Bendich, 1994). The quality and the quantity of the isolated nuclear DNA were assessed spectrophotometrically (Nanodrop Lite Thermo Scientific) and later it was used as a template in a polymerase chain reaction (PCR) to amplify the Internal Transcribed Spacer (ITS) rDNA regions. In the PCR amplification of the ITS rDNA regions, the ITS1 forward and ITS4 reverse universal oligonucleotide primers were utilized as described elsewhere (Stielow et al, 2015). The PCR amplicons were electrophoretically validated as single and sharp bands on an agarose gel and later they were purified with PureLink™ PCR Purification Kit (Thermo) and sequenced with Sanger dideoxy sequencing method using the ITS1 and ITS4 primers and the BigDye™ Direct Cycle Sequencing Kit (Thermo) in the sequencing PCR. The fragment analyses were performed using ABI Prism 310 Sequencer. Agarose gel electrophoresis and Sanger DNA sequencing were carried out as previously reported (Chen et al., 2014).

Phylogenetic Characteristics of ANK Akata & Altuntaş 699

In molecular phylogenetic analyses, the sequences obtained from the Sanger chromatograms were assembled using Geneious Prime software (Dotmatics) and a similarity index analysis was performed using the NCBI BLASTn online tool. According to this search tool, the in-group and the out-group members were determined and their sequence data were obtained from the NCBI GenBank for the phylogenetic analysis. The assembled sequence and the ITS rDNA sequences of the selected in-group and out-group members were aligned using the MUSCLE algorithm of MEGAX software (Kumar et al., 2018). The evolutionary history of ANK Akata & Altuntaş 669 was estimated from a phylogenetic tree constructed using the Maximum Likelihood method and K2 + G nucleotide substitution model (Kimura, 1980). The bootstrap method was implemented for the accuracy estimation by applying 1000 bootstrap replicates (Felsenstein, 1985).

Result

Fungi

Basidiomycota Whittaker ex R.T. Moore

Boletales E.-J. Gilbert

S*clerodermataceae* Corda

Pisolithus Alb. & Schwein

Pisolithus albus (Cooke & Massee) Priest, in Lebel, Pennycook & Barrett, Phytotaxa 348(3): 167 (2018) (Figure 1).

Basionym: *Polysaccum album* Cooke & Massee, Grevillea 20 (no. 94): 36 (1891).

Obligate synonym: *Pisolithus albus* (Cooke & Massee) Priest, in Bougher & Syme, Fungi of Southern Australia (Nedlands): 122 (1998).

Macroscopic and microscopic features

Basidiomata 30-50 mm in diam., epigeous, claviform, subglobose to pyriform, base mostly deeply rooting. **Peridium** thin, membranous, smooth, one-layered, whitish to grey or cream-colored, brownish in ripe basidiomata. **Gleba** ellipsoid to ovoid, developing within peridioles, **Peridioles** covered by a thin, yellowish to the ochraceous membrane, embedded in and divided by a gelatinous blackish matrix. **Stem** 10-20 mm broad, yellowish to light brown. **Spore mass**: olive-brown. Clamp connection present. **Basidia** not seen. **Spores** 9-11 µm diam (including ornamentation), yellowish brown, globose with erect or curved spines (up to 1µm high).

Examined samples: TÜRKİYE—Muğla: Bodrum, Turgutreis, under eucalyptus, sea level, 37° 01' 12'' N, 27°15' 07'' E, 21.09.2020, ANK Akata & Altuntas 699.

Evolutionary History of ANK Akata & Altuntaş 699

The nuclear ITS rDNA sequence of ANK Akata & Altuntaş 699 revealed by Sanger sequencing was entered to the NCBI GenBank with the accession no: OP363350.1. In a evolutionary history analysis of ANK Akata & Altuntaş 699, considering the results of the nucleotide BLAST analysis conducted using the ITS rDNA sequence of the specimen, some members of the genus *Pisolithus*, the single genus of the family *Pisolithaceae*, were chosen for ingroup sequences and

the nuclear ITS rDNA sequence of *Lycoperdon perlatum* was chosen for the outgroup sequences. As a result of the evolutionary history analysis, four distinct clades aroused in addition to an outgroup (Figure 2). While the clade 4 included some distinct isolates of *Pisolithus albus* and the specimen ANK Akata & Altuntaş 699, the clades 1, 2, and 3 comprised other species from the genus Pisolithus including *P. arhizus*, *P. capsulifer* and *P. croceorrhizus* respectively. On the other hand, *Lycoperdon perlatum* branched separately from the ingroup clades and formed an outgroup as anticipated. The BLAST analysis conducted with the nuclear ITS rDNA sequence of ANK Akata & Altuntaş 699 showed similarity rates above 99% with different isolates of *P. albus*. The phylogenetic analyses conducted herein further confirmed the close identity relationship of this specimen with *P. albus* with a high branch bootstrap rate.

Discussions

Pisolithus members can easily be recognized in the field because of their macroscopic appearance but it is not doable to define the full range of known *Pisolithus* species without using macroscopic and microscopic characteristics and information about mycorrhizal partners (Lebel et al., 2018).

P. albus is an ectomycorrhizal species associated with plants containing the members of *Eucalyptus, Kunzea, Acacia, Tristaniopsis, Arillastrum, Babingtonia, Melaleuca, Sannantha and Corymbia. P. thermaeus* T. Lebel, *P. orientalis* Watling, Phosri & M.P. Martín, Pennycook & Beever, *P. marmoratus* (Berk.) E. Fisch., *P. croceorrhizus* P. Leonard & McMull.-Fish. *P. microcarpus* (Cooke & Massee) G. Cunn., and *P. tympanobaculus* T. Lebel & M.D. Barrett may be confused with *P. albus* in terms of their similar morphology and ectomycorrhizal partners. Like *P. albus, P. croceorrhizus* form ectomycorrhizal associations with *Eucalyptus, Acacia, Corymbia,* and *Kunzea tenuicaulis* and it is characterized by its pale brown basidiomata suspended on golden rhizoids forming a pseudostipe, and its spiny reticulate basidiospores. This species may be confused with former species in young basidiomata but *P. albus* is easily separated from *P.croceorrhizus* by its larger spores with isolated spines.

Although *P. albus* and *P. marmoratus* are associated with similar plants (*Eucalyptus* and *Kunzea tenuicaulis*), the latter species differs from the former by its fragile and darker peridium (brown and amber) with warts, mass tan to sand brown spore mass, globose to subglobose spores (7–12 x 7–9µm in diam.) with echinulate spines. *P. microcarpus* has an ectomycorrhizal relationship with *Eucalyptus* and *Acacia* members.

Despite sharing similar habitats, *P. albus* and *P. microcarpus* can be distinguished from each other by using both microscopic and macroscopic features. While black-warted, golden-brown peridium and short (6–7.5µm diam.) with erect spines are characteristics of *P. microcarpus*, whitish to grey or cream-colored peridium and larger spores (9-12 µm diam.) with spines are of *P. albus. P. orientalis* and *P. tympanobaculus* are associated specifically with *Eucalyptus* species. While *P. orientalis* differs from *P. albus* by its snuff brown to cigar brown peridium and globose spores with isolated groups of connate spines, *P. tympanobaculus* by pale yellow buff peridium with black patches and smaller spores (6-8,5 µm diam.) with ornamentation of robust short spines coalescing into secondary conical warts to 0.6 µm high.*P. thermaeus* has only been recorded to associate with *Kunzea tenuicaulis* which is endemic species in New Zealand. This species could be distinguished from *P. albus* by its pale brown peridium with dark patches (Gargano et al., 2018; Jaouani et al., 2015; Lebel et al., 2018; Mifsud and Mifsud 2022; Phosri et al, 2012).

The genetic diversity of fungal species far exceeds their morphological diversity and therefore for more robust identifications of fungal species, the genetic information is usually exploited along with using conventional methods that rely solely on morphological data. For this purpose, various useful genetic markers including rRNA gene regions such as nrITS, nrSSU, and nrLSU as well as sequences of protein-coding genes are employed for molecular systematics studies for the last several decades (Raja et al., 2017). Among them, ITS is one of the most extensively used genetic markers for members of the kingdom fungi and therefore provides valuable information for molecular taxonomic studies. Hence, we utilized nuclear ITS rDNA sequences for the molecular identification of ANK Akata & Altuntaş 699. nrITS rDNA-based molecular identification revealed more than 99% similarity between *P. albus* and the specimen (GenBank ID: OP363350.1) (Figure 2).

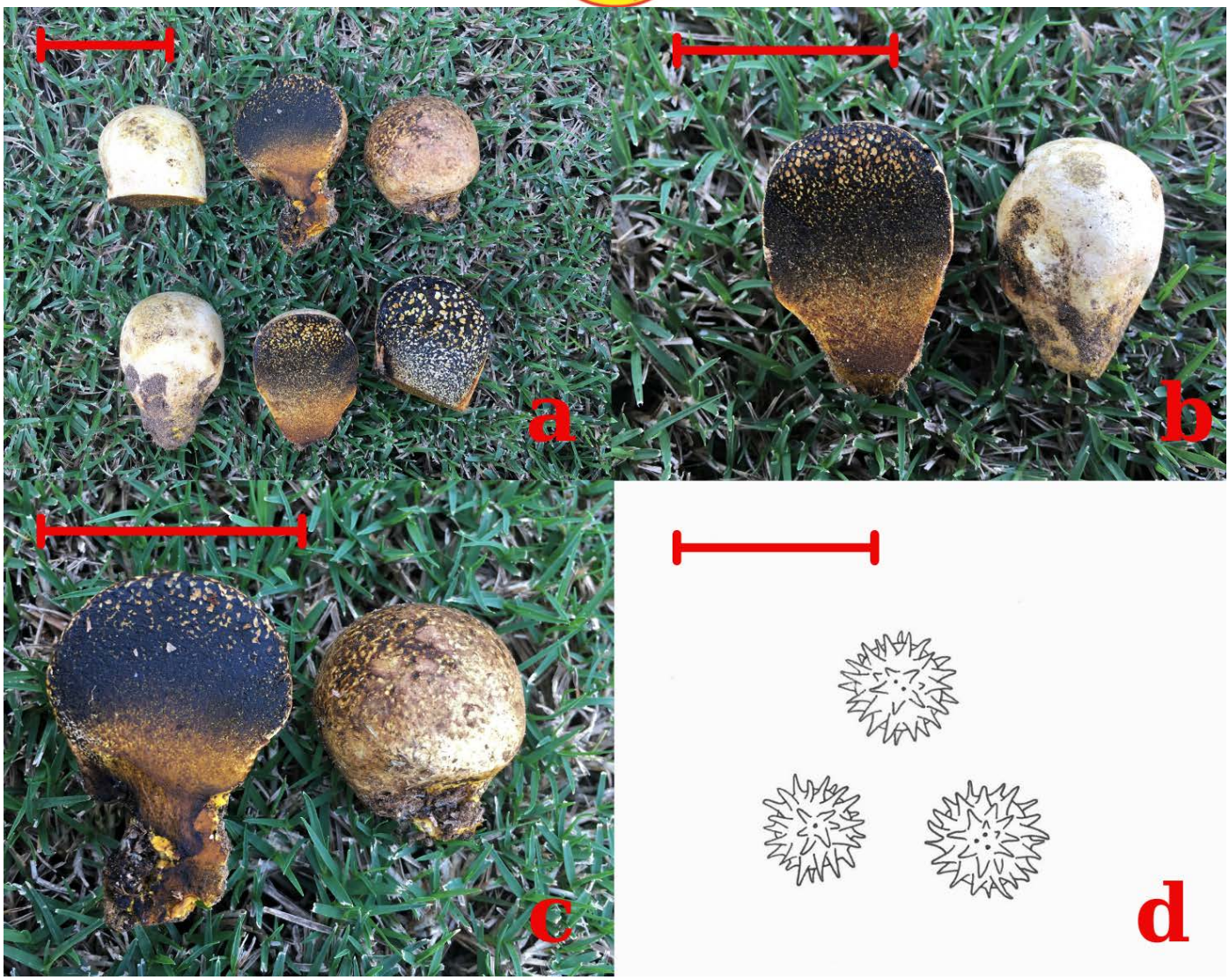

Figure 1. *Pisolithus albus*: **a-c.** basidiomata (bars: 5 cm)**, c.** spores (bar: 20 µm).

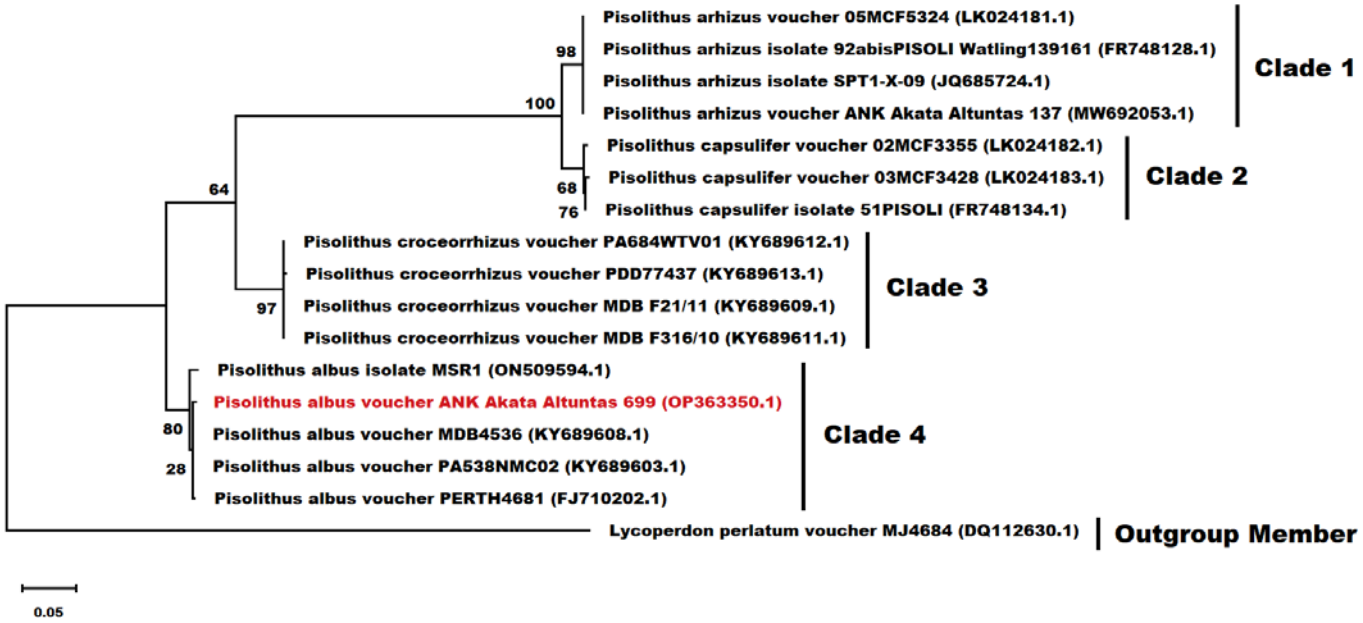

Figure 2. The ML phylogenetic tree showing the evolutionary relatedness of 17 fungal specimens conjectured from the nrITS rDNA region. Bootstrap rates (≥50) were shown for each branch. All of the sequences used to construct the phylogenetic tree were obtained from NCBI GenBank except for ANK Akata & Altuntaş 699. *Lycoperdon perlatum* was used as the outgroup member in the phylogenetic tree. GenBank accession numbers are also provided for each sequence. The scale bar given on the lower left indicates a genetic distance of 0.05.

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Molecular and Morphological Identification of *Melanoleuca cinereifolia* from Türkiye

Aysenur KALMER[1*], Ayten DIZKIRICI TEKPINAR[2], Ismail ACAR[3]

** Corresponding author: aysenurkalmer@gmail.com*

[1]Department of Molecular Biology and Genetics, Faculty of Science, Van Yüzüncü Yıl University, Van, Turkiye
Orcid No/Orcid ID: 0000-0001-6176-8812/aysenurkalmer@gmail.com
[2]Department of Molecular Biology and Genetics, Faculty of Science, Van Yüzüncü Yıl University, Van, Turkiye
Orcid No/Orcid ID: 0000-0002-0578-5092/aytendizkirici@gmail.com
[3]Department of Organic Agriculture, Başkale Vocational High School, Van Yüzüncü Yıl University, Van, Turkiye
Orcid No/Orcid ID: 0000-0002-6049-4896/iacar2011@gmail.com

Abstract: *Melanoleuca cinereifolia* is identified based on macro/micro-morphological characters and DNA sequences of the nuclear ribosomal Internal Transcribed Spacer (nrITS) region and is reported here for the first time from Diyarbakır province of Türkiye. Macro- and micro-morphological description of the species is provided along with the photographs of fresh basidiomes in natural habitat and the line drawings. The species is mainly characterized by basidiome with a short stipe, grayish-brown pileus, grey lamellae and lageniform cystidia. In the phylogram, *M. cinereifolia* is clustered with its allies in the subgenus *Melanoleuca*. Morphological and molecular similarities and differences among the species and the close relatives were discussed in detail.

Key words: DNA, ITS, Molecular taxonomy, *Agaricales*

Türkiye'den *Melanoleuca cinereifolia* Türünün Moleküler ve Morfolojik Teşhisi

Öz: Bu çalışmada *Melanoleuca cinereifolia*, Türkiye'nin Diyarbakır ilinden ilk kez rapor edilmiş, makro/mikro-morfolojik karakterleri ile nükleer ribozomal Internal Transcribed Spacer (nrITS) bölgesinin DNA dizileri baz alınarak tanımlanmıştır. Türün makro ve mikro morfolojik tanımı, doğal ortamdaki taze bazidyomların fotoğrafları ve mikroskobik yapılarının çizimleri ile birlikte verilmiştir. Bu tür esas olarak kısa saplı, grimsi kahverengi şapka, gri lamelli ve şişe biçiminde sistityumlu bazidiyom ile karakterize edilir. Filogramda, *M. cinereifolia*, *Melanoleuca* alt cinsindeki akrabaları ile birlikte kümelenmiştir. Türler ve yakın akrabaları arasındaki morfolojik ve moleküler benzerlikler ve farklılıklar ayrıntılı olarak tartışılmıştır.

Anahtar kelimeler: DNA, ITS, Moleküler taksonomi, *Agaricales*

Introduction

Melanoleuca Pat. (*Agaricales*) is fungus distributed widely throughout the world with several edible species (Antonín et al., 2017). The genus is mainly characterized by a collybioid to tricholomatoid habit, dull color basidiomes, white to pale yellowish lamellae, strongly amyloid and warted spores, distinct cheilocystidia, and a lack of clamp connections (Vesterholt, 2008). Species of *Melanoleuca* are difficult to distinguish morphologically since many species appear very similar and differentiated by only using a few ambiguous features (Vizzini et al., 2011). Molecular techniques are proved to be successful approaches along with traditional methods for correct identification and reclassification. The sequence of the nrITS region is a superior molecular DNA barcode for molecular identification of Basidiomycetes (Schoch et al., 2012) so this region is used in the current study. In Turkiye, 24 *Melanoleuca* species have been reported until 2020 (Sesli et al., 2020) and 3 of them were listed in our

studies (Acar et al., 2017; Kalmer et al., 2018). In the current study, *Melanoleuca cinereifolia* Bon (Bon) was identified based on microscopic/macroscopic and molecular analyses. Some *Melanoleuca* species are reported to be edible while no information is found for the rest (Wu et al., 2019). *Melanoleuca cinereifolia* was first described in 1970 by a French mycologist, Marcel Bon (Saba and Khalid 2014). There is not any report that points out whether this species is edible or not. Furthermore, *Melanoleuca* species may be useful for pharmacological studies because of their antioxidant capacity (Bahadori et al., 2019). The purpose of the present study is to identify the collected materials by using morphological and molecular data and to publish a new species, *Melanoleuca cinereifolia*.

Material and Metod

Morphological studies

Samples were determined during routine visits to the eastern region of Turkiye. Basidiomata were collected from Hani district of Diyarbakır in 2012 and photographed with a Canon (EOS 60D) camera equipped with Tokina 100 mm macro lens in their natural habitats. For micro-morphological studies, tissues from pileus, stipe, and gills were mounted in Melzer's reagent, and distilled water. Microscopic structures were stained with Melzer's reagent and KOH (5 %) and analyzed by using a Leica DM500 research microscope. Color images were obtained with the Leica ICC50 HD camera, and measurements were carried out with Leica Application Suite (version 3.4.0) programme. Methods used for morphological descriptions were performed based on the following literature; Boekhout, (1999); Breitenbach and Kränzlin (1991); Vizzini et al., (2011); Buczacki, (2012); Garcia et al., (2013); Kuo and Methven (2014). The voucher specimens were deposited in the Fungarium of Van Yüzüncü Yıl University (VANF).

Molecular studies

Total DNA was extracted from dried basidiomata using the CTAB method with minor modifications (Doyle and Doyle, 1987). The purity and quantity of extracted DNA were determined by using NanoDrop2000c UV–Vis Spectrophotometer (Thermo Scientific) and 0.8% agarose gel electrophoresis. DNA amplification was performed in a 25 µl volume mixture containing genomic DNA (10 ng/µl), 10X PCR Buffer, MgCl2 (25 mM), dNTP mixture (10 mM), selected primer pair (10 µM), Taq polymerase (5u/µl) and sterile water. To amplify ITS (ITS1-5.8S-ITS2) region, primer pairs N-nc18S10 5'AGGAGAAGTCGTAACAAG3'/C26A 5'GTTTCTTTTCCTCCGCT3' (Wen and Zimmer, 1996) were used. PCR products were run in a 1.0 % agarose gel and visualized by staining with Gelred dye. Positive reactions were sequenced with forward and reverse PCR primers using ABI 3730XL automated sequencer (Applied Biosystems, Foster City, CA, USA). Sequences were subjected to BLAST at GenBank and the *Melanoleuca* sequences with the highest homologies were retrieved for phylogenetic analysis. DNA sequences of nrITS region taken from the present study were aligned with 54 nrITS sequences (31 taxa) retrieved from GenBank using ClustalW (Thompson et al., 1994). Genetic parameters were calculated using Molecular Evolutionary Genetics Analysis software (MEGA 6; Tamura et al., 2013). To determine the phylogenetic positions of the sampled specimens, dataset was performed with IQ-TREE v.1.6.12 software (Nguyen et al. 2015) using TIM2+F+G4 model of evolution for ITS dataset. Branch support was obtained through 1000 replicates of ultrafast bootstrap (Hoang et al. 2018) and Shimodaira–Hasegawa (SH)-like approximate likelihood ratio tests (Guindon et al. 2010). Support values are given as SH-like approximate likelihood ratio test support (SH-aLRT) [%] / Ultrafast Approach Bootstrap (UFBoot) [%].

Results

Taxonomy

Melanoleuca cinereifolia Bon (Bon). Docums Mycol. 9(33): 71 (1978) (Fig. 1-2)

Synonymy: Synonymy: *Melanoleuca cinereifolia* var. *maritima* Huijsman ex Bon,–*Melanoleuca maritima* Huijsman, *Melanoleuca strictipes* var. *cinereifolia* Bon

Description: Pileus; 30–40 mm, plano-convex, thin, smooth, grayish-brown with slightly darker center. Lamellae; adnate, close, white to gray. Stipe; 20–30 × 4–7 mm, central, equal, striate, solid, sometimes bulbous at the base, fibrillose, brown to dark pale brown. Basidiospores; 7.6–9.0 × 4.0–5.8 µm, ellipsoid, apiculus absent, warty, amyloid, hyaline in KOH. Basidia; 8.0–10(12) × 25–30 µm, clavate, four-spored, hyaline in KOH. Cheilocystidia; 48–60(70) × 9–13(15) µm, lageniform, urticiform, sometimes septate, hyaline, with crystals at the apex. Pleurocystidia; similar to cheilocystidia. Pileipellis; a cutis, cylindrical, 8–15 µm wide, thin-walled, hyaline in KOH. Caulocystidia; cylindrical, 5–12(14) µm, hyaline to pale yellow in KOH. Clamp connections absent.

Specimens examined: TÜRKİYE, Diyarbakır, Hani, in grassland and meadows area, 38° 24' 08"N, 40° 23' 40"E, 846 m, 13.11.2012. Acar. 36 (VANF). Genbank accession numbers: OK356906-OK356907.

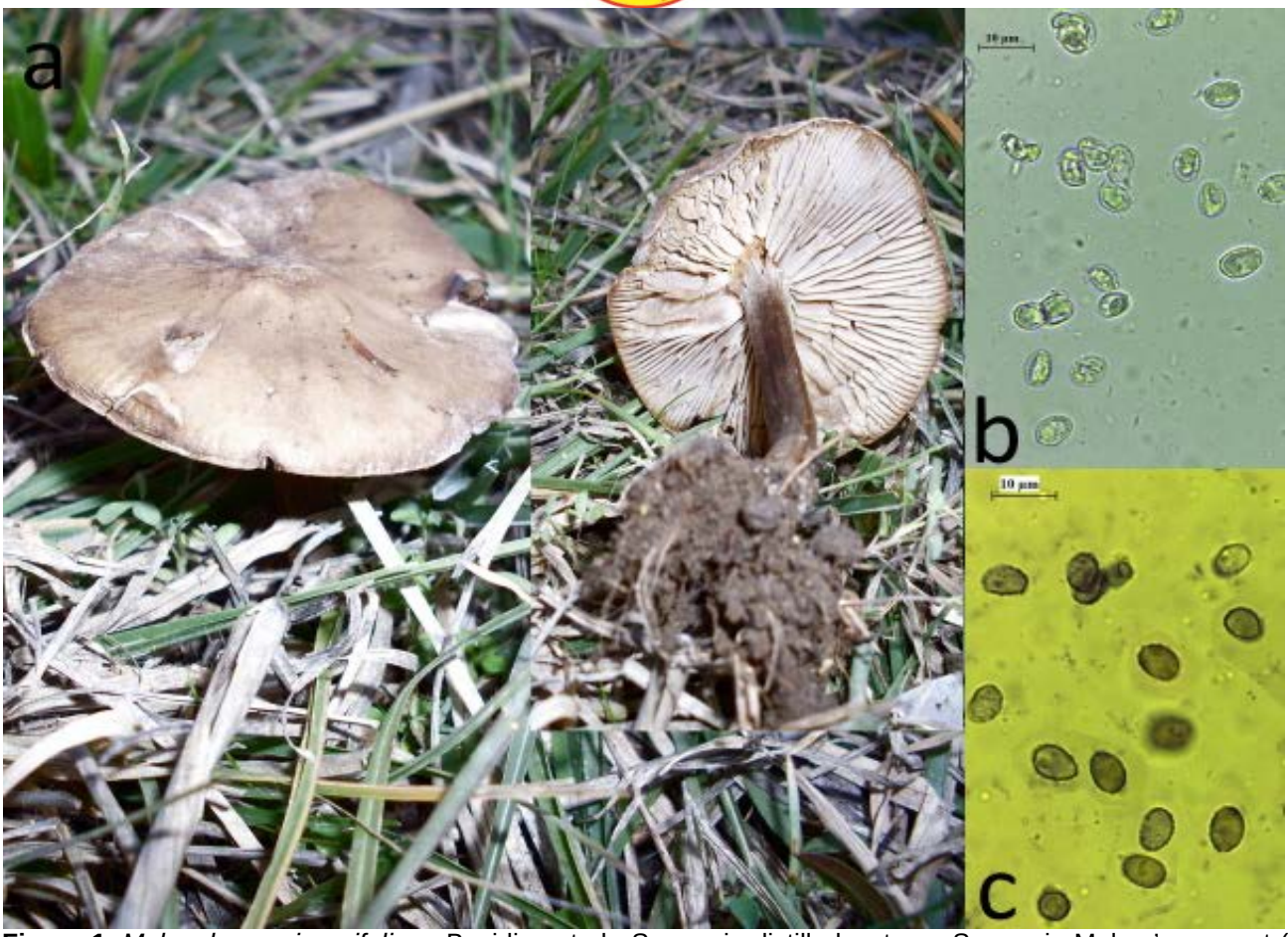

Figure 1. *Melanoleuca cinereifolia* a. Basidiomata b. Spores in distilled water c. Spores in Melzer's reagent (Scale bar=10 µm).

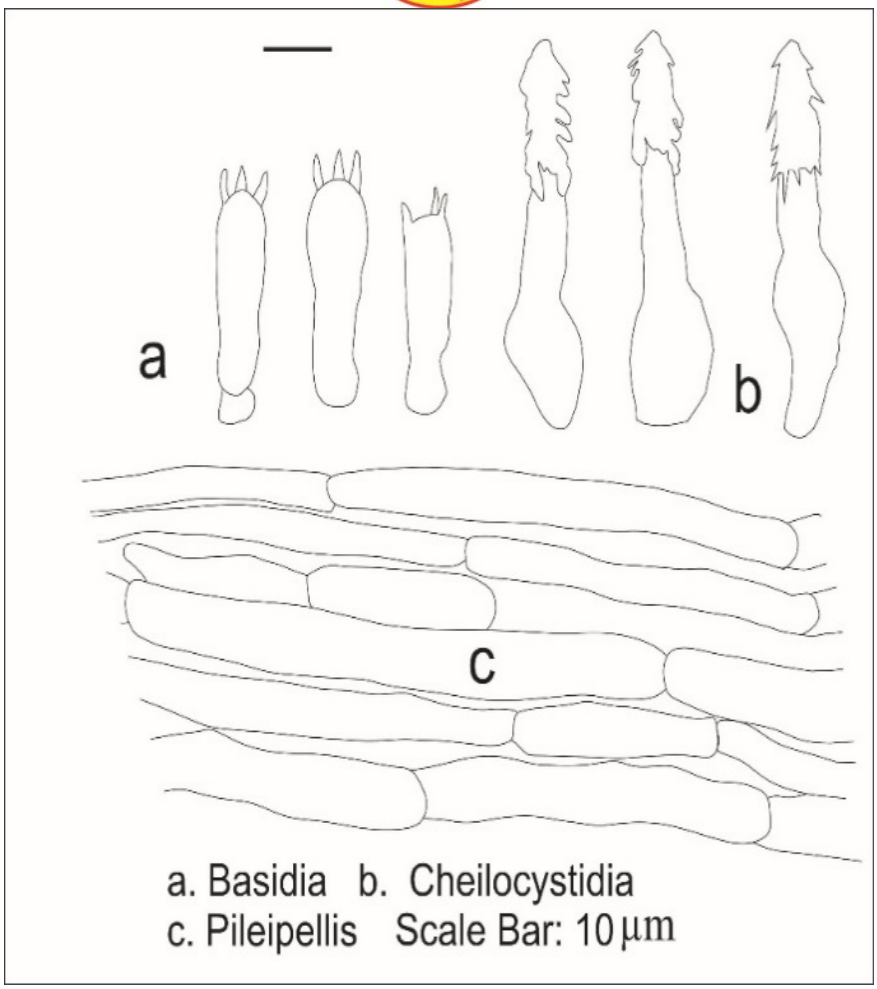

Figure 2. *Melanoleuca cinereifolia* a. Basidia b. Cheilocystidia c. Pileipellis (Scale bar=10 µm).

Molecular identification

Two nrITS sequences were used for phylogenetic analysis. The sequences were submitted to GenBank and the accession numbers were given in the text. The ITS data matrix included 54 sequences in total. The amplified DNA fragment of the region was approximately 650 bp length encompassing complete ITS1, 5.8S and ITS2 sub-regions. The final data set included a total of 636 positions, of which 452 were conserved, 181 were variable.

The studied *Melanoleuca cinereifolia* (OK356906-OK356907) sequences showed 100% homology with *M. cinereifolia* (JN052137-JN052138-JF908356). Some of the DNA sequences of our samples, especially the clean and reliable ones were blasted in NCBI and the samples showing the highest homologies were retrieved and added to our dataset.

Two major clades, supporting recognition of two subgenera (*Urticocystis* and *Melanoleuca*), were observed in the phylogram (Figure 3). Clade *Melanoleuca*, which was supported by 92% SH, 90% UF support, included the taxa with mainly lageniform cystidia or rarely without cystidia. Clade *Urticocystis* was supported by a robust support values (100% SH, 100% UF) and included the taxa mainly with mainly with urticocystidia but also with macrocystidia.

The studied specimens of *M. cinereifolia* is the part of the clade around *M. cinereifolia* and *M. ammophilum* (91% SH, 97% UF). The position of *M. cinereifolia* in this major clade was supported by the absence of the large brevipes-type cystidia.

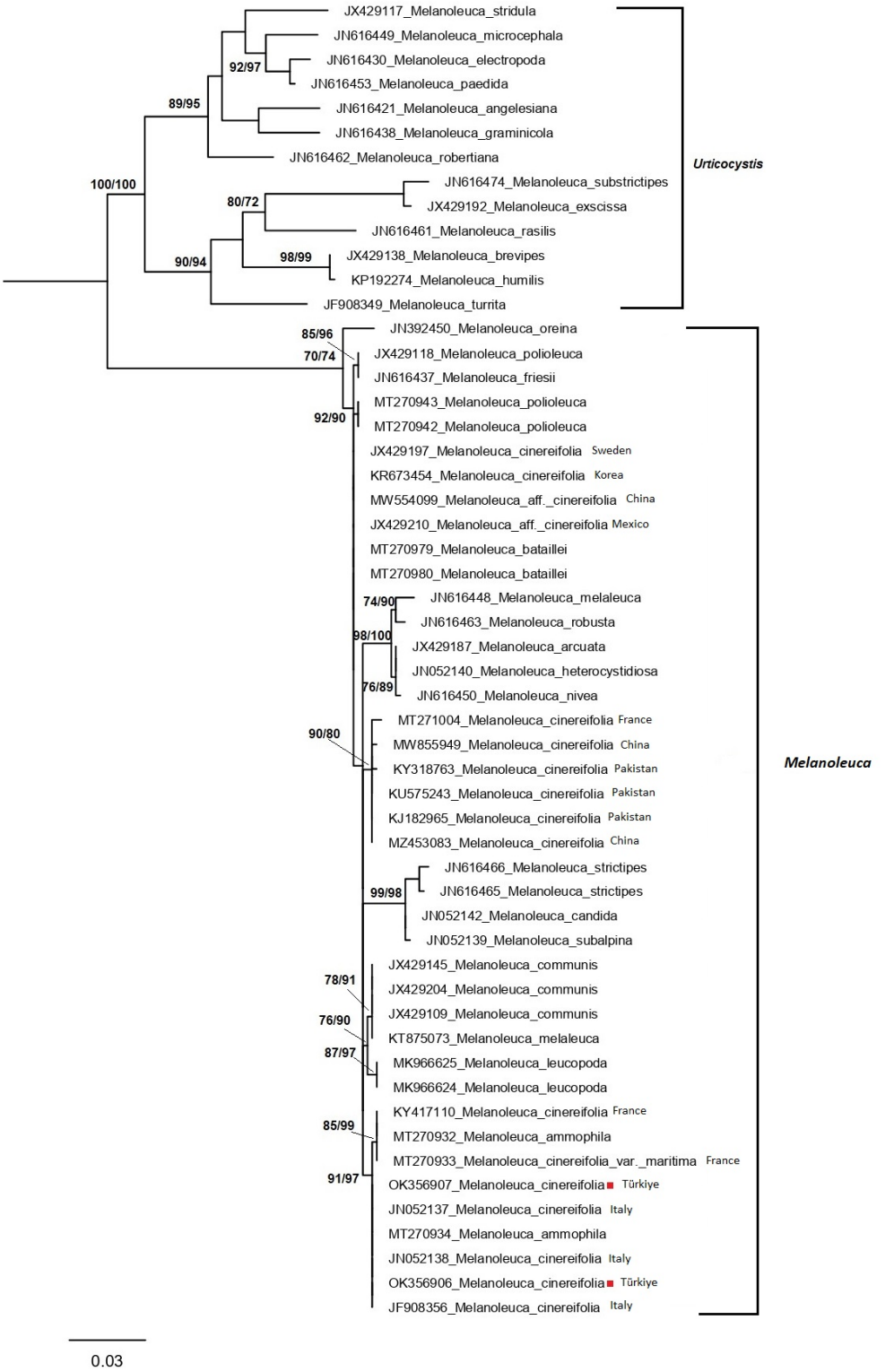

Figure 3. Phylogenetic relationship of *Melanoleuca cinereifolia* with other *Melanoleuca* spp. based on the ML method. Sequences generated from the local collection are marked with red bullets.

Discussions

Identification of *Melanoleuca* species is controversial since the morphology of the species are easily affected by environmental factors. Therefore, just traditional taxonomy may not be enough to determine the species correctly.

Melanoleuca cinereifolia is reported here for the first time from Diyarbakır province of Turkiye. Key characteristics of the species are as follow; convex, thin and greyish brown pileus with dark brown center; concolorous short solid stipe often with subbulbous base and the lower part of the stipe darker brownish, greyish close lamellae, quite lageniform cystidia and usually dunes habitats (Bon, 1991; Vesterholt, 2008; Saba and Khalid 2014; Duriska et al., 2017). Morphologically, *M. cinereifolia* can be confused with *M. polioleuca* (Fr.) Kühner & Maire however it differentiates from *M. polioleuca* in having a less color pileus with flexed to down at margin, a darker brown stipe, and a different shape of cheilo- and pleurocystidia. Phylogenetically, the Turkish specimens of *M. cinereifolia* closely grouped with *M. ammophila*. *Melanoleuca ammophila* has more robust and larger basidiomes (pileus 40–50 mm diam., stipe 30–70 mm long vs. 30–40, 20–30) (Antonín et al. 2021). Micromorphologically, the cheilocystidium of *M. ammophila* is thin-walled with slightly thick walled apex compared to *M. cinereifolia*. Another difference between these taxa is the pileipellis structure which in the new species presents a thicker ixocutis (15 µm vs. 11 µm).

In the phylogeny obtained, the sampled sequences of *M. cinereifolia* species appear in three clades. One of them, with collections from Sweden, Korea, China and Mexico. *Melanoleuca cinereifolia* closely clustered with sequences of Antonín et al. (2017) (KY417110), Antonín et al. (2021) (MT270933), Garbelotto et al. (unpublished-JN052137-JN052138), Osmundson et al. (2013) (JF908356) in the phylogram. The other two clades are composed of specimens from China and Pakistan included the type specimen (MT271004) form France.

Melanoleuca cinereifolia was originally described from Europe; usually develops in dunes (Vesterholt, 2008). Sánchez-García et al. (2013) reported *M. cinereifolia* from Mexico City and collected from mountain mesophilic forest. Also, *M. cinereifolia* collected from *Pinus wallichiana* forest in Pakistan (Saba and Khalid, 2014). However, Turkish specimens were collected from grassland and meadow. There are no previous reports of *M. cinereifolia* being associated with grassland. This report serves as the first documentation of this association. According to the reports of *M. cinereifolia*, it shows different ecological range.

In the present study, *Melanoleuca cinereifolia* specimens collected from Eastern Turkiye are identified by using morphological and molecular data. Morphological observation and phylogenetic analyses confirm that *Melanoleuca cinereifolia* is a new record for Turkish mycobiota.

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YAYIN İLKELERİ

SELÇUK ÜNİVERSİTESİ MANTARCILIK UYGULAMA Ve ARAŞTIRMA MERKEZİ'nin yayınladığı **MANTAR DERGİSİ (e-ISSN 2147 6845);** Ulusal veya Uluslararası Mikoloji alanıyla ilgili araştırma sonuçlarını içeren orijinal araştırma ve derleme makalelerin yayınlandığı elektronik HAKEMLİ bir dergidir.

Dergiye yayınlanmak üzere sunulan makaleler, Baş Editör tarafından konusu açısından dergide yayınlanmasının uygunluğuna karar verildikten sonra, derginin yazım kurallarına göre ön kontrolden geçirilir. Sonra Editör Kurulu aracılığı ile ilgili uzmanlık alanındaki hakemlere bilimsel yönden değerlendirilmek üzere gönderilir. Baş Editör, Bilimsel Hakemlerin eleştiri ve önerileri ile yazarın bunlara verdiği cevaplar doğrultusunda eserin yayınlanıp, yayınlanamayacağına karar verir. Yayınlanması uygun görülmeyen eserler hakkında yazarlara bilgi verilir. Yayınlanması uygun görülen eserlerin matbaa provası yazarlara gönderilir ve son kontrol okuması yapılır. Son okumada imla ve şekilsel hatalar dışında düzeltme veya ekleme yapılmaz. Derginin yayın dili Türkçedir. İngilizce dilinde de yayın kabul edilebilir.

Yazar makalesi ile ilgili en az 5 uzman ismini iletişim bilgileriyle beraber(cep tlf, e-posta adresi) word dosyası olarak, Hakem Öneri Formunu doldurarak sisteme ek dosya olarak yüklemelidir.

Sisteme yüklenen makalelerin bir an önce işleme alınabilmesi için; "Hakem Öneri Formu" ve "Son Kontrol Formu" renkli olarak taranmış şekilde sisteme ek dosya olarak yüklenmelidir.

MAKALE YAZIM KURALLARI

Makale, **A4 boyutunda,** kenarlarda **2 cm** boşluk bırakılacak şekilde, 1.5 **aralıklı**, **arial** yazı karakterinde, **10** punto kullanılarak Word 2003 veya daha üst sürümdeki programla yazılmalıdır. Makalenin word dosyasında otomatik numaralandırma kullanılmamalıdır. Makalenin bölümleri sırayla şöyle olmalıdır;

(Türkçe Makaleler için);

Türkçe Başlık, Yazarlar(sorumlu yazar belirtilmelidir) ve adresleri, E-postaları, Orcid numaraları, Öz, Anahtar kelimeler, İngilizce Başlık, Abstract, Key words, Giriş, Materyal ve Metot, Bulgular, Tartışma, Kaynaklar.

(İngilizce makaleler için);

İngilizce Başlık, yazarlar(sorumlu yazar belirtilmelidir) ve adresleri, E-postaları, Orcid numaraları, Abstract ve Key words, Türkçe Başlık, Öz ve Anahtar kelimeler, Introduction, Material and Method, Results, Discussion, References.

Derleme çalışmalarda da mevcut başlıkların (materyal ve metot hariç) kullanılması gerekir. Bulgular ve Tartışma başlıkları tek başlık altında verilebilir.

Yazar gerekli görürse alt başlıklar kullanabilir. Her bölüme ait başlıklar kalın ve ilk harfleri büyük yazılmalıdır. Metin içinde geçen tüm bilimsel isimler italik olmalı, eğer başlık içerisinde yer alıyorsa hem italik hem de kalın olmalıdır. Tür isimleri ilk geçtikleri yerde yazarlarıyla birlikte verilmelidir. Daha sonraki yerlerde sadece takson isimleri yazılmalıdır. Bölümler arasında bir satır boşluk bırakılmalıdır.

Başlık: Türkçe makalelerde; makalenin Türkçe başlığı 14 punto, İngilizce başlığı 12 punto, İngilizce makalelerde ise İngilizce başlık 14 punto, Türkçe başlık 12 punto, sadece baş harfleri büyük ve kalın olmalıdır. Yazar isimlerinin baş harfi ve soyadı büyük olmalı, adresler ismin altına yazılmalı, sorumlu yazarın e-mail adresi mutlaka belirtilmelidir. Akademik unvanlar makalede yer almamalıdır.

Anahtar kelimeler: 4-10 kelimeden oluşmalıdır.

Giriş: Araştırma konusu mümkün olduğu kadar güncel olarak kısa ve özlü değerlendirilir. Çalışmanın amacı da belirtilmelidir.

Kaynaklar: Kaynaklar metinde (soyadı, tarih) parantez içinde belirtilerek yazılmalıdır. Kaynaklar bölümü alfabetik sıraya göre 10 punto olarak yazılmalı ve yararlanılan eserlerin Yazar (yazarlarının) Adı ve soyadının ilk harfleri büyük olmalıdır. Kitap, makale ve tam metin yayımlanmış bildiri isimlerinin ilk harfleri büyük yazılmalıdır. **Lisansüstü tezler kaynak olarak gösterilemez.**

Kaynak künyeleri **APA stilinde** aşağıdaki sıraya uygun olarak yazılmalıdır (2019'dan itibaren).

Periyodik ise aşağıdaki örneğe uygun olarak:

Aktaş, S., Kaşık, G., Doğan, H. H. ve Öztürk, C. (2006). Two New Taxa Records for the Macrofungi of Turkey. *Tr.J.of Bot., 30* (4) 209-212.

Kitap ise aşağıdaki örneğe uygun olarak:

Kaşık, G., Öztürk, C., Doğan, H. H., Aktaş, S. ve Demirel, G. (2005). *Mikoloji Laboratuvarı*. Konya: Marifet Ofset Matbaa ve Kağıtçılık.

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İletişim Adresi:

S.Ü. Mantarcılık Uygulama ve Araştırma Merkezi Müdürlüğü

Mantar Dergisi Editörlüğü

Fen Fakültesi Binası B Blok Zemin Kat42079 Kampüs/KONYA E-posta: **mantarcilik@gmail.com**

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S.Ü. Mantarcılık Uygulama ve Araştırma Merkezi Müdürlüğü
Mantar Dergisi Editörlüğü
Fen Fakültesi Binası B Blok Zemin Kat42079 Kampüs/KONYA/TÜRKİYE E-posta: **mantarcilik@gmail.com**


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