Wild Edible Mushrooms as an Alternative for the Consumption of Antioxidants and Phenolic Compounds: An Overview

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Fungi are a diverse group, and they are essential for health, the economy, and food. Interest in these organisms has increased because of the importance and effect of their chemical components *viz*., phenolic compounds, which are considered an alternative source of antioxidants. Antioxidants are compounds that prevent cell damage and can help prevent or counteract certain diseases (cardiovascular, neurodegenerative, cancer, *etc*.) because they can improve cell function (changes in enzyme activity, enzyme patterns, membrane fluidity, and responses to stimuli), among others. To date, no adverse side effects have been reported. The difference in production is due to several factors, such as the growth environment, nutrition, cell age, the part from where the phenolic compounds are obtained (pileus, stipe, or mycelium), the extraction method, *etc*. This article aims to provide an overview of wild edible mushrooms, to promote the study of their antioxidant capacity, and to better understand the nutraceutical potential of edible mushrooms consumed in different parts of the world.

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INTRODUCTION

The macrofungus presents a distinctive fruiting body large enough to be seen with the naked eye (DaSilva 2005). Wild fungi are essential within the structure and functioning of the ecosystem. Saprotrophic fungi are the primary agents of decomposition of organic matter, releasing CO_2 and mineral nutrients, increasing soil fertility. Symbiotic fungi are the leading suppliers of nutrients for plants and receive in exchange the vegetable carbon derived from photosynthesis (Hawkins *et al*. 2023). Ectomycorrhizal fungi maintain efficient communication with plants and other microorganisms through a mycelial network and the exchange of nutrients, water, and defense compounds. Parasitic fungi regulate the structure of communities, maintaining biodiversity by limiting the dominance of any species within an ecosystem (Pérez-Moreno *et al*. 2021).

The role of wild fungi in nutrient recycling is of great ecological importance (Niego *et al*. 2023). Clemmensen *et al*. (2013, 2015) indicated that fungi have multifunctionality in the ecosystem (organic matter mineralization, climate regulation, and nutrient cycling). This is because of the production of a wide variety of extracellular enzymes that can break down organic matter, thus regulating carbon balance (between 40 to 55%), with production of carbon dioxide and organic acids. Moreover, *via* degradation they mobilize and release smaller organic molecules used for their growth and metabolic needs (Frąc *et al*. 2018). They also contribute to the nitrogen cycle, and this component is linked to organic substrates; in forests, almost 90 to 95% of the total soil nitrogen originates from organic matter (Niego *et al*. 2023). Hence, litter decomposition by saprotrophic fungi increases nitrogen availability in ecosystems. Fungal diversity is essential as a biotic predictor of soil multifunctionality, and fungi are critical to maintaining soil functions (Li *et al*. 2019). The fungi mineralize the organic nitrogenous components, which can be attributed to the enzymatic secretion profile that depends on the fungus species. It has been reported that the fungal species that form rhizomorphs (*Cortinarius*, *Suillus* and *Rhizopogon*) secrete high levels of nitrogenous compounds and enzymes that degrade cellulose (N-acetylglucosaminidase, β-glucuronidase). Therefore, they are usually abundant in soils with limited nutrients (Leski *et al*. 2010), and fungi with short/contact hyphae (*Russula* and *Tomentella*) usually secrete a large number of enzymes that degrade lignin (phenol-oxidase, primarily laccase). Thus, they easily access and assimilate inorganic nutrients (Ning *et al*. 2020). Wild fungi are also culturally significant. Although the vast majority of these fungi cannot be cultivated yet (studies are ongoing so that the cultivation can take place), they are essential fungi, either as a source of food with nutritional properties of quality and economic potential because the communities have an economic income with the sale of what they collect (Hall *et al*. 2003; Boa 2004).

Economic Importance of Wild Edible Mushrooms

Wild mushrooms are a significant forest, food, and economic resource, mainly for rural communities in several countries worldwide (Boa 2004). Witte and Maschwitz (2008) indicated that fungi probably developed the fruiting body at the same time as the evolution of omnivores because some animal species are strictly mycophagous. Since ancient times, man has been interested in mushrooms; the Egyptians (for 4,600 years) believed that the mushroom was the plant of immortality (El Sheikha and Hu 2018) and a gift from the god Osiris; therefore, they decreed that mushrooms were food for royalty only. The Greeks believed that consuming mushrooms gave warriors strength in battle; the Romans called them “food of the gods”, believing they emerged because of lightning strikes from Jupiter (Manzi *et al*. 1999; Arora and Shepard 2008).

The world trade of mushrooms in 2017 exceeded 1,230,000 tons as fresh or processed products (Pérez-Moreno *et al*. 2021). Among the commercially essential mushrooms is the *Amanita* sect. *caesarea*, *Morchella* spp., *Lactarius* sect. *deliciosus*, and *Ramaria* spp. For *Boletus edulis* (porcini) and related species, they are necessary for export (fresh, dried, or in brine); 50,000 tons of *Boletus* are harvested and sold annually in the national and international market. A Finnish company harvested 1,100 tons of mushrooms mainly *Boletus* in one year, with a turnover of 7.4 million USD (Cai *et al*. 2011). *Russula griseocarnosa* species is a valued species in China. This mushroom is believed to be used for the health of pregnant women, and the price of dried specimens is more than 800 Chinese yuan/kg (approximately $130/kg) (Comandini and Rinaldi 2020).

It has been indicated that there will be an annual growth rate of close to 6% in the intra-industrial trade indexes of edible wild mushrooms in different countries; apparently, the capacity to produce said resource is static, and if changes occur, they tend to decrease. In all countries, the following occurs, including global environmental problems such as deforestation, biodiversity loss, illegal trade, and climate change (de Frutos 2020). Therefore, it is crucial to promote the management of non-timber resources for conservation purposes to maintain ecosystems and, at the same time, improve and guarantee food security, environmentally friendly rural development (work and food), and preserve traditional knowledge (Pérez-Moreno *et al*. 2021).

The Edibility of Wild Fungi

Mushroom is a high protein content food that is often praised and valued because of its characteristic texture and flavor. It is estimated that there are approximately 2300 species of edible and medicinal wild fungi worldwide (Islam *et al*. 2019; Martínez-Medina *et al*. 2021). Peintner *et al*. (2013) mentioned that in European countries, there are approximately 268 species of wild mushrooms of commercial importance. Mexico is considered the wealthy second country in mushroom culture (Pérez-Moreno *et al*. 2020), with 371 edible mushroom species distributed among 99 genera (Garibay-Orijel *et al*. 2014). However, this number could be as high as 450 species by fully integrating traditional knowledge of edible mushrooms (Pérez-Moreno *et al*. 2020). China is the country with the largest number of edible fungi. Dai *et al*. (2010) reported 966 taxa (936 species, 23 varieties, three subspecies, and four forms) of edible mushrooms, while Wu *et al*. (2019) indicated 1662 taxa, of which 1020 are edible, and 692 are medicinal. Li *et al*. (2021a) conducted a review in this regard and stated that there are 2,006 edible species; the highest number of edible mushroom species was recorded in Asia (1493), followed by Europe (629), North America (487), Africa (351), South America (204), Central America (100), and Oceania (19). Approximately 614 species of edible mushrooms are found on two or more continents.

The interest in edible mushrooms has increased due to the search for foods rich in nutrients and beneficial health effects and providing income alternatives for rural communities (Pilz and Molina 2002). Because of the commercial importance of wild species, such as the matsutake (*Tricholoma* spp.) and *Lactarius* spp. (*L. deliciosus*, *L. hatsudake*, *L. volemus*, *L. vividus*, and *L. hygrophoroides*), morels (*Morchella* spp.) and boletus (*Boletus* spp.), among others, in certain countries can provide a significant economic income for collectors (Boa 2004; De-Román and Boa 2006). It is not yet known how the edible species were identified, and it is suggested that it was by trial and error, considering appearance characteristics (smell, colour, texture, *etc*.), testing small quantities (taste), and recording any adverse reactions (Li *et al*. 2021a).

There are several species of mushrooms with no nutritional or inedible value; this denomination is specific to the geographical area because, in several places, edible mushrooms are known only by their generic name, which is a guide to the traditional knowledge of consumption in each region (local practices and preferences). It should be taken into account that with certain species of mushrooms, there is no problem, as there is with *Cantharellus* species, where several species are consumed (although not all of them have a pleasant flavor). However, for the group of the genus *Amanita*, it is not possible, because this group presents not only edible species (*A. caesarea*), but toxic (*A. pantherina*), deadly (*A. verna*), and edible post treatment (*A. muscaria*) (Boa 2004). Approximately 183 mushroom species were reported to require treatment before consumption (Li *et al*. 2021a) because some mushroom species contain toxins when raw and require treatment (tissue softening and detoxification) before consumption (Niksic *et al*. 2016). Cooking and pre-treatments help to destroy and eliminate toxic compounds from raw mushrooms, as Rubel and Arora (2008) reported that parboiling is a safe detoxification method for *Amanita muscaria*.

However, some species of fungus are considered edible in some areas but not in other regions, as in the case of *Gyromitra* spp., which are edible mushrooms in Finland, Russia, Poland, Lithuania, Estonia, and Sweden, where the product is sold in cans under the brand name Fammarps. The bonnet mushroom (*G. esculenta*) is highly appreciated. It is considered an exquisite snack after being carefully cooked (Boa 2004; Hall *et al*. 2007; Li *et al*. 2021a). Also in southern Chile *Gyromitra* sp. is considered a meat substitute after treatment, which involves several steps of washing, rinsing, heating, and dehydration (Barreau *et al*. 2016). However, in some countries (Italy, Spain, and the USA), *G. esculenta* is not edible (false morels). In this regard, Leathem and Dorran (2007) indicated that 27 poisonings by *G. esculenta* have been reported; none were fatal, but there was liver damage (33%) and kidney failure (11%). Poisonings were more common in the eastern USA, whereas west of the Rocky Mountains poisonings were rare. Hence, growth conditions (biotic and abiotic factors) are essential. Additionally, the edible species of the *Boletus* are not consumed in Tanzania; however, in other places, they are widely consumed (China, Italy) and even exported (Boa 2004). The *Armillaria mellea* is an edible and medicinal mushroom (honey fungus). It has been reported as a saprophytic, pathogenic, and mycorrhizal fungus, and it grows wild on live and dead trees. Young fruiting bodies are considered edible when fully cooked, but there have been cases of allergy to this fungus; therefore, great care must be taken when preparing and consuming it (Sośnicka *et al*. 2018). In general, few mushrooms are eaten raw, but it should be recommended that the specimens be cooked and/or treated before consumption (Li *et al*. 2021a).

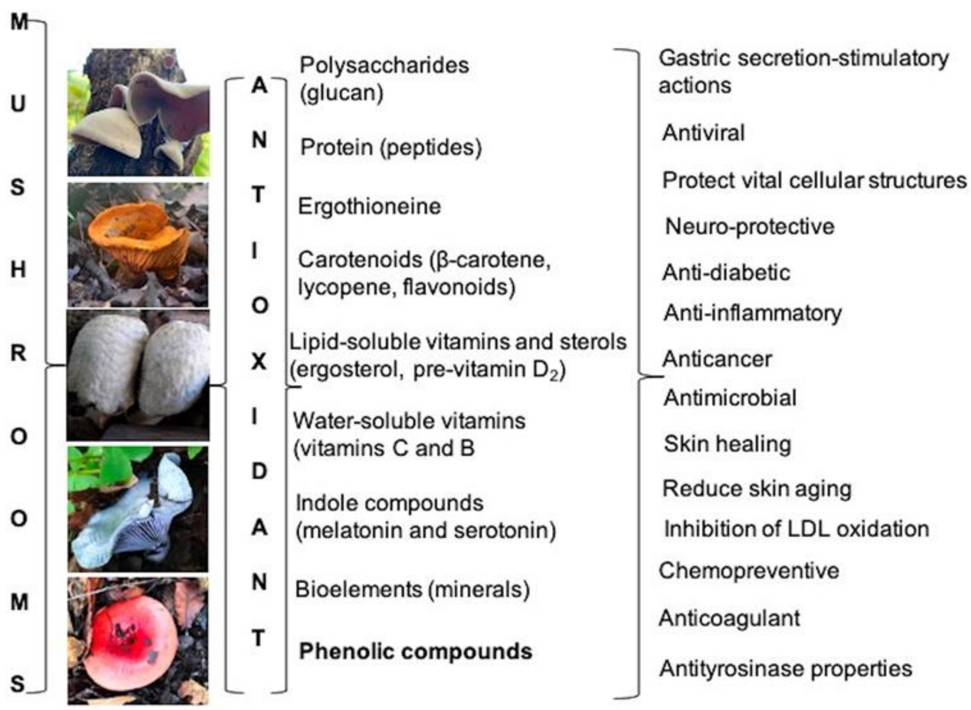

Fig. 1. Mushroom molecules with antioxidant activity and biological activity

It has been reported that wild mushrooms may have higher concentrations of secondary metabolites than cultivated mushrooms, which could result from the selection of mushroom cultivation that flavour yield without considering the quality of secondary metabolites. This is probably because the substrates used may not provide the necessary nutrients, and the climatic and environmental influence may contribute to these differences by providing optimal growth conditions (pH, light, humidity, temperature, *etc.*), where the natural environmental stress influences the production of secondary metabolites (Mwangi *et al*. 2022). Edible wild mushrooms have had great importance within the population, either as food, medicine, or both; they are essential for the survival and economy of ethnic groups and present components that have attributions to health (Lakhanpal and Rana 2005; Chang 2006).

Most mushrooms are rich in non-starch polysaccharides, beta-glucans, dietary fibre, protein, ergosterol, statins, minerals, *etc*. (Fig. 1), which have antioxidant activity (Novaković *et al*. 2020). Pharmacological studies of fungi have shown that *Basidiomycete* and *Ascomycete* are immense sources of biologically active molecules. Still, less than 10% of all species have been described, and even fewer have been analyzed for their therapeutic effects (Smith *et al*. 2015). Despite this lack of general characterization of active compounds, edible fungi are frequently recognized as nutraceuticals or functional foods because, in addition to their nutritional value, they often have medicinal benefits (Rasalanavho *et al*. 2020), as is the case with phenolic compounds that have been attributed to antitumor, hypoglycemic, cytotoxic, and antihyperlipidemic activity, among others.

Phenolic Compounds in Edible Mushrooms

Two groups of phenolic acids are distinguished: derivatives of benzoic acid and cinnamic acid. Several authors have indicated that the leading phenolic group in fungi is phenolic acids, to which biological activities have been attributed (Muszyńska *et al*. 2013b; Taofiq *et al*. 2015; Nowacka-Jechalke *et al*. 2018). Such activity has been confirmed for certain phenolic compounds, as in the case of *Macrolepiota procera,* for which the researchers identified the molecules involved in the anti-inflammatory activity and determined the presence of cinnamic, ρ-coumaric, and ρ-hydroxybenzoic acids (Taofiq *et al*. 2015). For *Calocybe*, the *in vitro* activity of antityrosinase was correlated with the presence of six phenolic acids (gallic, homogentisic, protocatechuic, chlorogenic, caffeic, and ferulic) present in acetone, methanol, and hot water extracts (Alam *et al*. 2019). In another study with antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *S. epidermidis*, and *Bacillus subtilis*, the methanolic crude extract presented several compounds, including phenolic acids (Datta *et al*. 2020). Ghosh *et al*. (2020) indicated that an ethyl acetate extract of the fruiting body of *C. indica* inhibited the formation of colonies, cell migration, and cell proliferation of HeLa and CaSki (cervical cancer cell lines); the analysis of the extract showed the presence of phenolic compounds, flavonoids, and ascorbic acid.

Erbiai *et al*. (2021) showed that there was a quantitative difference between samples of *A. mellea* from northern Morocco and Portugal; in the species of fungi from the latter site, cinnamic acid (155.2 μg/g dw), protocatechuic acid (43.90 μg/g dw), and ρ-hydroxybenzoic acid (43.85 μg/g dw), and for *A. mellea* from northern Morocco vanillic acid (198.4 μg/g dw) was found, followed by cinnamic (100.6 μg/g), proto-catechuic (48.34 μg/dw), and gallic acids (32.24 μg/g dw). Another important edible mushroom *Sparassis crispa* is consumed in Japan, and to date, it is considered a safe therapy for chronic diseases and cancer (Kimura *et al*. 2013). Kim *et al*. (2008) reported that the methanol extract from the fruiting body of *S. crispa* from Korea, commonly known as cauliflower mushroom because of the shape of the above-ground basidiomes, presented 764 μg/g phenolic compounds and 15 phenolic compounds: gallic acid, pyrogallol, 5-sulfosalicylic acid, protocatechuic acid, ρ-hydroxybenzoic acid, vanillic acid; caffeic acid, syringic acid, ρ-coumaric acid, veratric acid, benzoic acid, resveratrol, quercetin, naringenin, and kaempferol. However, Sułkowska-Ziaja *et al*. (2015) indicate that an extract using HCl (2M) and ethyl acetate presented seven phenolic compounds (gallic acid, ρ-hydroxybenzoic acid, caffeic acid, ρ-coumarin acid, protocatechuic acid, and syringic acid) and 85.65 mg/100 g of total phenols in fruiting bodies of a different strain of *S. crispa* obtained from northern Poland. Another review reports six phenolic compounds for *S. crispa* in aqueous and methanol extracts (protocatechuic acid, ρ-hydroxybenzoic acid, syringic acid, ρ-coumaric acid, gallic acid, pyrogallol, and quercetin); the fruiting bodies were obtained from India, Korea, and Poland (Quintero-Cabello *et al*. 2021). There is a difference in the content and type of phenolic compounds reported, hence it is also very important to consider the origin and processing of samples, as depending on the growth condition (biotic and abiotic factors), there is a difference in the production of metabolites.

Several solvents have been used, ranging from polar to non-polar (water, acidic water, ethanol, methanol, acetone, ethyl acetate, chloroform, *etc*.). Solvents perform a selective extraction of specific molecules, which could improve the antioxidant activity, indicating that in some cases, increasing the polarity of the solvent results in higher extraction performance of phenolic compounds (Petrović *et al*. 2014) and presents more significant bioactivity (Truong *et al*. 2019). Still, obtaining bioactive compounds (phenolic and antioxidants) depends on multiple factors, and the solvent is one of them. In this regard, Fogarasi *et al*. (2021) compared the antioxidant activity and phenolic compounds obtained from the powder of fruiting bodies with different solvents. In general, the order of the content of phenolic compounds (in decreasing order) extracted with each solvent was water, hydroalcoholic, hexane, and diethyl ether. Seventeen phenolic compounds were determined in water and hydroalcoholic extracts of *Boletus edulis*, while only five were found in the hexane and ethanol extracts. For *Cantharellus cibarius*, there were 14 in water, four in ethanol, and only two in hexane. The genus *Melanoleuca* has approximately 50 species worldwide (Ainsworth 2008); the *M. cognata* and *M. stridula* (consumed in Turkey) reported six phenolic compounds were quantified in ethyl acetate extracts, methanol, and water (benzoic acid, ρ-coumaric acid, ρ-hydroxybenzoic acid, protocatechuic acid, syringic acid, and trans-cinnamic acid); the syringic acid was the main phenolic in both species, followed by benzoic acid (34.1 and 32.2 μg/g dw, respectively). There was no difference in the presence of phenolic compounds depending on the solvent, but there was a higher content of phenolic compounds and antioxidant activity in water extracts (Bahadori *et al*. 2019).

Bioactive molecules can lose their activity due to the extraction processes because they can be eluted and destroyed. One of the crucial factors is the temperature. When they are taken out at high temperatures, it can cause the destruction or loss of active compounds that are vulnerable to heat, but when doing the extraction at low temperatures it could be that these compounds are not correctly extracted. Liang *et al*. (2010) reported that the ethanol and hot water extracts of mycelium and *S. crispa* culture broth identified five compounds in the ethanol extract (ascorbic acid, β-carotene, α-tocopherol, and gamma-tocopherol) and only two in the hot water extract (ascorbic acid and α-tocopherol) in the mycelium. However, in the culture broth with ethanol, there were two compounds (ascorbic acid and α-tocopherol); in hot water, only ascorbic acid was detected. Both extracts had antioxidant activity and reducing power, but high temperature decreased the content of phenolic compounds. Lee *et al*. (2016) reported that high temperature favoured the *S. crispa* mycelium extract when exposed to 95 °C. It presented 30.3 mg GAE/g of polyphenols and 2.65 mg QE/g of flavonoids, compared to the 60 °C extract that had 26.8 mg GAE/ g and 2.02 mg QE/g. For the extract from the fruiting body, it was 25.7 mg

GAE/g of polyphenols and 1.5 mg QE/g flavonoids at 95 °C. At 60 °C, it was 19 mg GAE/g and 0.54 mg QE/g, respectively. The mycelium contains many components, and the elution of the elements was better when extracted at high temperatures.

It has been documented that the processing of samples affects polyphenol content. This is because physical processes, such as crushing, could cause oxidative degradation of polyphenols by cell breakdown, cytoplasmic oxidase enzymes, and phenolic substrates present in vacuoles (Manach *et al*. 2004). There are several studies on the content of polyphenols in edible fungi (Table 1). Still, it is difficult to compare them due to the diversity of the research material (geographical area, cellular stage, the composition of the procurement site, *etc*.), growth factors, drying method, solvent type, extraction process, analysis, and expression of the results.

Table 1. Phenolic Compounds of Edible Mushrooms

Mushrooms	Extract	Phenolic Compounds	Reference
Armillaria mellea	E	Protocatechuic acid (2.25 mg/kg dw), salicylic acid (trace)	Nowacka *et al*. (2014)
	HA	Protocatechuic acid (2.23 mg/kg dw), sinapic acid (3.77 mg/kg dw)	Muszyńska *et al*. (2013a)
Auricularia auricula-judae	W	Gallic acid (360 μg/g), catechin (360 μg/g), ρ-hydroxybenzoic acid (700 μg/g), caffeic acid (200 μg/g), syringic (140 μg/g), vanillin (40 μg/g), sinapinic acid (100 μg/g)	Oke *et al*. (2011)
	M	Gallic acid (636 μg/g), catechin (314 μg/g), ρ-hydroxybenzoic acid (488 μg/g), caffeic acid (76 μg/g), syringic (104 μg/g), vanillin (30 μg/g), sinapinic acid (254 μg/g), ρ-coumaric acid (12 μg/g), rosmarinic acid (112 μg/g), cinnamic acid (8 μg/g), luteolin (4 μg/g)	
	M	Gallic acid (2.3 mg/100 g dw), caffeic acid (2.7 mg/100 g dw), 3,4-hidroxybenzoic acid (36.6 mg/100 g dw), vanillic acid (13.2 mg/100g dw), ρ-coumaric acid (1.1 mg/100 g dw), *trans*-cinnamic acid (14.5 mg/100 g dw)	Kokoti *et al*. (2021)
Auricularia polytricha	W	Tannic acid (1.72 mg/g), gallic acid (1.04 mg/g), protocatechuic acid (0.31 mg/g), gentisic acid (0.03 mg/g), vanillic acid (0.07 mg/g)	Puttaraju *et al*. (2006)
	M	Tannic acid (2.17 mg/g), gallic acid (0.04 mg/g), protocatechuic acid (0.01 mg/g), gentisic acid (0.06 mg/g), vanillic acid (0.02 mg/g)	
Aleurodiscus vitellinus	M	Gallic acid (1.26 μg/100 g dw)	Toledo *et al*. (2016)
Boletus appendiculatus	M 80%	ρ-Hydroxybenzoic acid (0.434 mg/kg dw), chlorogenic acid (1.15 mg/kg dw), vanillin acid (47.7 mg/kg dw), caffeic acid (0.782 mg/kg dw), ρ-coumaric acid (0.586 mg/kg dw), ferulic acid (0.705 mg/kg dw)	Dimitrijević *et al*. (2017)
Boletus fechtneri	M 80%	Caffeic acid (0.302 mg/kg dw), ρ-coumaric acid (2.434 mg/kg dw), ferulic acid (0.179 mg/kg dw)	
Boletus rhodoxanthus	M 80%	Chlorogenic acid (2.12 mg/kg dw), vanillin acid (5.88 mg/kg dw), caffeic acid (0.542 mg/kg dw), ρ-coumaric acid (0.605 mg/kg dw), ferulic acid (0.432 mg/kg dw)	

Boletus purpureus	M 80%	Vanillin acid (13.02 mg/kg dw), caffeic acid (0.657 mg/kg dw), syringic acid (5.919 mg/kg dw), ρ-coumaric acid (0.904 mg/kg dw), ferulic acid (0.801 mg/kg dw)	
Boletus badius	HA	Protocatechuic acid (21.38 mg/kg dw), ρ-hydroxybenzoic acid (1.28 mg/kg dw), ρ-coumaric acid (13.91 mg/kg dw), sinapic acid (1.5 mg/kg dw), cinnamic acid (8.73 mg/kg dw), ferulic acid (1.45 mg/kg dw)	Muszyńska *et al*. (2013a)
	HA	ρ-Hydroxybenzoic acid (0.13 mg/g dw), protocatechuic acid (2.14 mg/g dw), ρ-coumaric acid (1.39 mg/g dw), sinapic acid (0.15 mg/g dw), cinnammic acid (0.87 mg/g dw), ferulic acid (0.15 mg/g dw)	Muszyńska *et al*. (2015)
Boletus edulis	W	Tannic acid (9.59 mg/g), protocatechuic acid (0.30 mg/g), caffeic acid (0.20 mg/g), ρ-coumaric acid (0.10 mg/g)	Puttaraju *et al*. (2006)
	M	Tannic acid (4.08 mg/g), protocatechuic acid (3.92 mg/g)	
	M	Caffeic acid (15.09 μg/g dw), chlorogenic acid (62.79 μg/g dw), ρ-coumaric acid (0.87 acid (161.83 μg/g dw), gallic acid (212.96 μg/g dw), gentisic acid (60.85 μg/g dw), ρ-hydroxybenzoic acid (24.07 μg/g dw), homogentisic acid (2290.97 μg/g dw), myricetin (17.98 μg/g dw), protocatechuic acid (168.46 μg/g dw)	Palacios *et al*. (2011)
	HA	Protocatechuic acid (7.5 mg/kg dw), ρ-hydroxybenzoic acid (1.28 mg/kg dw)	Muszyńska *et al*. (2013a)
Cantharellus cibarius	HA	ρ-Hydroxybenzoic acid (0.23 mg/g dw), protocatechuic acid (0.23 mg/g dw), vanillic acid (0.33 mg/g dw), sinapic acid (0.30 mg/g dw), cinnammic acid (0.13 mg/g dw)	Muszyńska *et al*. (2015)
	M	Caffeic acid (16.34 μg/g dw), catechin (5.82 μg/g dw), ferulic acid (10.384 μg/g dw), gallic acid (161.83 μg/g dw), gentisic acid (53.97 μg/g dw), ρ-hydroxybenzoic acid (15.68 μg/g dw), homogentisic acid (316.76 μg/g dw), myricetin (23.27 μg/g dw), protocatechuic acid (42.79 μg/g dw), pyrogallol (91.09 μg/g dw)	Palacios *et al*. (2011)
	M	Pyrogallol (187.28 mg/kg), ρ-hydroxybenzoic acid (0.49 mg/kg), catechin (2.51 mg/kg), caffeic acid (1.0 mg/kg), trans-cinnapic acid (0.98 mg/kg), benzoic acid (6.08 mg/kg), resveratrol 1.65 mg/kg), trans-cinnamic acid (0.63 mg/kg), gallic acid (4.71 mg/kg), homogentisic acid (3.75 mg/kg), ρ-coumaric acid (0.05 mg/kg)	Ayvaz *et al*. (2019)
	HA	Protocatechuic acid (1.54 mg/kg dw), p-hydroxybenzoic acid (2.3 mg/kg dw), vanilic acid (3.32 mg/kg dw), sinapic acid (3.04 mg/kg dw), cinnamic acid (1.29 mg/kg dw)	Muszyńska *et al*. (2013a)
Cantharellus clavatus	W	Tannic acid (4.45 mg/g), gallic acid (2.38 mg/g), protocatechuic acid (3.57 mg/g), gentisic acid (1.12 mg/g), vanillic acid (0.80 mg/g), cinnamic acid (0.90 mg/g)	Puttaraju *et al*. (2006)

	M	Tannic acid (0.68 mg/g), gallic acid (0.43 mg/g), protocatechuic acid (0.70 mg/g), gentisic acid (0.14 mg/g), vanillic acid (0.06 mg/g), syringic acid (0.03 mg/g), caffeic acid (0.02 mg/g), ferulic acid (0.10 mg/g), cinnamic acid (o.04 mg/g)	
Craterellus cornucopiodes	E	Protocatechuic acid (2.05 mg/kg dw), 4-hydroxybenzoic acid (12.68 mg/kg dw), vanillic acid (1.52 mg/kg dw), p-coumaric acid (0.28 mg/kg dw), ferulic acid (trace), salicylic acid (trace)	Nowacka *et al*. (2014)
	M	Ferulic acid (14.03 μg/g dw), gallic acid (118.78 μg/g dw), ρ-hydroxybenzoic acid (6.28 μg/g dw), homogentisic acid (851.86 μg/g dw), myricetin (35.91 μg/g dw), protocatechuic acid (5.31 μg/g dw), pyrogallol (92.34 μg/g dw)	Palacios *et al*. (2011)
Chroogomphus rutilus	A: W (80:20)	Gallic acid (1.2 μg/g), fumaric acid (27.82 μg/g), protocatechuic acid (1.18 μg/g), catechin hydrate (7.81 μg/g), ρ-hydroxybenzoic acid (0.27 μg/g), 2,4-dihydroxy benzoic acid (1.33 μg/g), ρ-coumaric acid (0.05 μg/g), coumarin (0.36 μg/g), rosmarinic acid (0.31 μg/g)	Çayan *et al*. (2020)
Calocybe gambosa	M	Caffeic acid (14.92 μg/g dw), chlorogenic acid (63.04 μg/g dw), ferulic acid (14.52 μg/g dw), gallic acid (113.24 μg/g dw), gentisic acid (38.55 μg/g dw), ρ-hydroxybenzoic acid (11.3 μg/g dw), homogentisic acid (4280.11 μg/g dw), myricetin (20.75 μg/g dw), protocatechuic acid (36.96 μg/g dw), pyrogallol (240.07 μg/g dw)	Palacios *et al*. (2011)
Fistulina antarctica	M	Gallic acid (3.14 μg/100g dw), ρ-hydroxybenzoic acid (6.71 μg/100g dw)	Toledo *et al*. (2016)
Fistulina endoxantha	M	Gallic acid (4.59 μg/100g dw)	
Hygrosphorus marzuolus	M	Caffeic acid (14.59 μg/g dw), ρ-coumaric acid (4.69 μg/g dw), gallic acid (165.2 μg/g dw), gentisic acid (158.46 μg/g dw), ρ-hydroxybenzoic acid (5.49 μg/g dw), homogentisic acid (340.71 μg/g dw), protocatechuic acid (14.59 μg/g dw)	Palacios *et al*. (2011)
Lactarius deliciosus	E	Tannic acid (5.92 mg/g), gallic acid (0.14 mg/g), protocatechuic acid (0.07 mg/g), gentisic acid (1.05 mg/g), ferulic acid (0.14 mg/g)	Puttaraju *et al*. (2006)
	M	Tannic acid (3.26 mg/g), protocatechuic acid (1.53 mg/g)	
	M	Caffeic acid (15.51 μg/g dw), chlorogenic acid (62.7 μg/g dw), ferulic acid (11.43 mg/g), gallic acid (162.42 μg/g dw), gentisic acid (57.67 μg/g dw), ρ-hydroxybenzoic acid (21.4 μg/g dw), homogentisic acid (366.8 μg/g dw), myricetin (20.86 μg/g dw) protocatechuic acid (18.64 μg/g dw), pyrogallol (26.28 μg/g dw)	Palacios *et al*. (2011)
	HA	Protocatechuic acid (1.37 mg/kg dw), sinapic acid (14.24 mg/kg dw), cinnamic acid (4.06 mg/kg dw)	Muszyńska *et al*. (2013a)
	A: W (80:20)	Gallic acid (0.69 μg/g), fumaric acid (6.95 μg/g), protocatechuic acid (0.85 μg/g), catechin hydrate (15.82 μg/g), ρ-hydroxybenzoic acid (1.14 μg/g), 6,7-dihydroxy coumarin (0.73 μg/g), vanillin (0.1	Çayan *et al*. (2020)

		μg/g), 2,4-dihydroxy benzoic acid (0.61 μg/g), ρ-coumaric acid (0.02 μg/g), coumarin (0.09 μg/g), rosmarinic acid (0.09 μg/g), *trans*-cinnamic acid (0.16 μg/g)	
	M	Pyrogallol (415.59 mg/kg), ρ-hydroxybenzoic acid (0.55 mg/kg), catechin (2.13 mg/kg), vanillic acid (0.05 mg/kg), caffeic acid (0.29 mg/kg), trans-cinnapic acid (1.5 mg/kg), benzoic acid (12.06 mg/kg), resveratrol (3.28 mg/kg), trans-cinnamic acid (1.7 mg/kg), gallic acid (0.6 mg/kg), ρ-coumaric acid (0.17 mg/kg)	Ayvaz *et al*. (2019)
	M	ρ-hydroxybenzoic acid (24.5 μg/100 g fw), ρ-OH-phenylacetic acid (18.3 μg/100 g fw), 3-4-di OH-phenylacetic acid (0.4 μg/100 g fw), syringic acid (0.5 μg/100 g fw), vanillic acid (0.2 μg/100 g fw), caffeic acid (0.3 μg/100 g fw), cinnamic acid (8.8 μg/100 g fw), chlorogenic acid (3.9 μg/100 g fw), ferulic acid (14.4 μg/100 g fw), ο-coumaric acid (30.2 μg/100 g fw), ρ-coumaric acid (1.1 μg/100 g fw)	Kalogeropoulos *et al*. (2013)
Lactarius salmonicolor	A:W (80:20)	Gallic acid (0.43 μg/g), fumaric acid (11.01 μg/g), protocatechuic acid (0.87 μg/g), catechin hydrate (1.44 μg/g), ρ-hydroxybenzoic acid (0.44 μg/g), 2,4-dihydroxy benzoic acid (0.28 μg/g), coumarin (0.03 μg/g), rosmarinic acid (0.18 μg/g), *trans*-cinnamic acid (0.04 μg/g)	Çayan *et al*. (2020)
Lactarius sanguifluus	M	ρ-Hydroxybenzoic acid (19.4 μg/100 g fw), ρ-OH-phenylacetic acid (28.4 μg/100 g fw), 3-4-di OH-phenylacetic acid (0.6 μg/100 g fw), protocatechuic acid (0.3 μg/100 g fw), syringic acid (0.6 μg/100 g fw), vanillic acid (0.3 μg/100 g fw), caffeic acid (2.9 μg/100 g fw), cinnamic acid (5.2 μg/100 g fw), chlorogenic acid (2.1 μg/100 g fw), ferulic acid (5.9 μg/100 g fw), ο-coumaric acid (21.7 μg/100 g fw), ρ-coumaric acid (2.8 μg/100 g fw), sinapic acid (0.4 μg/100 g fw)	Kalogeropoulos *et al*. (2013)
Lactarius semisanguifluu	M	ρ-Hydroxybenzoic acid (17.6 μg/100 g fw), ρ-OH-phenylacetic acid (12.6 μg/100 g fw), 3-4-di OH-phenylacetic acid (0.5 μg/100 g fw), syringic acid (0.7 μg/100 g fw), vanillic acid (0.2 μg/100 g fw), caffeic acid (0.5 μg/100 g fw), cinnamic acid (5.8 μg/100 g fw), chlorogenic acid (2.4 μg/100 g fw), ferulic acid (9.1 μg/100 g fw), ο-coumaric acid (25.1 μg/100 g fw), ρ-coumaric acid (1.5 μg/100 g fw), sinapic acid (0.6 μg/100 g fw)	
Lactarius pyrogalus	M	Pyrogallol (81.45 mg/kg), ρ-hydroxybenzoic acid (1.71 mg/kg), catechin (2.61 mg/kg), caffeic acid (0.22 mg/kg), trans-cinnapic acid (0.69 mg/kg), benzoic acid (12.46 mg/kg), resveratrol (1.53 mg/kg), trans-cinnamic acid (0.12 mg/kg), gallic acid (0.46 mg/kg), homogentisic acid (1.39 mg/kg), ρ-coumaric acid (0.03 mg/kg)	Ayvaz *et al*. (2019)

Laetiporus sulphureus	M:HC: W (8:1:1)	Protocatechuic acid (17.7 μg/g dw)	Sułkowska-Ziaja *et al.* (2012)
	E	4-Hydroxybenzoic acid (0.75 mg/kg dw), p-coumaric acid (0.22 mg/kg dw), salicylic acid (trace)	Nowacka *et al*. (2014)
	A: W (80:20)	Gallic acid (0.24 μg/g), fumaric acid (5.72 μg/g), catechin hydrate (4.01 μg/g), ρ-hydroxybenzoic acid (0.14 μg/g), 6,7-dihydroxy coumarin (0.28 μg/g), caffeic acid (0.16 μg/g), coumarin (0.01 μg/g), ellagic acid (0.2 μg/g)	Çayan *et al*. (2020)
	A:M (70%)	Gallic (2059 mg/g dw), protocatechic (1207 mg/g dw)	Karaman *et al*. (2010)
Leccinum scabrum	E	Protocatechuic acid (0.23 mg/kg dw), 4-OH-benzoic acid (0.50 mg/kg dw), caffeic acid (trace), p-coumaric acid (0.47 mg/kg dw), ferulic acid (trace), salicylic acid (trace)	Nowacka *et al*. (2014)
Lepista nuda	A:W (80:20)	Gallic acid (1.9 μg/g), fumaric acid (53.7 μg/g), protocatechuic acid (1.9 μg/g), catechin hydrate (2.76 μg/g), ρ-hydroxybenzoic acid (5.44 μg/g), 6,7-dihydroxy coumarin (1.11 μg/g), 2,4-dihydroxy benzoic acid (0.99 μg/g), ρ-coumaric acid (0.05 μg/g), trans-2-hydroxy cinnamic acid (0. 3 μg/g), rosmarinic acid (0.85 μg/g), *trans*-cinnamic acid (0.08 μg/g)	Çayan *et al*. (2020)
	A:W (80:20	Protocatechuic acid (33.47 mg/kg dw), ρ-hydroxybenzoic acid (29.31 mg/kg dw), ρ-coumaric acid (3.75 mg/kg dw)	Barros *et al*. (2009)
Lepista personata	A: W (80:20)	Gallic acid (1.71 μg/g), fumaric acid (34.27 μg/g), protocatechuic acid (4.03 μg/g), catechin hydrate (1.33 μg/g), ρ-hydroxybenzoic acid (0.3 μg/g), 6,7-dihydroxy coumarin (0.29 μg/g), vanillin (0.22 μg/g), ρ-coumaric acid (0.04 μg/g), ferulic acid (0.32 μg/g), trans-2-hydroxy cinnamic acid (0. 3 μg/g), rosmarinic acid (0.07 μg/g), *trans*-cinnamic acid (0.16 μg/g)	Çayan *et al*. (2020)
Lentinus squarrosulus	M	Gallic acid (99.91 mg/100 g dw), 3,4-hidroxybenzoic acid (282.3 mg/100 g dw), *trans*-cinnamic acid (19.8 mg/100 g dw)	Kokoti *et al*. (2021)
	M	Gallic acid (14.5 mg/100 g dw), 3,4-hidroxybenzoic acid (73.6 mg/100 g dw), *trans*-cinnamic acid (12.1 mg/100 g dw)	
	M	Gallic acid (5.2 mg/100 g dw), 3,4-hidroxybenzoic acid (20.1 mg/100 g dw), *trans*-cinnamic acid (35.8 mg/100g dw)	
Leucoagaricus leucothites	A: W (80:20)	Gallic acid (0.21 μg/g), fumaric acid (4.42 μg/g), protocatechuic acid (0.91 μg/g), ρ-hydroxybenzoic acid (0.47 μg/g), 6,7-dihydroxy coumarin (9.02 μg/g), 2,4-dihydroxy benzoic acid (0.13 μg/g), ellagic acid (0.34 μg/g), *trans*-cinnamic acid (0.38 μg/g)	Çayan *et al*. (2020)
Leucopaxillus tricolor	A: W (80:20)	Gallic acid (1.18 μg/g), protocatechuic acid (1.95 μg/g), catechin hydrate (2.11 μg/g), ρ-hydroxybenzoic acid (0.41 μg/g), 2,4-dihydroxy benzoic acid (0.29 μg/g), ellagic acid (0.25 μg/g)	

Lycoperdon scabrum	M	Gallic acid (66.7 mg/100 g dw), caffeic acid (66.7 mg/100 g dw), 3,4-hidroxybenzoic acid (351.5 mg/100 g dw), vanillic acid (7.9 mg/100 g dw), ρ-coumaric acid (1.4 mg/100 g dw), *trans*-cinnamic acid (41.1 mg/100 g dw)	Kokoti *et al*. (2021)
Lycoperdon perlatum	E	4-Hydroxybenzoic acid (3.66 mg/kg dw), ρ-coumaric acid (1.86 mg/kg dw), salicylic acid (trace)	Nowacka *et al.* (2014)
Marasmius oreades	E	4-Hydroxybenzoic acid (1.55 mg/kg dw), vanillic acid (trace), p-coumaric acid (trace), salicylic acid (trace)	
	A: W (80:20)	Fumaric acid (25.85 μg/g), protocatechuic acid (2.83 μg/g), ferulic acid (0.05 μg/g), coumarin (0.01 μg/g), *trans*-2-hydroxy cinnamic acid (0.1 μg/g), rosmarinic acid (0.2 μg/g), *trans*-cinnamic acid (0.01 μg/g)	Çayan *et al*. (2020)
Macrolepiota procera	E	Protocatechuic acid (5.19 mg/kg dw), caffeic acid (trace)	Nowacka *et al*. (2014)
Melanoleuca cognata	EA	ρ-Coumaric acid (0.13 μg/g dw), ρ-hydroxybenzoic acid (1.9 μg/g dw), *trans*-cinnamic acid (2.7 μg/g dw)	Bahadori *et al*. (2019)
	M	ρ-Coumaric acid (0.8 μg/g dw), ρ-hydroxybenzoic acid (16 μg/g dw), syringic acid (4 μg/g dw), *trans*-cinnamic acid (10 μg/g dw)	
	W	ρ-Coumaric acid (4.4 μg/g dw), ρ-hydroxybenzoic acid (16.1 μg/g dw), protocatechuic acid (7.3 μg/g dw), syringic acid (4.4 μg/g dw), *trans*-Cinnamic acid (12 μg/g dw)	
Melanoleuca stridula	EA	ρ-Coumaric acid (0.09 μg/g dw), ρ-hydroxybenzoic acid (3 μg/g dw), protocatechuic acid (0.47 μg/g dw), *trans*-cinnamic acid (1.6 μg/g dw)	
	M	ρ-Coumaric acid (1.8 μg/g dw), syringic acid (28.2 μg/g dw), *trans*-Cinnamic acid (8 μg/g dw)	
	W	ρ-Coumaric acid (7.1 μg/g dw), ρ-hydroxybenzoic acid (21.3 μg/g dw), protocatechuic acid (14.2 μg/g dw), syringic acid (34.1 μg/g dw), *trans*-cinnamic acid (11.4 μg/g dw)	
Morchella anguiticeps	E	Tannic acid (8.63 mg/g), gallic acid (3.20 mg/g), protocatechuic acid (0.94 mg/g), syringic acid (0.15 mg/g)	Puttaraju *et al*. (2006)
	M	Tannic acid (1.38 mg/g), gallic acid (0.89 mg/g), protocatechuic acid (0.16 mg/g), gentisic acid (0.05 mg/g), caffeic acid (0.03 mg/g)	
Morchella conica	E	Tannic acid (4.05 mg/g), gallic acid (12.85 mg/g)	
	M	Gallic acid (2.7 mg/g), protocatechuic acid (0.79 mg/g), gentisic acid (0.28 mg/g), vanillic acid (0.1 mg/g), syringic acid (0.04 mg/g), caffeic acid (0.09 mg/g), coumaric acid (0.56 mg/g), ferulic acid (0.04 mg/g)	
Morchella elata	A: W (80:20)	Gallic acid (1.17 μg/g), protocatechuic acid (1.98 μg/g), catechin hydrate (10.24 μg/g), ρ-coumaric acid (0.11 μg/g), ellagic acid (0.39 μg/g), rosmarinic acid (0.04 μg/g)	Çayan *et al*. (2020)
Morchella esculenta	A: W (80:20)	Gallic acid (1.32 μg/g), protocatechuic acid (3.85 μg/g), catechin hydrate (5.04 μg/g), ρ-	

		hydroxybenzoic acid (0.17 μg/g), caffeic acid (0.18 μg/g), ρ-coumaric acid (0.01 μg/g), *trans*-cinnamic acid (0.02 μg/g)	
Pholiota mutabilis	E	Protocatechuic acid (2.18 mg/kg dw), 4-hydroxybenzoic acid (24.84 mg/kg dw), caffeic acid (1.13 mg/kg dw), p-coumaric acid (29.10 mg/kg dw), ferulic acid (trace), salicylic acid (trace)	Nowacka *et al*. (2014)
Polyporus arcularius	M	Gallic acid (2.4 mg/100 g dw), 3,4-hidroxybenzoic acid (11.8 mg/100 g dw), ρ- coumaric acid (1.4 mg/100 g dw), *trans*-cinnamic acid (35.8 mg/100 g dw)	Kokoti *et al*. (2021)
	M	Gallic acid (11.4 mg/100 g dw), caffeic acid (2.8 mg/100 g dw), 3,4-hidroxybenzoic acid (67.1 mg/100 g dw), ρ- coumaric acid (1.1 mg/100 g dw), *trans*-cinnamic acid (32.6 mg/100 g dw)	
Ramaria botrytis	A: W (80:20)	Protocatechuic acid (342.7 mg/kg dw), ρ-hydroxybenzoic acid (14 mg/kg dw)	Barros *et al*. (2009)
Ramaria flava	A: W (80:20)	Gallic acid (0.29 μg/g), fumaric acid (4.72 μg/g), protocatechuic acid (0.89 μg/g), catechin hydrate (5.77 μg/g), ρ-coumaric acid (0.01 μg/g), coumarin (0.09 μg/g), trans-cinnamic acid (0.05 μg/g)	Çayan *et al*. (2020)
Ramaria patagonica	M	Gallic acid (4.56 μg/100g dw), ρ-hydroxybenzoic acid (126.42 μg/100 g dw), ρ-coumaric acid (3.41 μg/100 g dw), cinnamic acid (3.1 μg/100 g dw)	Toledo *et al*. (2016)
Russula aurora	A: W (80:20)	Gallic acid (2.96 μg/g), ellagic acid (0.45 μg/g), rosmarinic acid (0.59 μg/g), trans-cinnamic acid (0.39 μg/g)	Çayan *et al*. (2020)
Russula azurea	A: W (80:20)	Gallic acid (1.45 μg/g), fumaric acid (41.76 μg/g), 6,7-dihydroxy coumarin (0.49 μg/g), ρ-coumaric acid (0.07 μg/g), ferulic acid (0.11 μg/g), ellagic acid (0.73 μg/g), rosmarinic acid (0.09 μg/g), *trans*-cinnamic acid (0.35 μg/g)	
Russula brevepis	E	Tannic acid (0.11 mg/g), gallic acid (3.9 mg/g), protocatechuic acid (0.6 mg/g), gentisic acid (0.66 mg/g), vanillic acid (0.16 mg/g), syringic acid (0.07 mg/g)	Puttaraju *et al*. (2006)
	W	Tannic acid (0.45 mg/g), gallic acid (0.18 mg/g), protocatechuic acid (0.05 mg/g), coumaric acid (0.02 mg/g)	
Russula delica	A: W (80:20)	Gallic acid (0.07 μg/g), fumaric acid (15.59 μg/g), protocatechuic acid (4.89 mg/g), catechin hydrate (2.27 μg/g), ferulic acid (0.35 μg/g), *trans*-cinnamic acid (0.05 μg/g)	Çayan *et al*. (2020)
	M	ρ-Hydroxybenzoic acid (1.6 μg/100 g fw), ρ-OH-phenylacetic acid (0.5 μg/100 g fw), syringic acid (1.3 μg/100 g fw), vanillic acid (0.4 μg/100 g fw), caffeic acid (0.2 μg/100 g fw), cinnamic acid (0.8 μg/100 g fw), chlorogenic acid (3.2 μg/100 g fw), ferulic acid (2.3 μg/100 g fw), o-coumaric acid (6 μg/100 g fw), ρ-coumaric acid (1.8 μg/100 g fw)	Kalogeropoulos *et al.* (2013)
Russula vinosa	A: W (80:20)	Gallic acid (2.5 μg/g), fumaric acid (52.08 μg/g), catechin hydrate (3.65 μg/g), ρ-coumaric acid (0.01 mg/g), *trans*-cinnamic acid (0.17 μg/g)	Çayan *et al*. (2020)
Russula virescens	W	Catechin (0.151 mg/mL), ferullic acid (0.405 mg/mL), kaempferol (1.23 mg/mL), luteolin (0.22	Hasnat *et al*. (2014)

		mg/mL), vanillic acid (0.14 mg/mL), apigenin (0.047 mg/mL), lupane (0.36 mg/mL)	
	E	Ferullic acid (0.151 mg/mL), kaempferol (1.05 mg/mL), luteolin (0.042 mg/mL), apigenin (0.019 mg/mL), lupane (0.55 mg/mL)	
Sparassis crispa	E	Gallic acid (3 mg/g), protocatechuic acid (1.33 mg/g), gentisic acid (0.72 mg/g), coumaric acid (0.45 mg/g)	Puttaraju *et al*. (2006)
	M	Gallic acid (1.25 mg/g), protocatechuic acid (0.08 mg/g), ferulic acid (0.36 mg/g), cinnamic acid (0.01 mg/g)	
	M	Gallic acid (19 μg/g), pyrogallol (66 μg/g), 5-sulfosalicylic acid (53 μg/g), protocatechuic acid (96 μg/g), ρ-hydroxybenzoic acid (34 μg/g), vanillic acid (5 μg/g), caffeic acid (18 μg/g), syringic acid (5 μg/g), ρ-coumaric acid (37 μg/g), veratric acid (12 μg/g), benzoic acid (348 μg/g), resveratrol (1 μg/g), quercetin (24 μg/g) , naringenin (36 μg/g), kaempferol (7 μg/g)	Kim *et al*. (2008)
	E	4-Hydroxybenzoic acid (0.97 mg/kg dw), caffeic acid (trace), p-coumaric acid (trace), salicylic acid (trace)	Nowacka *et al*. (2014)
Suillus bellinii	M	ρ-Hydroxybenzoic acid (6.6 μg/100 g fw), ρ-OH-phenylacetic acid (44.9 μg/100 g fw), 3-4-di OH-phenylacetic acid (10 μg/100 g fw), protocatechuic acid (2.3 μg/100 g fw), syringic acid (0.2 μg/100 g fw), vanillic acid (0.2 μg/100 g fw), caffeic acid (0.2 μg/100 g fw), cinnamic acid (2.1 μg/100 g fw), chlorogenic acid (2.8 μg/100 g fw), ferulic acid (4 μg/100 g fw), ο-coumaric acid (14.8 μg/100 g fw), ρ-coumaric acid (1.1 μg/100 g fw), sinapic acid (0.7 μg/100 g fw)	Kalogeropoulos *et al*. (2013)
Suillus granulatus	A: W (80:20)	Fumaric acid (48.38 μg/g), protocatechuic acid (2.11 μg/g), catechin hydrate (16.59 μg/g), ρ-hydroxybenzoic acid (2.55 μg/g), 2,4-dihydroxy benzoic acid (0.91 μg/g), ellagic acid (0.84 μg/g), rosmarinic acid (0.29 μg/g), *trans*-cinnamic (0.12 μg/g)	Çayan *et al*. (2020)
Termitomyces heimii	W	Tannic acid (15.54 mg/g), gallic acid (4.07 mg/g), protocatechuic acid (11.1 mg/g), gentisic acid (1.48 mg/g), vanillic acid (0.37 mg/g), coumaric acid (3.7 mg/g), ferulic acid (0.37 mg/g), cinnamic acid 0.37 mg/g)	Puttaraju *et al*. (2006)
	M	Tannic acid (2.31 mg/g), gallic acid (0.52 mg/g), protocatechuic acid (5.39 mg/g), gentisic acid (0.55 mg/g), caffeic acid (0.55 mg/g), coumaric acid (0.22 mg/g), cinnamic acid (1.43 mg/g)	
Termitomyces tylerance	W	Gallic acid (6 mg/g), protocatechuic acid (11.6 mg/g), caffeic acid (0.28 mg/g)	
	M	Tannic acid (2.75 mg/g), gallic acid (4.58 mg/g), gentisic acid (0.16 mg/g), syringic acid (0.25 mg/g), caffeic acid (0.12 mg/g)	
Termitomyces mummiformis	W	Tannic acid (10.56 mg/g), gallic acid (5.76 mg/g), protocatechuic acid (0.58 mg/g), gentisic acid (1.92	

		mg/g), syringic acid (0.19 mg/g), cinnamic acid (0.19 mg/g)	
	M	Tannic acid (0.68 mg/g), gallic acid (0.66 mg/g), protocatechuic acid (0.22 mg/g), gentisic acid (0.48 mg/g), syringic acid (0.02 mg/g), cinnamic acid (0.13 mg/g)	
Termitomyces microcarpus	W	Gallic acid (2.52 mg/g), protocatechuic acid (1.22 mg/g), gentisic acid (1.8 mg/g), vanillic acid (0.43 mg/g), syringic acid (0.46 mg/g), caffeic acid (0.18 mg/g), ferulic acid (0.12 mg/g)	
	M	Tannic acid (2.21 mg/g), gallic acid (1.5 mg/g), protocatechuic acid (0.29 mg/g), gentisic acid (0.08 mg/g), vanillic acid (0.17 mg/g), caffeic acid (0.15 mg/g)	
Termitomyces shimperi	W	Gallic acid (10.4 mg/g), protocatechuic acid (3.75 mg/g), gentisic acid (0.45 mg/g), vanillic acid (0.45 mg/g), caffeic acid (0.15 mg/g)	
	M	Tannic acid (1.6 mg/g), gallic acid (1.92 mg/g), protocatechuic acid (0.40 mg/g), gentisic acid (0.12 mg/g), ferulic acid (0.36 mg/g), cinnamic acid (0.4 mg/g)	
Tricholoma acerbum	A:W (80:20	Protocatechuic acid (33.47 mg/kg dw), ρ-hydroxybenzoic acid (29.31 mg/kg dw),ρ-coumaric acid (3.75 mg/kg dw)	Barros *et al*. (2009)
Xerocomellus chrysenteron	M 80%	Chlorogenic acid (0.954 mg/kg dw), vanillin acid (8.548 mg/kg dw), syringic acid (20.4 mg/kg dw), ρ-coumaric acid (0.597 mg/kg dw),	Dimitrijević *et al*. (2017)
Xerocomus badius	M 80%	Vanillin acid (6.89 mg/kg dw), caffeic acid (0.07 mg/kg dw), syringic acid (6.89 mg/kg dw), ρ-coumaric acid (0.811 mg/kg dw)	
	E	Protocatechuic acid (1.2 mg/kg dw), ρ-coumaric acid (trace)	Nowacka *et al*. (2014)

Acetone (A); ethyl acetate (EA); hydrochloric acid (HA); hydrochloric acid (HC); methanol (M); ethanol (E); water (W); dry weight (dw); fresh weight (fw)

Antioxidant Activity of Wild Edible Mushrooms

Antioxidants have been classified according to their mechanism of action. Primary antioxidants neutralize free radicals by donating H-atoms or transferring electrons, and they can break autoxidation chain reactions. They are needed in low amounts to neutralize large amounts of free radicals; secondary or defense antioxidants are characterized by neutralizing pro-oxidant catalysts, chelating metals (Fe and Cu), and inhibiting or decomposing lipid hydroperoxides; in addition, they can neutralize a free radical, so they are quickly depleted from the system (Zeb 2020; Mwangi *et al*. 2022). Zeb (2020) indicated that there are tertiary antioxidants, which are molecules that repair damaged biomolecules such as DNA or proteins. It has been suggested that antioxidants from fungi present some of the following mechanisms: inhibition of the formation of free radicals, neutralization of reactive oxygen species, inactivation of metals that facilitate oxidative processes, inhibition of peroxidases, and cell protection (Nowacka-Jechalke *et al*. 2018). There are also fungal compounds that, by serving as cellular signals and/or inducers, have the antioxidant capacity, modify gene expression, and activate enzymes to eliminate reactive oxygen species (Mwangi *et al*. 2022).

The antioxidant activity is attributed to phenolic compounds. For *Hypsizygus marmoreus*, all the aqueous extracts that underwent heating inhibited DPPH (2,2-diphenyl-

1-picrilhidrazil) radical activity (89 to 92%). There was a correlation between antioxidant activity and the content of phenolic compounds (R^2 of 0.99 to 0.74), and the extracts kept their antioxidant activity when exposed to heat for up to 4 h, even increasing as the heating time increased; thus, this fungus is a source of antioxidants even after cooking (Xu *et al*. 2007). Stojanova *et al*. (2021) indicated a strong correlation between the antioxidant activity (DPPH) and the total phenols content in edible and medicinal mushrooms from Macedonia. They obtained a coefficient of determination of 0.99 for the three fungi in the aqueous extracts, and the ethanolic extracts, it was 0.97 for *Suillus granulatus*, *Coriolus versicolor*, and *Fuscoporia torulosa* presented an R^2 of 0.81. In another work, Khumlianlal *et al*. (2022) characterized three edible wild fungi of the tribal populations of Manipur. The percentage of inhibition of the DPPH radical was 73.1% for *Macrocybe gigantea*, 65.37% for *Ramaria thindii*, and 61.43% for *Lactifluus leptomerus* at a concentration of 1400 μg/mL. Higher phenolic compound content was detected in *R. thindii*, and there was a correlation with DPPH activity (R^2 of 0.99). Still, there was no correlation between DPPH activity and total flavonoid content, and the radical removal effect was attributed to phenolic compounds.

Wild edible mushrooms are a non-timber natural resource, several species of the *Boletus* are among the most sought-after edible mushrooms worldwide; thus, the mushroom is economically important. They are appreciated for their flavour, texture, nutrition, and medicinal effects qualities. Witkowska *et al*. (2011) indicate that *B. bainiugan* has been considered a source of antioxidants, reduces proinflammatory response, and increases anti-inflammatory responses (Wu *et al*. 2016). The total phenol content of *B. auranticus* was 36.4 mg GAE/g, and the flavonoid content was 17.6 mg CE/g. In *B. edulis*, phenol content was 41.8 mg GAE/g, flavonoid content was 8.7 mg CE/g, and the variegatic acid content of *B. anticaurus* was lower (0.35 mg/g) than that of *B. edulis* (1.36 mg/g). This acid is considered a strong antioxidant compound when analyzing the chemical structure, number, and position of hydroxyl groups and double bonds (Vidović *et al*. 2010). Zhuang *et al*. (2020) reported 11 phenolic compounds. The fungus *B. auripes* presented approximately 80.6 mg/kg; for *B. edulis* it was 4.2 and 1.9 mg/kg for *B. aureu*, the content and quantity of phenolic compounds was associated with the smoky attribute characteristic of the genus. Three different phenols were identified in *B. aereu*, whereas in *B. rubellus* 2,4-dimethyl phenol was high (75.8 mg/kg). Metabolic analysis of the edible mushrooms *B. bainiugan* and *B. subsplendidus* identified 516 metabolites, of which 194 were significantly modified between the two species. The results showed that most of the metabolites were associated with metabolism (80.9%), followed by environmental information (12.4%), genetic information (7.9%), and 3.4% with infection in humans. In general, the molecules were grouped into 30 organic acids, 18 phenolic acids, 49 lipids, 34 amino acids and derivatives, 16 nucleotides and derivatives, 13 alkaloids, six flavonoids, three lignanes and coumarins, three tannins, two terpenoids, and 20 others (Li *et al*. 2021b).

The metabolomic analysis provides evidence of the differences among species responsible for each edible mushroom's unique flavor, texture, and nutritional content characteristics. Therefore, it is an essential tool that could be widely used to compare the metabolite composition of wild *versus* cultivated mushrooms because cultivated species can sometimes have different organoleptic characteristics that consumers appreciate and increase commercial importance.

The study of edible mushrooms has increased in several countries (Table 3). For example, Puttaraju *et al*. (2006) compared the antioxidant activity of 23 species of fungi from India; *Termitomyces heimii* was the species that presented the highest content of phenols (37 mg/g sample), and more phenolic compounds were found in aqueous extracts (2.0 to 37 mg/g) compared to the methanol extract (0.7 to 11.2 mg/g). In the phenolic compounds profile for *T. heimii* and *Termitomyces mummiformis*, the highest amounts were tannic acid, gallic acid, protocatechuic acid, and gentisic acid, and the authors indicate that the amount and type of phenolic antioxidants present in each of the fungi depend on the location, the species, and growth conditions (stress, presence of xenobiotic compounds, *etc*.). Further, in the work by Butkhup *et al*. (2018), antioxidant activity is attributed to phenolic compounds in the analyzed 25 species of edible wild fungi native to Thailand. The phenolic compounds determined in all analyzed species included (+)-catechin and (-)-epicatechin, and the DPPH radical inhibition percentage was between 86.6% and 36.8%. Gąsecka *et al*. (2018) report that in Poland, where the authors analyzed popular edible species *versus* edible species that are not usually consumed in the area, the phenol content was between 0.14 to 1.54 mg CHA/g DM. The flavonoid content was between 0.21 to 0.77 mg CHA/g extract. The fungus *Leccinum scabrum* had 11 phenols, the most abundant of which were trans-cinnamic (8.64 mg/g DM), gallic (7.6 mg/g DM), and vanillic acids (4.49 mg/g DM). For *Leccinum gilva*, there were 10 phenolic compounds, and trans-cinnamic (12.57 mg/g DM) and protocatechuic acid (4.21 mg/g DM) were the most abundant. The percentage of inhibition of the DPPH radical increased with the concentration of the extracts; the highest value was for *L. scabrum* (87%) at 10 mg/mL. The authors indicate that environmental conditions, habitat, and cell stage affect metabolite synthesis.

Cellular age can substantially decrease antioxidant capacity, as in *Lactarius piperatus*. This mushroom is consumed worldwide, and due to its acidic flavor, it is usually used as a condiment. Among its main antioxidant components are total phenols, but the content differs depending on the cell age of the fruiting body. There was greater content of phenolic compounds (5.52 and 5.76 mg/g) and flavonoids (1.26 and 1.58 mg/g) in the stages. These present immature spores compared to fruiting bodies with mature and degraded spores (3.09 and 2.03 mg/g phenols, and flavonoids content was 0.35 and 0.19 mg/g, respectively). The authors related this decrease to the production of reactive oxygen species during the ageing process; in other words, the decrease in the antioxidant content and capacity is because, in these stages, there is an increase in the number of reactive species that must be neutralized (Barros *et al*. 2007). The activity in different parts of the fruiting body has also been characterized. The antioxidant activity of *Coprinus comatus* extracts showed more significant inhibition of linoleic acid peroxidation in the ethanolic extract of the stipe (80.6% at 1 mg/mL) compared to the pileus (70.5% at 5 mg/mL). That for the aqueous extract was 61.5% in the stipe and 72.6% from the pileus to 10 mg/mL, L-ascorbic acid (1 mg/mL) was used as a control, which was lower than that determined in the ethanolic extract of the stipe (Li *et al*. 2010). Kruzselyi *et al*. (2020) indicate that no significant differences were found in the content of total phenols (3.5 to 4.0 mg GAE/g) and antioxidant activity (86% at 200 μg/mL) in methanolic extracts of the stem, stipe, and fruiting body of the fungus *Cyclocybe cylindracea*. For *Leccinum duriusculum* there was a higher content in the stem (1.5 mg GAE/g; 80% at 200 μg/mL) than in the stipe and complete fruiting body (1.0 mg GAE/g; 30% to 40% at 200 μg/mL), and for *Flammulina velutipes* the stem, and the fruiting body was not different (1.0 mg GAE/g; 25% at 200 μg/mL). The authors indicate that the fruiting bodies of the fungi have characteristic antioxidant potential and that the responsible molecules, including phenols, are mainly concentrated in the skin and gills that make up the pileus.

Some fungi's fruiting bodies and mycelium have different antioxidants that exert various antioxidant properties (Carvajal *et al*. 2012; Correa *et al*. 2015). Liquid culture has economic and environmental advantages because, in some cases, higher metabolite production can be obtained in a smaller space, with greater control, less time, and less chance of contamination compared to the cultivation of fruiting bodies. This technique has produced biomass and valuable metabolites, mainly in pharmaceuticals and cosmetics (Elisashvili *et al*. 2012). The genus *Suillus* is an ectomycorrhizal symbiote that establishes a relationship with a wide range of host plants, especially with conifers. The species *S. bellinii* produces much biomass and exudates (Franco and Castro 2015). It was reported that the fruiting body of *S. bellinii* had 1821 µg/g of ρ-hydroxybenzoic acid and 39 µg/g extract of cinnamic acid. The mycelium of the liquid culture had 213 µg/g of ρ-hydroxybenzoic acid and 130 µg/g extract of cinnamic acid. The solid medium (agar) had 394 µg/g of ρ-hydroxybenzoic acid, and the extract had 25 µg/g of cinnamic acid. The content of phenolic compounds was higher in the mycelium compared to the fruiting body. Petri dishes are becoming an alternative source of bioactive compounds, given their advantages in terms of less incubation time and easier growing conditions (less space required, low probability of contamination, and higher biomass production) compared to the fruiting bodies (Souilem *et al*. 2017).

In another example, Jiamworanunkul (2020) cultured *Schizophyllum commune* for 21 days in three different liquid culture media (malt extract broth, potato dextrose broth, and yeast extract sucrose broth). They reported that the culture broth had higher antioxidant activity (78.9%, 81.0%, and 78.8%) than the mycelium (34.3%, 41.4%, and 46.5%). The antioxidant activity of the culture broth was even more substantial than the antioxidant ascorbic acid (75.3%). In comparison, an extract of the fruiting body of *S. commune* had an antioxidant activity of 70.5%, the total phenol content, the three broths contained 62.5%, 98.1%, and 154.5%, and the mycelium from each culture medium had 34%, 41.5%, and 46.5% phenol contents, respectively (Table 2). Thus, the total phenol content was also highest in the culture broth. These data suggest that liquid culture induced the production and secretion of antioxidant metabolites into the culture media rather than accumulating in the mycelium; however, it is essential to remember that each species has its phenol synthesis system and cellular metabolism.

Table 2. Total Phenol, Flavonoids, and Antioxidant Activity Content of Wild Edible Fungi

Mushrooms	**Extract**	**Phenol-ics**	**Flavo-noid**	**Scavenging Activity**				**References**
				DPPH	ABTS	Chela-ting activity	FRAP Assay	
Amanita hamibapa	M 60%	8.53 g GAE/kg dw	0.81 g CE/kg dw	72%			7.6 Fe(II)/kg dw	Butkhup *et al.* (2018)
Amanita princeps	M 60%	1.68 g GAE/kg dw	0.62 g CE/kg dw	59.4%			3 g Fe(II)/kg dw	
Amanita rubescens var. *rubescens*	M 80%	5708 mg/kg		90.1%			7457 µM/g	Keleş *et al*. (2011)
Amanita rubescens	A	4.86 µg PE/mg	1.48 µg RE/ mg	50% (114 µg/mL)				Kosanic *et al*. (2013)

	M	5.22 PE/mg	1.65 RE/mg	50% (185 µg/mL)				
Armillaria ostoyae	M 80%	2908 mg/kg		42%			5028 µM/g	Keleş *et al*. (2011)
Apioperdon pyriforme	M	8.8 mg GAE/g	0.44 mg/g					Altaf *et al*. (2020)
Auricularia auricula-judae	M	10.5 mg GAE/g						Oke *et al*. (2011)
	W	13.6 mg GAE/g						
	M 60%	0.95 g GAE/kg dw	0.15 g CE/kg dw	41%			0.1 g Fe(II)/kg dw	Butkhup *et al.* (2018)
Auricularia polytricha	W	3.2 mg GAE/g						Puttaraju *et al*. (2006)
	M	2.3 mg GAE/g						
Boletus aereus	A/W/AA (70:29.5:0.5)	11.9 mg GAE/g	1.13 mg CE/g	17.6 mM TE/g	28.2 mM TE/g		6.4 mM of Fe_2/100 g	Islam *et al*. (2016)
Boletus appendiculatus	M 80%	144.7 mg GAE/g		24.5 mg TE/g	3.2 mg TE/g			Dimitrijević *et al.* (2017)
	Hydrolysates	53.92 mg GAE/g		1.44 mg TE/g	0.43 mg TE/g			
Boletus edulis	M	5.5 mg GAE/g	2.0 mg/g					Palacios *et al.* (2011)
	E 70%			60% (0.6 mg/mL)	70% (0.2 mg/mL)	60% (0.6 mg/mL)		Vamanu and Nita (2013)
	M 70%			60% (0.6 mg/mL)	70% (0.2 mg/mL)	33% (0.6 mg/mL)		
	HW			45% (0.6 mg/mL)	70% (0.2 mg/mL)	29% (0.6 mg/mL)		
	CW			50% (0.6 mg/mL)	45% (0.2 mg/mL)	21% (0.6 mg/mL)		
	W	10.2 mg GAE/g						Puttaraju *et al*. (2006)
	M	8.4 mg GAE/g						
	M	5.03 mg/g	1.75 mg/g					Barros *et al*. (2008)
Boletus erythropus var. *erythropus*	M 80%	9931.1 mg/kg		90.3%			62771.4 µmol/g	Keleş *et al*. (2011)

Boletus fechtneri	M 80%	171.6 mg GAE/g		26.01 mg TE/g	3.94 mg TE/g			Dimitrijević *et al*. (2017)
	Hydrolysates	39.6 mg GAE/g		1.2 mg TE/g	0.43 mg TE/g			
Boletus rhodoxanthus	M 80%	140.1 mg GAE/g		14.8 mg TE/g	1.3 mg TE/g			
	Hydrolysates	2.03 mg GAE/g		1.2 mg TE/g	0.1 mg TE/g			
Boletus pnophilus	A/W/AA (70:29.5:0.5)	8.4 mg GAE/g	1.8 mg CE/g	17.7 mM TE/g	54.8 mM TE/g		4.1 mM of Fe_2/100 g	Islam *et al*. (2016)
Boletus purpureus	M 80%	49.3 mg GAE/g		13.53 mg TE/g	0.7 mg TE/g			Dimitrijević *et al*. (2017)
	Hydrolysates	2.04 mg GAE/g		1.32 mg TE/g	0.9 mg TE/g			
Boletus pseudosulphureus	M 80%	11375.6 mg/kg		90.82%			47528.6 µmol/g	Keleş *et al*. (2011)
Cantherallus clavatus	W	13.5 mg GAE/g						Puttaraju *et al*. (2006)
	M	2.2 mg GAE/g						
Cantharellus cibarius	M	2.2 mg GAE/g	1.5 mg/g					Palacios *et al*. (2011)
	A	4.88 PE/mg extract	1.46 RE/mg extract	50% (158.4 µg/mL)				Kosanic *et al*. (2013)
	M	4.7 PE/mg extract	1.49 RE/mg extract	50% (192.6 µg/mL)				
	A/W/AA (70:29.5:0.5)	3.2 mg GAE/g	04 mg CE/g	10.9 mM TE/g	16.3 mM TE/g		0.4 mM of Fe_2/100 g	Islam *et al*. (2016)
	M	0.88 mg/g	0.67 mg/g					Barros *et al*. (2008)
Chlororphyllum rhacodes	M 80%	4353.33 mg/kg		80.6%			17885 µM/g	Keleş *et al*. (2011)
Craterellus cornucopioides	M	1.5 mg GAE/g	1.9 mg/g					Palacios *et al*. (2011)
	M	2.13 mg/g	1.71 mg/g					Barros *et al*. (2008)
Calocybe gambosa	M	2.0 mg GAE/g	1.0 mg/g					Palacios *et al*. (2011)
	M	1.70 mg/g	1.18 mg/g					Barros *et al*. (2008)
Coprinus atramentaria	M:W (80:20)	33.58 mg GAE/g						Heleno *et al*. (2012)

Collybia albuminosa	A/W/AA (70:29.5:0.5)	0.9 mg GAE/g	0.9 mg CE/g	15 mM TE/g	87.9 mM TE/g		39.9 mM Fe_2/100 g	Islam *et al*. (2016)
Cortinarius magellanicus	M	9.86 mg GAE/g extract		50% (15.72 mg/mL)				Toledo *et al.* (2016)
Cyttaria hariotii	M	8.48 mg GAE/g extract		50% (19.24 mg/mL)				
Helvella elastica	M	7.5 mg GAE/g	0.78 mg/g					Altaf *et al*. (2020)
Hydropus dusenii	M	16.4 mg GAE/g extract		50% (17.88 mg/mL)				Toledo *et al*. (2016)
Hygrosphorus marzuolus	M	0.8 mg GAE/g	2.3 mg/g					Palacios *et al.* (2011)
Hydnum repandum	M 80%	420 mg/kg		10.2%			145.5 µM/g	Keleş *et al*. (2011)
Hypomyces lactifluorum	M 80%	2.98 EAG/g			50% (5.78 µm TE/g)		3.75 µm TE/g	Espejel-Sánchez *et al.* (2021)
Fistulina antarctica	M	7.82 mg GAE/g extract		50% (13.78 mg/mL)				Toledo *et al*. (2016)
Fistulina endoxantha	M	33.56 mg GAE/g extract		50% (1.54 mg/mL)				
Grifola gargal	M	9.77 mg GAE/g extract		50% (12.17 mg/mL)				
Lactarius deliciosus	M	1.5 mg GAE/g	2.9 mg/g					Palacios *et al.* (2011)
	M 80%	2708 mg/kg		47.3%			2671 µM/g	Keleş *et al.* (2011)
	M			1.83 mM TE/100 g fw		52.3 µM Fe_2/100 g	1.32 mM TE/100g fw	Kalogeropoulos *et al*. (2013)
Lactarius indigo	H:DM (1:1)							Yahia *et al*. (2017)
	A:W:AA (70:29.5:0.5)							
	A:FA (80:20 %)	56.5 mg GAE/100 g fw	12.3 mg CE/100 g fw					
Lactarius piperatus	A	4.93 PE/mg extract	1.53 RE/mg extract	50% (99.2 µg/mL)				Kosanic *et al.* (2013)
	M	5.32 PE/mg extract	2.81 RE/mg extract	50% (172.8 µg/mL)				
	M 80%	3442.2 mg/kg		52.6%			3528 µM/g	Keleş *et al*. (2011)

Lactarius salmonicolor	M 80%	3242 mg/kg		46.2%			4242 µM/g	
Lactarius sanguifluus	M			1.93 mmol TE/100 g fw		2.12 µmol Fe_2/100 g	49.8 mmol TE/100 g fw	Kalogeropoulos *et al.* (2013)
Lactarius semisanguifluus	M			1.49 mM TE/100 g fw		1.7 µM Fe_2/100 g	41 mM TE/100 g fw	
Lactarius volemus	M 60%	3.6 g GAE/kg dw	0.52 g CE/kg dw	67%			0.92 Fe(II)/kg dw	Butkhup *et al*. (2018)
Laetiporus sulphureus	M:HC: W (8:1:1)	10.4 mg GAE/g					3.53 (mM TE/kg)	Sułkowska-Ziaja *et al*. (2012)
	M 70%	7.25 CHAE mg/g		50% (59.2 µg/mL)				Karaman *et al*. (2010)
	TM	0.33 CHAE mg/g						
Leccinum scabrum	M 80%	3175.6 mg/kg		74.2%			23814 µmol/g	Keleş *et al.* (2011)
Lepista nuda	M 80%	4175.6 mg/kg		85.6%			12171 µmol/g	
	M	27.34 mg GAE/g extract		50% (2.16 mg/mL)				Toledo *et al*. (2016)
Lepista personata	M 80%	4220 mg/kg		89.3%			8314.3 µmol/g	Keleş *et al*. (2011)
Lentinus giganteus	M 60%	1.5 g GAE/kg dw	0.21 g CE/kg dw	57%			3.7 g Fe(II)/kg dw	Butkhup *et al.* (2018)
Lentinus squarrosus	M 60%	5.42 g GAE/kg dw	1.2 g CE/kg dw	72%			2.7 g Fe(II)/kg dw	Butkhup *et al*. (2018)
Lentinus polychrous	M 60%	5.4 g GAE/kg dw	2.2 g CE/kg dw	85.4%			3.9 g Fe(II)/kg dw	
Macrolepiota procera var. procera	M 80%	4020 mg/kg		90.1%			7457 µmol/g	Keleş *et al*. (2011)
Melanoleuca cognata	EA	7.3 µmol GAE/g dw	0.36 µmol GAE/g dw	0.12 µmol TE/g dw	0.18 µmol TE/g dw	0.93 µmol EDTAEs /g dw	0.38 µmol TE/g dw	Bahadori *et al*. (2019)
	M	101 µmol GAE/g dw	1.3 µmol GAE/g dw	3.5 µmol TE/g dw	4.3 µmol TE/g dw	8.8 µmol EDTAE/ g dw	9 µmol TE/g dw	
	W	255 µmol GAE/g dw	7.0 µmol GAE/g dw	11.7 µmol TE/g dw	12 µmol TEs/g dw	21.7 µmol EDTAE/ g dw	14 µmol TE/g dw	

Melanoleuca stridula	EA	7.6 µmol GAE/g dw	0.13 µmol GAE/g dw	0.21 µmol TE/g dw	0.2 µmol TE/g dw	0.54 µmol EDTAE/g dw	0.2 µmol TE/g dw	
	M	114 µmol GAE/g dw	2.2 µmol GAE/g dw	5.5 µmol TE/g dw	5.7 µmol TE/g dw	9.4 µmol EDTAE/g dw	7.9 µmol TE/g dw	
	W	200 µmol GAE/g dw	6.7 µmol GAE/g dw	12.1 µmol TE/g dw	12.6 µmol TE/g dw	18.9 µmol EDTAE/g dw	15 µmol TE/g dw	
Marasmius oreades	M	3.2 mg/g	2.26 mg/g					Barros *et al.* (2008)
Morchella esculenta	A/W/AA (70:29.5:0.5)	5.7 mg GAE/g	0.8 mg CE/g	14.9 mM TE/g	23.3 mM TE/g		1.6 mM Fe_2/100 g	Islam *et al.* (2016)
Morchella conica	M	24.5 mg GAE/g	12.3 mg/g					Altaf *et al.* (2020)
Phallus indusiatus	HW	6.6 mg GAE/g	6.0 mg GAE/g	45% (1 mg/mL)				Liu *et al*. (2018)
				40% (1 mg/mL)				
Polyporus tenuiculus	PE	15 mg GAE/g		38% (20 mg/mL)		38% (20 mg/mL)		Chye *et al*. (2008)
	M	17 mg GAE/g		58% (20 mg/mL)		82% (20 mg/mL)		
Polyporus squamosus	M 80%	4531 mg/kg		43%			2242.7 µmol/g	Keleş *et al*. (2011)
Ramaria botrytoides	A/W/AA (70:29.5:0.5)	5.6 mg GAE/g	3.7 mg CE/g	16.9 mM TE/g	5.4 mM TE/g		3.6 mM Fe_2/100 g	Islam *et al*. (2016)
Ramaria flava	M 80%	4.4 EAG/g	2.25 mg carotene/g		23.65 µm TE/g		20.17 µm TE/g	Espejel-Sánchez *et al.* (2021)
Ramaria patagonica	M	50.82 mg GAE/g extract		50% (0.77 mg/mL)				Toledo *et al.* (2016)
Rhizopogon luteolus	M	18.2 mg GAE/g	5.0 mg/g					Altaf *et al.* (2020)
Russula alboareolata	M 60%	4.7 g GAE/kg dw	1.1 g CE/kg dw	63%			2.7 Fe(II)/kg dw	Butkhup *et al.* (2018)
Russula delica	M			1.15 mmol TE/100 g fw		1.18 µmol Fe_2/100 g	52.5 mmol TE/100 g fw	Kalogeropoulos *et al*. (2013)
Russula emetica	M 60%	1.7 g GAE/kg dw	0.75 g CE/kg dw	46.3%			0.2 Fe(II)/kg dw	Butkhup *et al.* (2018)
Russula cyanoxantha	A	5.23 PE/mg extract	1.55 RE/mg extract	50% (86.3 µg/mL)				Kosanic *et al.* (2013)
	M	4.55 PE/mg extract	1.44 RE/mg extract	50% (262.1 µg/mL)				

Russula galochroides	M 60%	2.4 g GAE/kg dw	1.4 g CE/kg dw	69.8%			3.9 Fe(II)/kg dw	Butkhup *et al*. (2018)
Russula nigricans	M 60%	2.3 g GAE/kg dw	1.03 g CE/kg dw	52%			0.32 Fe(II)/kg dw	
Russula luteotacta	M 60%	4.6 g GAE/kg dw	2.09 g CE/kg dw	81%			7.5 Fe(II)/kg dw	
Russula virescens	E	2.21 mg GAE/g	1.02 mg/g	52.6% (2 mg/mL)	87.1 (2 mg/mL)			Hasnat *et al*. (2014)
	W	8.74 mg GAE/g	2.83 mg/g	81.12 (2 mg /mL)	96.6 (2 mg/ mL)			
Schizophyllum commune	PE	18 mg GAE/g		58% (20 mg/mL)		58% (20 mg/mL)		Chye *et al*. (2008)
	M	23 mg GAE/g		35% (20 mg/mL)		75% (20 mg/mL)		
	E 50%	1.75 mg GAE/g	22 µg CE/mL	50% (0.5 mg/mL)	50% (0.3 mg/mL)	50% (3.02 mg/mL)		Vamanu and Voica (2017)
Sparassis crispa	M 80%	690 ug/g	50 ug/g	55%				Kim *et al*. (2008)
Suillus bellinii	M			3.24 mmol TE/100 g fw		4.54 µmol Fe^2/100 g	27 mmol TE/100 g fw	Kalogeropoulos *et al*. (2013)
Termitomyces clypeatus	M 60%	8.8 g GAE/kg dw	5.1 g CE/kg dw	83.1%			9.8 Fe(II)/kg dw	Butkhup *et al*. (2018)
Termitomyces crassus	M 60%	2.6 g GAE/kg dw	1.53 g CE/kg dw	64.2%			0.37 Fe(II)/kg dw	
Termitomyces fuliginosus	M 60%	6.3 g GAE/kg dw	2.2 g CE/kg dw	72.3%			4.5 Fe(II)/kg dw	
Termitomyces heimii	W	37 mg/g						Puttaraju *et al*. (2006)
	M	11 mg/g						
Termitomyces tylerance	W	18 mg/g						
Termitomyces mummiformis	W	19.2 mg/g						
	M	2.2 mg/g						
Termitomyces microcarpus	W	7 mg/g						
	M	4.4 mg/g						
Termitomyces shimperi	W	15.2 mg/g						
	M	4.8 mg/g						
Tremella mesenterica	A/W/AA (70:29.5:0.5)	0.9 mg GAE/g	0.22 mg CE/g	4.4 mM TE/g	3.4 mM TE/g		0.3 mM Fe_2/100 g	Islam *et al.* (2016)

Tricholoma matsutake	A/W/AA (70:29.5:0.5)	1.4 mg GAE/g	0.3 mg CE/g	1.4 mM TE/g	10.8 mM TE/g		1.0 mM Fe_2/100 g	
Umbilicaria esculenta	A/W/AA (70:29.5:0.5)	26.2 mg GAE/g	2.1 mg CE/g	9.6 mM TE/g	109.2 mM TE/g		1.3 mM Fe_2/100 g	
Xerocomus badius	M 80%	198.9 mg GAE/g		30.7 mg TE/g	4.01 mg TE/g			Dimitrijević *et al*. (2017)
	Hydroly-sates	8.5 mg GAE/g		1.2 mg TE/g	0.6 mg TE/g			
Xerocomellus chrysenteron	M 80%	21.7 mg GAE/g		18.7 mg TE/g	2.9 mg TE/g			
	Hydroly-sates	99.1 mg GAE/g		2.02 mg TE/g	1.8 mg TE/g			

Acetone (A); ethyl acetate (EA); acetic acid (AA); hydrochloric acid (HC); methanol (M); petroleum ether (PE); ethanol (E); water (W); hot water (HW); cold water (CW); hexane (H); dichloromethane (DM); trichloromethane (TM); formic acid (FA); Chlorogenic acid equivalents (CHAE); equivalent gallic acid/gram (GAE/g); Trolox equivalents (TE); ethylenediaminetetraacetic acid (disodium salt) equivalents (EDTAE); catechin equivalent (CE); Fe(II) equivalents (Fe (II), Fe_2); pyro-catechol equivalent (PE); Rutin equivalent (RE); dry weight (dw); fresh weight (fw).

The nutritional components and biomolecules present in mushrooms make them considered functional food because phenolic compounds, proteins/enzymes, and some metalic elements (chromium, cobalt, copper, iron, manganese, and zinc) are essential for the development and functioning of the human body (Zsigmond *et al*. 2015; Aprotosoaie *et al*. 2017), have an effect as modulators in nutrient metabolism, in the immune and gastrointestinal systems, and counteract oxidative stress. However, it must be taken into account that depending on the climate and soil conditions (disturbance and presence of contaminants), wild edible mushrooms may contain compounds that affect human health through the accumulation of toxic heavy metals, such as mercury, lead, cadmium, and organic substances resulting from human industrial activities (Zsigmond *et al*. 2020). Therefore, it is advisable to know the place of origin to prevent the consumption of toxic substances. Despite the statements mentioned above, fungi have been and will continue to be of great interest in the biomedical, environmental, and biotechnological fields. Accordingly, identification, ecology and conservation studies of said non-timber forest resources should be promoted.

CONCLUDING REMARKS

1. Wild edible mushrooms are an important source of food. They present bioactive molecules, including phenolic compounds with antioxidant activity, which provide health benefits to those who consume them.
2. The study of the content of phenolic compounds and antioxidant activity of wild edible mushrooms will make it possible, in the first instance, to identify the species with the greatest bioactivity and seek strategies to establish conditions for their cultivation and increase their availability.
3. Wild edible mushrooms contain phenolic compounds as well as other molecules such as polysaccharides, minerals, vitamins, proteins, amino acids, *etc*., which can contribute to antioxidant activity and other biological activities, so they can be considered functional foods.

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