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Some minerals and fatty acid compositions of five different wild edible mushrooms species collected in Tokat and Yozgat provinces in Turkey

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Türkiye'de Tokat ve Yozgat illerinde toplanan beş farklı yenilebilir mantar türünün bazı mineralleri ve yağ asidi bileşimleri

Abstract: The present study was made to determine the fatty acids composition and some minerals of five wild edible mushrooms species (*Agaricus benesii* (Pilát) Pilát, *Amanita vaginata* (Bull.) Lam., *Leccinum aurantiacum* (Bull.) Gray, *Macrolepiota phaeodisca* Bellù, *Sarcodon imbricatus* (L.) P. Karst.). Mushroom specimens, which were our research material, were collected from different localities in Tokat and Yozgat provinces. The minerals were examined in atomic absorption spectrophotometric (AAS) and fatty acids were detected by Gas chromatographic-mass spectrometry system (GC-MS) on dried mushrooms samples. In the result of analyses, six different minerals (Cu, Mn, Zn, Ni, Fe, Al) and six different fatty acids (pentadecanoic, palmitic, palmitoleic, stearic, oleic and linoleic acid) have been identified. The dominant fatty acid in basidiocarps of *A. benesii* and *M. phaeodisca* was linoleic acid (C18:2), and was determined as 62.58%, 45.02%, respectively. The dominant fatty acid in basidiocarps of *A. vaginata*, *L. aurantiacum* and *S. imbricatus* was oleic acid (C18:1), and was determined as 54.32%, 46.98% and 48.67%, respectively. The most abundant mineral in basidiocarp of *S. imbricatus* was Zinc (Zn) with 112.29 mg/kg. Also it was found that aluminium (Al) was the most abundant mineral in other ones with quantities ranging from 93.77–3349.02 mg/kg.

Key words: AAS, GC-MS, nutrition, wild edible mushrooms, Turkey

Özet: Bu çalışma, beş yabani yenilebilir mantar türünün (*Agaricus benesii* (Pilát) Pilát, *Amanita vaginata* (Bull.) Lam., *Leccinum aurantiacum* (Bull.) Gray, *Macrolepiota phaeodisca* Bellù, *Sarcodon imbricatus* (L.) P. Karst.)'un yağ asitleri bileşimini ve bazı minerallerini belirlemek için yapılmıştır. Araştırma materyalimiz olan mantar örnekleri Tokat ve Yozgat illerinin farklı yörelerinden toplanmıştır. Kuru mantar örneklerinde mineraller atomik absorpsiyon spektrofotometrik (AAS) ve yağ asitleri Gaz kromatografik-kütle spektrometri sistemi (GC-MS) ile tespit edilmiştir. Analizler sonucunda altı farklı mineral (Cu, Mn, Zn, Ni, Fe, Al) ve altı farklı yağ asidi (pentadekanoik, palmitik, palmitoleik, stearik, oleik ve linoleik asit) tanımlanmıştır. *Agaricus benesii* ve *M. phaeodisca*'nın basidiokarplarında dominant yağ asidi linoleik asit (C18: 2) olup, sırasıyla %62.58, %45.02 olarak belirlenmiştir. *A. vaginata*, *L. aurantiacum* ve *S. imbricatus*'un bazidiyokarplarında dominant yağ asidi oleik asit (C18: 1) olup, sırasıyla %54.32, %46.98 ve %48.67 olarak belirlenmiştir. *S. imbricatus*'un basidiocarp'ında en bol bulunan mineral 112.29 mg/kg ile Çinko (Zn) idi. Ayrıca 93.77–3349.02 mg/kg arasında değişen miktarlarda alüminyumun (Al) diğerlerinde en bol bulunan mineral olduğu bulunmuştur.

Anahtar Kelimeler: AAS, GC-MS, beslenme, yabani yenilebilir mantar, Türkiye

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1. Introduction

Fungi are one of organisms having the most diverse in the world. Although it is estimated that there are 1.5 million fungi species in worldwide, 70 thousand of them are in the literature. About 10 thousand species of these recorded fungi are macrofungi including 5020 edible, 1250 inedible, 1010 poisonous, 1820 medicinal (Hawksworth, 1996, 2001; Pekşen, 2013).

Mushrooms are used in medicine as support for the treatment and prevention of many diseases, such as cardiovascular and inflammatory diseases. The nutrients used for these purposes are called nutraceutical. They have antioxidant, antitumor and antimicrobial properties. Mushrooms, one of these nutraceutical foods, attract attention with their low cholesterol, fat and carbohydrate content as well as basic nutritional elements. It has been recommended for people who diet with food having with high protein and low lipid content. Many studies have shown that mushrooms are excellent sources of essential unsaturated fatty acids. The unsaturated fatty acids are precursors for the synthesis of eicosanoids such as prostaglandins that are important for cardiovascular health. Oleic acid from the omega-9 family is a monounsaturated fatty acid, and is produced in our body. It is known as blood cholesterol lowering. Linoleic acid from the omega-6 can not be synthesized by the human body. This fatty acid is very important for human health, especially to regulate blood lipid profiles. In addition, linoleic acid is used in the production of arachidonic acid, which is the polyunsaturated fatty acid from Omega-6 group, in our body (Barros, 2008; Riberio, 2009; Orsine, 2012; Ravikrishnan, 2015; Doğan, 2016).

The elements are inorganic substances that are not produced in the human body and must be taken from

outside with liquid or solid foods. Minerals such as zinc, copper, iron and manganese are found in the human body in small amounts (approximately 0.02% of the total body weight or required in amounts <100 mg/day), and that's why they are called microelements (trace elements). These minerals must be taken from outside with nutrients even if their requirements are low. Zinc (Zn) involved in the structure of some important metabolic enzymes such as polymerase, carbonic anhydrase, peptidase, alkaline phosphatase has important task in the metabolic functions of our body (wound healing, improved resistance against the infections, synthesis of nucleic acids and proteins etc.), and at protection of children against certain diseases. Copper (Cu) is an important trace element involved in multiple enzyme systems such as ascorbic acid oxidase, cytochrome oxidase, monoamine oxidase, superoxide dismutase and lactase. It is also an essential element for the neurologic and hematologic systems. Manganese (Mn) takes part in the activation of enzymes such as superoxide dismutase, glycosyltransferase, pyruvate carboxylase. It is also involved in blood sugar regulation, fat and carbohydrate metabolism, normal brain and nerve functions, and calcium absorption. Iron (Fe) is used in metabolic processes such as DNA synthesis, electron and oxygen transport, production of hemoglobin and myoglobin, synthesis of connective tissue and some hormones. Nickel (Ni) is also accepted as ultra-trace nutrient. The functions of nickel in the human body have not been fully revealed. However, it is thought that it is a cofactor of some enzymes involved in the metabolism of glucose. Also it is a toxic mineral for many systems in human body. Contact with nickel can cause the allergic reactions on skin such as contact dermatitis. Some studies have shown that it causes respiratory cancers (Wada, 2004; Duda-Chodak, 2008; Al-Fartusie, 2017). Aluminum (Al) is the toxic microelement for human body, in spite of the fact that it is the most abundant metal in the earth's crust. It has an inhibitory effect for many biological functions (Kawahara, 2007).

The aim of this study was to examine the composition of some mineral and fatty acids of five edible mushroom species, namely *Agaricus benesii, Amanita vaginata, Leccinum aurantiacum, Macrolepiota phaeodisca,* and *Sarcodon imbricatus.*

2. Materials and Method

2.1. Collection and Identification of Mushroom Samples

During regular field trips, mushroom samples were collected from different regions in Tokat and Yozgat provinces and fatty acid and mineral analysis were made. The habitats, localities and families of the samples are given in Table 1.

The fresh specimens were photographed in the field, and their macroscopic and ecological features were noted. They were brought to the laboratory and the collection numbers were given to each. Afterly the specimens were dried and put into polyethylene bags for later studies. Characteristics of microscopical structures were investigated under a light microscope by mounting them in some reagents (lactofenol stain, Melzer's reagent, congo red, KOH 5%, distilled water etc). The specimens were identified based on their ecological, macroscopic and microscopic features with the literature such as Philips (1981), Moser (1983), Bon (1987), Jordan (1995) and Breitenbach and Kränzlin (1995). The examined specimens were deposited in the Fungarium of Biology Department, Gaziosmanpaşa University, Tokat, Turkey.

2.2. Fatty acid analysis

The fatty acids were detected by gas chromatographic-mass spectrometry instrument (GC-MS, Agilent 7890 GC/5970 MS Series-Santa Clara, CA, USA) using the conditions in Table 2, and a high polarity capillary column (HP-88, 100 m × 0.25 mm, 0.20 um film (Part no: 112-88A7, Agilent, Santa Clara, CA, USA). Dried and ground mushroom samples were used in chemical analyzes. The method of Hara and Radin (1978), for lipid extraction and Christie (1990), Christie (1998) and Wretensjö (1990), process to obtain methyl esters was revised and used. For this purpose, 5 g of dried mushroom samples were taken and broken in 10 mL of hexane/isopropanol (3:2) in homogenizer at 10.000 rpm for 30 seconds. After then, the mixture was centrifuged at 5000 rpm for 10 minutes, the upper part was taken, and filtered and then it was put into test tubes. The lipid extract was transferred to cap tubes (30 mL) to prepare the methyl ester. 5 mL of 2% methanolic sulfuric acid was added into the extract and it was vortexed. This mixture was held for methylation in the incubator at 50˚C for 15 hours. After then, the tubes were removed from the incubator and cooled to room temperature and vortexed with the addition of 5 mL of 5% NaCl. The methyl esters of the fatty acids formed in the tubes were extracted with 5 mL of hexane. The hexane phase was taken from the top with a Pasteur pipette and treated with 5 mL of 2% $KHCO_3$ and kept for 1-2 hours to separate the phases. The solvent of the mixture containing the methyl esters was evaporated under nitrogen at 45˚C. Fatty acids at the under of the test tubes were dissolved with 1 mL of hexane and analyzed with GC-MS by transferring to dark GC vials. SGE Analytical (BP×90 100 m × 0.25 mm × 0.25 um) column (Australia) and Agilent brand GC-MS instrument were used in our study. The temperature was gradually increased from 120˚C to 250˚C within 45 minutes and kept at this temperature during the analysis. In the analysis of the samples, Helium (He) was selected as the carrier gas. The system was calibrated with the standard fatty acid samples and natural fatty acids in the samples were determined. All analyzes were carried out in triplicate and average of the results were taken. The results of fatty acids methyl ester were reported as percentage (Bengü, 2019).

2.3. Mineral analysis

The minerals were examined in atomic absorption spectrophotometric instrument (AAS, Perkin Elmer brand AAS 800 Model, USA). In the preparation of the samples, approximately 0.5 g of the dried mushroom samples were weighed and transferred to the microwave oven teflon containers, and 10 mL nitric acid was added to each sample and burned in the microwave. The samples were read with each element wavelength, specific lamp, and standard graphics in AAS studies. The studies had been made in the form of three repetitions and were averaged. The data of mineral analysis were reported as mg/kg.

3. Results

The results of fatty acid analysis of the five wild edible macrofungi species and the amounts of total saturated (ΣSFAs), unsaturated (ΣUFAs), monounsaturated (ΣMUFAs) and polyunsaturated fatty acids (ΣPUFAs) in the analyzed samples were given in Table 3.

According to the results, six different saturated (pentadecanoic, palmitic and stearic acid) and unsaturated fatty acids (palmitoleic, oleic and linoleic acid), which carbon chain lengths ranging from 14-24, have been detected in quantities ranging from 1.61% to 62.58% from five wild edible mushrooms (*A. benesii*, *A. vaginata*, *L. aurantiacum*, *M. phaeodisca*, *S. imbricatus*) collected from different localities in Tokat and Yozgat provinces in Turkey. As a result of the analysis of the samples, short chain fatty acids could not be detected due to the destruction and loss of fatty acids as a result of the temperature applied during the preparation and methylation of the extraction. It has been reported that short-chain fatty acids, which are liquid at room temperature, evaporate easily at high temperatures (Woldegiorgis, 2015). The highest rate of total saturated fatty acid was found in *M. phaeodisca* with 43.11% due to the high levels of palmitic acid (30.70%), while the lowest of total saturated fatty acid was found in *L. aurantiacum* with 21.65%. The highest rate of total unsaturated fatty acid was determined in *L. aurantiacum* with 78.35% due to the high levels of oleic acid (46.98%) and linoleic acid (31.37%), while the lowest of total unsaturated fatty acid was determined in *M. phaeodisca* with 56.89%. Also it was determined that the unsaturated fatty acid levels (ΣMUFAs+ΣPUFAs) in all of the analyzed mushroom species samples was higher than the saturated fatty acid levels (Table 3). This result is consistent with previous studies such as Ribeiro et al. (2009), Ravikrishnan et al. (2015), Yılmaz et al. (2006), Ergönül et al. (2012), Doğan and Akbaş (2013), Goyal et al. (2015), Pietrzak-Fiećko et al. (2016), Türkekul et al. (2017), Bengü (2019) and Bengü et al. (2019). ΣPUFAs amount was higher in *A. benesii* and *M. phaeodisca* samples, and ΣMUFAs was higher in *A. vaginata* and *S. imbricatus*. Because of the major fatty acid was linoleic acid, which is the precursor of mushroom alcohol (1-octen-3-ol), was found in the samples of *A. benesii* and *M. phaeodisca* with 62.58%¬45.02%, respectively. The major fatty acid was oleic acid in the samples of *A. vaginata*, *L. aurantiacum* and *S. imbricatus* with 54.32%, 46.98% and 48.67%, respectively. While pentadecanoic acid with 1.83% was observed only in *L. aurantiacum* species, palmitoleic acid was observed only in *M. phaeodisca* species. Palmitic, stearic, oleic and linoleic acid were determined in different amounts in all mushroom samples (Table 3). The main fatty acid in mushrooms was found to be linoleic acid, followed by oleic acid and palmitic acid as were in many studies, such as Akyüz (2011) Goyal (2015), Pietrzak (2016) and Bengü et al. (2019). Our results are consistent with the results of these studies.

In literature review, any work on the fatty acid profiles of *A. benesii* could not detected. In our studies made on this mushroom; palmitic, stearic, oleic and linoleic acids were detected with proportions of 19.95%, 12.59%, 4.88% and 62.58%, respectively (Table 3). In a similar study made with *Agaricus bisporus* and *Pleurotus sajor caju* by Goyal et al. (2015), seven different fatty acids have been identified including palmitic, stearic, oleic and linoleic acid. Arachidic acid, which we could not detect in our study, was found in studies made with *Agaricus bisporus* and *A. campestris* by Yılmaz et al. (2006). In a study made on natural specimens of *A. bisporus* by Bengü et al. (2019), nine different fatty acids (myristic, penthadecanoic, palmitic, heptadecanoic, stearic, oleic, linoleic, eicosenoic, behenic acid) have been identified. Unlike this result, myristic, penthadecanoic, heptadecanoic, eicosenoic, behenic acid could not be detected in *A. benesii* samples which we used in our studies.

In our studies made with *Amanita vaginata*, four different fatty acids (palmitic, stearic, oleic and linoleic acid) were found with proportions of 20.68%, 4.81%, 54.32% and 20.19%, respectively (Table 3). The fatty acids of *A. rubescens* has been analyzed in a similar study made by Ribeiro et al. (2009). Twenty one different fatty acids have been detected in the result of this study. The rates of palmitic, stearic, oleic and linoleic acid which we were identified in our work were higher than the others. In a study made by Karliński et al. (2007), *A. muscaria* and *A. rubescens* were analyzed for the determination of fatty acids content. The dominant fatty acid in basidiocarps of *A. muscaria* was linoleic acid. In addition tridesilic acid (C13:0) was found to be the dominant fatty acid in *A. rubescens.*

In the chemical analysis of *L. aurantiacum*, five different fatty acids (pentadecanoic, palmitic, stearic, oleic and linoleic acid) were found with proportions of 1.83%, 14.93%, 4.89%, 46.98% and 31.37%, respectively (Table 3). Pentadecanoic acid could only be detected in this mushroom among the fungi which we analyzed. In this study made to determine fatty acid composition of *L. aurantiacum* species by Pedneault et al. (2006), the major fatty acid was linoleic acid. In our studies, we found that the highest amount of fatty acid is oleic acid. In the study made with *L. scabrum* by Karliński et al. (2007), linoleic acid was identified to be the most abundant fatty acid with proportions of 72.6%. In addition, in this study made on *L. scabrum* by Dembitsky et al. (2010), oleic acid and linoleic acid was found to be the most abundant fatty acids with proportions of 31.7% and 45.8%, respectively.

In literature searches, any work made on the fatty acid profiles of *M. phaeodisca* could not detected. However, there are studies made with similar species such as *Macrolepiota procera*, *M. mastoidea*. Palmitic, palmitoleic, stearic, oleic and linoleic acid were found with proportions of 30.70%, 2.01%, 12.41%, 9.86% and 45.02%, respectively in analysis that we made with the test samples of *M. phaeodisca* (Table 3). In the result of study made by Barros et al. (2008), it was detected that the proportion of palmitic, oleic and linoleic acid was higher than others in the dry samples of *Macrolepiota procera* and *Macrolepiota mastoidea*. In this study made on *Macrolepiota procera* by Fernandesa et al. (2013), linoleic acid was detected as the major fatty acid compared to other fatty acids.

In the chemical analysis of *S. imbricatus*, four different fatty acids (palmitic, stearic, oleic and linoleic acid) were found with proportions of 15.95%, 8.93%, 48.67% and 26.45%, respectively (Table 3). Pentadecanoic and palmitoleic acid were not found in our samples. Oleic and

linoleic acid were detected in our study as the major fatty acids. The studies made on dry samples of *S. imbricatus* by Barros et al. (2007) were showed that the major fatty acids were palmitic, stearic, oleic and linoleic acids as in our results.

According to the results of mineral analysis, six different minerals (Cu, Mn, Zn, Ni, Fe, Al) have been detected in quantities ranging from 4.81 mg/kg to 3349.02 mg/kg from five wild edible mushrooms (*A. benesii*, *A. vaginata*, *L. aurantiacum*, *M. phaeodisca*, *S. imbricatus*) collected from different localities in Tokat and Yozgat provinces in Turkey (Table 4, Figure 1).

While copper (Cu) was found at the highest level in *S. imbricatus* with 66.16 mg/kg, it was found at the lowest level in *L. aurantiacum* with 41.11 mg/kg. Manganese (Mn) was found at most in *A. vaginata* with 69.90 mg/kg, it was found at lowest in *S. imbricatus* with 7.18 mg/kg. The lowest and highest levels of Zinc (Zn) were found in *M. phaeodisca* (with 53.68 mg/kg) and *S. imbricatus* (with 112.29 mg/kg), respectively. In our research, the amount of nickel (Ni) was found to be higher in *A. vaginata* with 15.29 mg/kg than the others, and the lowest value of this mineral was measured in *M. phaeodisca* with 4.81 mg/kg. Iron (Fe) mineral was measured at the most level in *A. vaginata* with 1631.86 mg/kg, and the least level of it was observed in *S. imbricatus* with 35.45 mg/kg was observed at the least amount in this mushroom. In addition, the analysis showed that aluminum (Al) was at the highest level in *A. vaginata* with 3349.02 mg/kg and was at the lowest level in *M. phaeodisca* with 93.77 mg/kg. In result the highest concentration of Mn, Ni, Fe and Al was observed in *A. vaginata* with 69.90, 15.29, 1631.86, 3349.02 mg/kg, respectively, and the the highest concentration of Cu and Zn was observed in *S. imbricatus* with 66.16–112.29 mg/kg, respectively.

In the present study, Cu, Mn, Zn, Ni, Fe, Al contents were 58.96, 15.74, 97.43, 9.62, 85.95 and 309.10 mg/kg in *Agaricus benesii* and 60.25, 69.90, 104.61, 15.29, 1631.86 and 3349.02 mg/kg in *Amanita vaginata*, respectively (Table 4). In study made for *Agaricus xanthodermus* by Jonnalagadda et al. (2006), Fe and Mn have been detected to be 306 mg/kg and 30 mg/kg, respectively. *Agaricus bisporu*s from *Agaricus* genus is one of the most studied fungi in the world. In study made on *A. bisporu*s by Işıldak et al. (2004), they found that Fe was the dominant element followed by Cu and Zn. *Amanita vaginata* is an edible macrofungi that naturally collected and consumed in many regions in Turkey. Cu, Mn, Zn, Ni, Fe, Al were determined in quantities ranging from 15.29 mg/kg to 3349.02 mg/kg in our *A. vaginata* samples collected from different area of Tokat province. The study made on *A. vaginata* by Radulescu et al. (2010). Cu, Mn, Zn, Ni, Fe were determined in quantities ranging from 0.7 mg/kg to 112.10 mg/kg. Zn content was higher in this study than our results. But Cu, Mn, Ni, Fe amounts in our study were higher than the results of the study made by Radulescu et al. (2010).

In addition Cu, Mn, Zn, Ni, Fe, Al contents were 41.11, 19.30, 77.33, 9.10, 227.38 and 480.28 mg/kg in *L. aurantiacum* and 61.18, 10.33, 53.68, 4.81, 53.92 and 93.77 mg/kg in *M. phaeodisca*, respectively (Table 4). Trace minerals (Cu, Mn, Zn, Fe) that we found in the studies were detected by Brzezicha-Cirocka et al. (2016) from *L. aurantiacum* samples with 37, 17, 100 and 150 mg/kg, respectively. According to this, our results are higher in terms of these minerals than the results of Brzezicha-Cirocka et al. (2016). In literature searches, any work made on the mineral content of *Macrolepiota phaeodisca* could not detect. But in a study made on a close species (*M. procera*) by Keleş et al. (2017), Cu, Mn, Zn, Fe and Ni were determined in quantities ranging from 6.98 to 151.5 mg/kg. In our studies copper content was found to be higher according to other study, and iron content was higher at the study made by Keleş et al. (2017).

In analysis of *S. imbricatus* samples; the amounts of Cu, Mn, Zn, Ni, Fe and Al were found as 66.16, 7.18, 112.29, 5.38, 35.45, 94.49 mg/kg, respectively. Among mushroom species analyzed, the greatest concentrations of Cu an Zn were obtained in *S. imbricatus* with 66.16 mg/kg and 112.29 mg/kg, respectively. In a study made to determine the amount of Zn, Mn, Fe and Cu on dry samples of the same macrofungi by Çolak et al. (2009), it was determined that Zn was the highest amount mineral compared to other minerals like our study. Although the amount of copper at our studies is higher compared to the study made by Çolak et al. (2009). The amont of Mn detected by Çolak et al. (2009) is higher than our study.

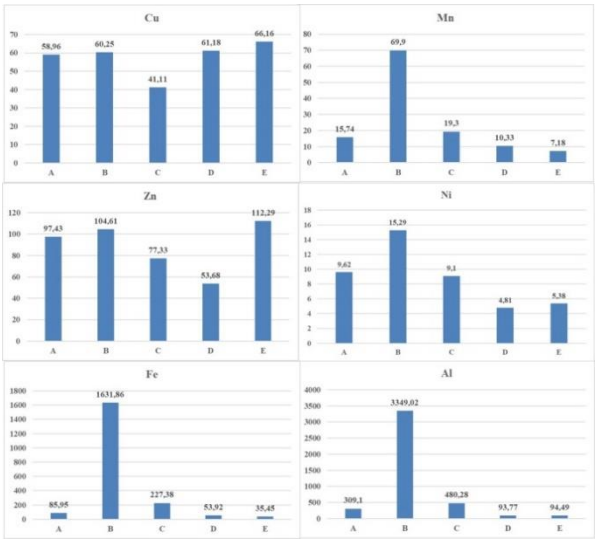

Figure 1. Microminerals levels of mushroom samples (mg/kg)

Table 1. Some features of the mushroom species

Species	Family	Localities	Habitat
Agaricus benesii	*Agaricaceae*	Yozgat-Akdağmadeni	Under deciduous trees
Amanita vaginata	*Amanitaceae*	Tokat center	In broad-leaf woods
Leccinum aurantiacum	*Boletaceae*	Tokat center	On soil under poplar
Macrolepiota phaeodisca	*Agaricaceae*	Yozgat-Kadışehri	On soil under oak
Sarcodon imbricatus	*Bankeraceae*	Yozgat-Akdağmadeni	In coniferous woods

Table 2. GC-MS analytical conditions for fatty acid analysis

Parameter/Component	Description / Value
GC-MS instruments	Agilent- Santa Clara, CA, USA
Series	7890 GC/5970 MS
Column	SGE Analytical BP×90 100m × 0.25 mm × 0.25 um (Australia)
Detector	FID for GC, Triple-axis for MS
Auto sampler	CTC- PAL
Temperature program	120°C to 250°C, 5°C/min. with temperature rise rate
Total time	45 min.
Split ratio	10:1
Injection volume	1 µL
Solvent delay	12 min.
Dry air flow	350 mL/min.
H_2 flow mode	35mL/min.
N_2 flow mode	20,227 mL/min.
Carrier gas	He
He flow mode	1 mL/min, constant flow mode

4. Discussions

The edible macrofungi, which are rich in terms of minerals, proteins, fiber, vitamins, and are low in terms of calories and cholesterol, are becoming increasingly important as a food source. Both the results of this study and the previously reported studies have shown that macrofungi are rich in terms of mono- and polyunsaturated fatty acids too. In addition, the studies have shown that macrofungi are an important nutrient sources in terms of minerals too. Wild and cultivated mushrooms species can be an important sources of food to meet the nutritional needs of the growing world population. Besides the wild edible macrofungi are an important source of income both nutrient and economically in many places around the world. However, studies made on the diagnosis of macrofungi were shown that very few of the edible macrofungi are known and consumed by the local people.

Table 3. Fatty acid profile of five wild edible mushrooms (%)

Fatty Acid Type	*A. benesii*	*A. vaginata*	*L. aurantiacum*	*M. phaeodisca*	*S. imbricatus*
Pentadecanoic acid (C15:0)	ND	ND	1.83	ND	ND
Palmitic acid (C16:0)	19.95	20.68	14.93	30.70	15.95
Palmitoleic acid (C16:1)	ND	ND	ND	2.01	ND
Stearic acid (C18:0)	12.59	4.81	4.89	12.41	8.93
Oleic acid (C18:1)	4.88	54.32	46.98	9.86	48.67
Linoleic acid (C18:2)	62.58	20.19	31.37	45.02	26.45
ΣSFAs	32.54	25.49	21.65	43.11	24.88
ΣUFAs	67.46	74.51	78.35	56.89	75.12
ΣMUFAs	4.88	54.32	46.98	11.87	48.67
ΣPUFAs	62.58	20.19	31.37	45.02	26.45

Table 4. Mineral levels of mushroom samples (mg/kg)

Species	Cu	Mn	Zn	Ni	Fe	Al
Agaricus benesii	58.96	15.74	97.43	9.62	85.95	309.10
Amanita vaginata	60.25	69.90	104.61	15.29	1631.86	3349.02
Leccinum aurantiacum	41.11	19.30	77.33	9.10	227.38	480.28
Macrolepiota phaeodisca	61.18	10.33	53.68	4.81	53.92	93.77
Sarcodon imbricatus	66.16	7.18	112.29	5.38	35.45	94.49

The results of this study provide us with information on the fatty acid and some mineral contents of five different wild edible macrofungi species that are *A. benesii*, *A. vaginata*, *L. aurantiacum*, *M. phaeodisca*, *S. imbricatus*. For some of these mushroom species, no studies can be found on the analysis of fatty acid or mineral content. According to results of the present study, the analyzed macrofungi can be sorted according to total unsaturated fatty acid content like *L. aurantiacum* > *S. imbricatus* > *A. vaginata* > *A. benesii* > *M. phaeodisca*. Evaluation of mineral analysis results show that *A. vaginata* is richer in Mn, Ni, Fe and Al while *S. imbricatus* is in Cu, Zn than the other mushroom specimens under discussion. This reported study will contribute to the studies on this subject.

Conflict of Interest

Authors have declared no conflict of interest.

Authors' Contributions

The authors contributed equally.

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