

Some elements and fatty acid profiles of three different wild edible mushrooms from Tokat province in Turkey

Aydin Sukru Bengu

Vocational School of Health Services, Department of Medical Services and Technics Bingol University, Bingol, Turkey.
abengu@bingol.edu.tr, aydinbengu75@gmail.com

Summary. Three wild edible mushrooms species were collected from the Tokat district to determine fatty acid profiles and some microelement contents. According to analyze results, the highest amount of Fe was found in *Coprinus atramentarius*, Cu was in *Suillus luteus*. The dominant fatty acid at all mushroom species was Oleic acid and the next three acids were Linoleic, Palmitic and Stearic acid ranging from 7.73-33.17%, 21.24-28.60% and 10.49-28.55% respectively. In addition to these acids, seven different kinds of fatty acids have been investigated too in this research. The results of the study showed that *Coprinus atramentarius*, *Laetiporus sulphureus* and *Suillus luteus* species have a rich measure of fatty acids and microelements.

Key words: fatty acids, mushrooms, microelements, Tokat Province

Introduction

Wild mushrooms distribute worldwide and they play important role in the ecosystem due to they are able to biodegrade the substrate and recycle valuable minerals and nutrient to nature back. They include a high quantity of protein, carbohydrates, and vitamin, besides minerals, fiber, and valuable fatty acids. Dried mushrooms contain 22% protein, 5% fat mostly in the form of the Linoleic acid, 63% carbohydrates, 10% minerals and provide several vitamins including thiamin, riboflavin, niacin, and biotin (1-2).

Wild edible mushrooms are become more important to human daily life due to their nutritional, pharmacological and economic potentials. Turkey has a rich diversity of edible mushroom species because of different geomorphology, weather conditions, and environmental features. Wild edible mushroom have been used as a natural food source since ancient times and are generally used in pharmacology and cosmetics, especially used as a source of income. Local people are collecting them to achieve economic income and so that Turkey is becoming a major exporter of edible mushrooms.

In addition to, wild edible mushrooms includes important fatty acids contents which are mostly not synthesized in the human body. Linoleic fatty acid is reported as omega 6 (W-6), Linolenic fatty acid as omega 3 (W-3). Omega 6 has important roles in blood circulation and omega 3 is considered the most valuable fatty acid and can be taken from only plants and animal nutrients. Fatty acids compositions have important effects on blood lipid profiles. Saturated fatty acids increase high-density lipoprotein (HDL) cholesterol and reduce low-density lipoprotein (LDL) cholesterol, triacylglycerol, and lipid oxidation (3).

Minerals from bioelements found in the living structure are composed of macro elements (Na, K, Ca, P and Mg) at the milligram level per kilogram (mg/kg), trace elements (Fe, Cu, Zn, Co, Mn and F) at the microgram per kilogram ($\mu\text{g}/\text{kg}$) level, (Ni, Al, Ag, As, Li, Pb and Au), and minerals also participate in the co-factor portion of enzymes that play a role in the regeneration of living organisms. Iron; is an essential mineral needed by all tissues and the lack of body structure is the cause of anemia. Copper; it catches free oxygen radicals and participates in the structure of many enzymes. Zinc; plays an important role in the function of

the male reproductive system in the production of pancreatic functions, insulin production, and cofactor for more than a hundred enzymes. Manganese; protein, polysaccharide and cholesterol, in fetal development and lactation, hydrolases, transferases and kinases (4).

Recommended Daily Allowance (RDA) provides information on the daily recommended mineral intake for a healthy lifestyle. RDA value for iron; 8 mg/day for men and 8-18 mg/day for women, for copper 900 micrograms/day, for manganese 2.3 mg/day for men and 1.8 mg/day for women, for zinc 11mg/day for men and 8mg/day for women.

This study aims to define some mineral and fatty acid positions in some edible fungus samples which were collected from Tokat (*Coprinus atramentarius*, *Laetiporus sulphures*, *Suillus luteus*) and it is desired to contribute to the knowledge of these mushroom which is not sufficient literature. According to the results; these mushroom specimens are rich in minerals and fatty acids and are therefore thought to can be used as human nutritional supplements.

Materials and Methods

The mushrooms were collected from different places in Tokat province and photographs were taken on, habitat characteristics were recorded and dried in the laboratory environment. Then the mushrooms were identified. After the dried mushrooms were milled with the homogenizer, the following treatments were carried out.

Microwave digestion: Cem brand and Mars 6 one touch (USA) model mikrowave digestion system was used. The process steps are as follows; 0.5 gr sample is weighed and transferred to teflon tubes of the device. Close the mouth tightly by adding 10 mL HNO₃. The maximum temperature is raised to 210°C in 15 minutes and it is kept at this temperature in 15 minutes, the total time is 30 minutes. At this time, the device works with 400-1800 W. Teflon tubing is pulled out under the oven and taken up with 10 mL ultra pure water in mouth-capped flasks, filtered if any particulates are present.

AAS analysis: Perkin Elmer brand and AAS 800 Model (USA) Atomic Absorption Spectrometry was

used. In AAS analysis samples are read with each element specific lamp, wavelength and standard graphics. Each sample is read 3 times and the average is taken.

Wavelength and slit used in AAS are as follows;

Element	Wavelength (nm)	Slit (nm)
Fe	248.3	0.2
Cu	324.8	0.7
Zn	213.9	0.7
Mn	279.5	0.2

Fame (fatty acid methyl ester) Analysis: Fatty acids need to be derivatized in order to be analyzed in GC-MS. Derivatization with methyl esters is generally preferred. For this purpose Christie (1990) (5) method was preferred because it is practical and highly efficient. According to this method: the lipid extract was transferred to the lid-capped tubes to prepare methyl esters. 5 mL of 2% methanolic sulfuric acid was added and vortexed. This mixture was kept at 50°C for 15 hours of methylation. After 15 hours, the tubes were removed, cooled to room temperature, and vortexed with the addition of 5 mL of 5% NaCl. The fatty acid methyl esters (FAME) formed in the tubes was extracted with 5 mL of hexane. The hexane phase was removed from the top with a pasteur pipette and treated with 5 mL of 2% NaHCO₃ and waited for 1-2 hours to separate the phases. The solvent of the mixture containing the methyl esters was then evaporated under nitrogen. Fatty acids under the test tubes were dissolved in 1 mL of hexane and analyzed by GC-MS.

The chromatographic conditions of the GC-MS: Agilent brand GC-MS instrument (USA) 7890A / 5970C and SGE Analytical BPX90 100m x 0.25 mm x 0.25 um column (Australia) were used. The temperature program was gradually heated from 120°C to 250°C and the total time was set to 40 minutes. The temperature program: It is heated up to 120°C and 250°C at 5°C / min and is hold at this temperature for 14 minutes and the total time is 40 minutes.

Injection volume was 1 µL and split ratio was 25:1, solvent delay time was 12 minutes, carrier gas He was selected and the constant gas flow was set at 1 mL / min flow. H₂ flow 35 mL / min, dry air flow 350 mL / min, N₂ 20.227 mL / min automatically set by

Table 1. Fatty acid profiles of mushroom samples

Mushroom species	C14:0	C15:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C22:0	C20:3	C20:4
<i>Laetiporus sulphureus</i>	0.71	0.00	28.60	0.47	28.55	33.94	7.73	0.00	0.00	0.00	0.00
<i>Suillus luteus</i>	0.49	0.34	25.97	0.65	17.09	24.60	29.05	0.00	0.33	0.00	1.47
<i>Coprinus atramentarius</i>	0.28	0.58	21.24	0.46	10.49	29.81	33.17	3.73	0.00	0.26	0.00

the program. GC-FID and MS results were recorded simultaneously. The results were evaluated by pairing with the NIST and WHILEY libraries registered on the device.

Result and Discussion

The present study gives an overview for the fatty acid profiles and the level of some microelements (Fe, Cu, Mn, and Zn) detected at *Coprinus atramentarius*, *Laetiporus sulphureus* and *Suillus luteus* species which were collected from Tokat's different localities in Turkey.

According to the result of the study, oleic, linoleic, palmitic and stearic acid levels were high and ranging from 24.60-33.94%, 7.73-33.17%, 21.24-28.60%, 10.49-28.55%, respectively.

While the highest measure of oleic, stearic, miristic and palmitic acids levels was detected at *Laetiporus sulphureus*, the highest linoleic and linolenic acids levels were noticed at *Coprinus atramentarius*. Behenic and palmitoleic acids were found in the very high range at *Suillus luteus*. The results of fatty acid profiles were given Figure 1-2.

Microelements levels are generally high in all mushroom samples and while the highest levels of Fe, Cu, Zn, and Mn was found at *Coprinus atramentarius*, 1183.60 mg/kg⁻¹, 57.12 mg/kg⁻¹, 288.40 mg/kg⁻¹ and 64.20 mg/kg⁻¹ respectively, the lowest levels of all elements were detected in *Laetiporus sulphureus*. The results of mineral levels were given table 2 and figure 3-4.

Comparison to literature data; Sesli and Tüzen (1999) studied different macrofungi which were collected from East Black Sea Region and they found 87.6 µg/g Fe, 10.3 µg/g Cu, 17.0 µg/g Mn, and 62.4 µg/g Zn at *Suillus granulatus* species which was familiar with *Suillus luteus* species (6). Again Tüzen et al. (2007) examined macrofungi species and detected 658

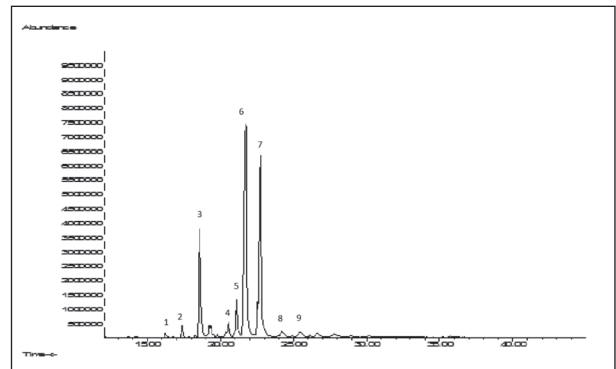


Figure 1. GC-MS chromatogram of *Suillus luteus*: number of 1.C14:0, 2.C15:0, 3.C16:0, 4.C16:1, 5.C18:0, 6.C18:1, 7.C18:2, 8.C22:0, 9.C20:4.

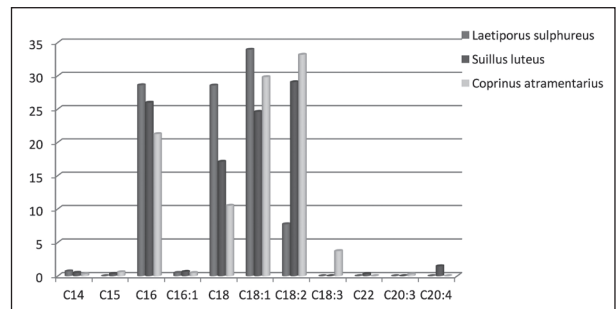


Figure 2. Fatty acid profiles of mushroom samples (C14:0 myristic, C15:0 pentadecanoic, C16:0 palmitic, C16:1 palmitoleic, C18:0 stearic, C18:1 linoleic, C18:3 linolenic, C22:0 behenic, C20:4 arasidonic acid)

Table 2. Mineral levels of mushroom samples (as mg/kg⁻¹)

Mushroom species	Fe	Cu	Mn	Zn
<i>Laetiporus sulphureus</i>	162.920	5.000	19.360	28.360
<i>Suillus luteus</i>	283.240	13.360	22.840	118.840
<i>Coprinus atramentarius</i>	1183.600	57.120	64.200	288.400

$\mu\text{g/g}$ Fe, $35.8 \mu\text{g/g}$ Cu, $77.5 \mu\text{g/g}$ Mn, and $59.8 \mu\text{g/g}$ Zn contents at *Suillus granulatus* species (7). Dursun et al (2006) studied mineral contents profiles of some wild growing mushroom species from Turkey and found $1425.6 \text{ mg/kg}^{-1}$ Fe, 39.3 mg/kg^{-1} Zn, 9.6 mg/kg^{-1} Cu, 38.3 mg/kg^{-1} Mn at *Suillus luteus* and 63.8 mg/kg^{-1} Zn at *Laetiporus sulphureus* (8). Ayaz et al. (2011) were detected 28.6 mg/kg^{-1} Fe, 5.0 mg/kg^{-1} Mn, 38.6 mg/kg^{-1} Zn and 2.8 mg/kg^{-1} Cu in *Laetiporus bisporus* which was collected Black Sea region of Turkey and at another study levels of Fe 5.18 mg/kg^{-1} , Cu 0.08 mg/kg^{-1} , Mn 0.20 mg/kg^{-1} , and Zn 0.48 mg/kg^{-1} were found *Suillus luteus* that was collected from Western Black Sea region of Turkey (9). In addition to, *Laetiporus* species which was collected near the Balikesir-Manisa highway from two different areas (from roadside and background area) was examined to determine levels of minerals. While levels of Cu 6.5 mg/kg^{-1} , Zn 38 mg/kg^{-1} , Mn 3.7 mg/kg^{-1} and Fe 162 mg/kg^{-1} were found at roadside samples, Cu 5.6 mg/kg^{-1} , Zn 33 mg/kg^{-1} , Mn 5.6 mg/kg^{-1} and Fe 90 mg/kg^{-1} were detected at background samples (Yilmaz et al. 2003) (10). Uzun et al (2011) detected mineral contents in *Suillus luteus* and *Laetiporus sulphureus* which were collected from Bingol and Selim district and according to the results while *Suillus luteus* species have 30 mg/kg^{-1} Fe, 146 mg/kg^{-1} Zn, 38 mg/kg^{-1} Cu and 10.8 mg/kg^{-1} Mn, *Laetiporus sulphureus* species have 1190 mg/kg^{-1} Fe, 314 mg/kg^{-1} Zn, 77 mg/kg^{-1} Cu and 28.5 mg/kg^{-1} Mn contents (11). Yamaç et al. (2007) investigated Central Anatolia mushroom samples and they found 57 mg/kg^{-1} Zn, 562 mg/kg^{-1} Fe, 32.60 mg/kg^{-1} Mn, and 20.40 mg/kg^{-1} Cu in *Suillus bovinus* and 45.20 mg/kg^{-1} Zn, 228 mg/kg^{-1} Fe, 6.20 mg/kg^{-1} Mn, and 26.60 mg/kg^{-1} Cu in *Suillus collinitus* species (12). Genççelep et al. (2009) collected mushroom samples from the Erzurum province and examined samples to levels of mineral contents (13). They found 433 mg/kg^{-1} Fe, 111 mg/kg^{-1} Zn, 31.2 mg/kg^{-1} Cu and 43.4 mg/kg^{-1} Mn in *Suillus luteus* and 148 mg/kg^{-1} Fe, 94.3 mg/kg^{-1} Zn, 75.0 mg/kg^{-1} Cu and 13.9 mg/kg^{-1} Mn in *Coprinellus micaceus* which was close species to *Coprinus atramentarius*.

In addition to some studies from the foreign literature; *Suillus luteus* species was analyzed and except the Fe mineral, $130 \mu\text{g/g}$ Zn, $22 \mu\text{g/g}$ Cu, and $6.4 \mu\text{g/g}$ Mn were detected (14). Melczek et al. (2013) studied some

Poland's mushroom species and they detected 38.94 mg/kg^{-1} Cu and 64.29 mg/kg^{-1} Zn in *Suillus luteus* (15). Konuk et al. (2006) also found iron as the highest mineral in a study on some edible mushrooms (16).

According to this study; while, Fe, Cu, Mn, and Zn elements levels of *Coprinus atramentarius*, *Laetiporus sulphureus*, *Suillus luteus* are seen very close to literature data which were done examining mineral levels and literature data are very unsatisfactory about fatty acid levels of these mushroom species. Our study gives very qualified information about these species and provides sufficient literature on these mushroom species.

Conclusion

This research is give an information about some mineral elements and fatty acid profiles of some wild-grown edible mushroom species that are *Laetiporus sulphureus*, *Suillus luteus* and *Coprinus atramentarius*. According to results, mineral elements (Fe, Zn, Cu,

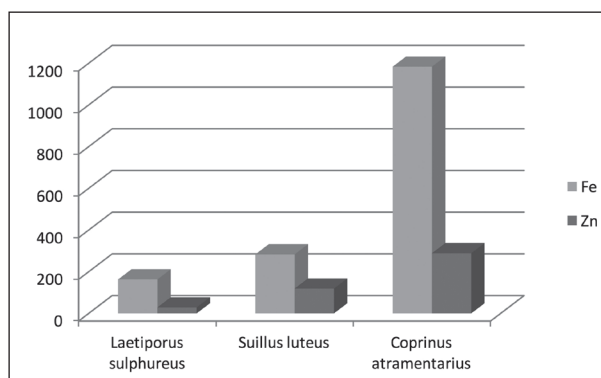


Figure 3. Mineral levels of mushroom samples (as mg/kg^{-1})

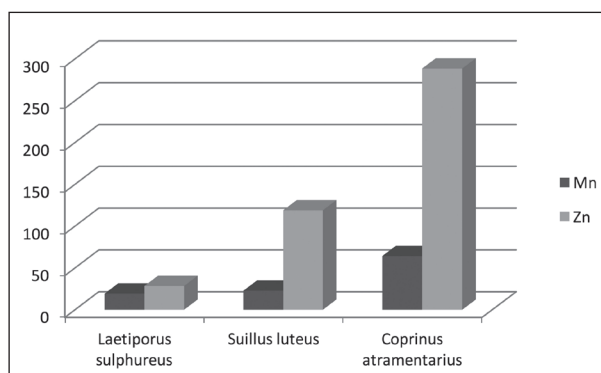


Figure 4. Mineral levels of mushroom samples (as mg/kg^{-1})

and Mn) levels were detected very high at *Coprinus atramentarius* species, fatty acid profile have some differences among these species. While, the highest levels of mineral elements were detected at *Coprinus atramentarius* species, *Laetiporus sulphureus* have the lowest. But if we look at the fatty acid profiles, some differences will be seen. *Laetiporus sulphureus* species have high quantity of myristic, palmitic, stearic, and oleic acids and *Suillus luteus* species have high levels of palmitoleic, behenic, and arachidonic acid, also again high level of pentadecanoic, linoleic which is called omega 6, and linolenic which is called omega 3 that is very important to human health and intake from the only vegetable and animal nutrition, in *Coprinus atramentarius*.

The results of this study provide important information in completing the literature data that is lacking in mineral contents and fatty acid levels of these mushroom species, and also it shows that these wild edible mushroom samples are very healthy to human because of the fatty acid profiles and rich mineral contents. It can be an alternative food supplement to those suffering from anemia, especially thanks to its rich iron content. Furthermore, RDA values for mineral will be met if a daily portion is eaten from any of types of mushrooms subject to our work.

Acknowledgements

The author would like to thank all persons of Bingol University Central Research Laboratory.

References

- Breene W. Nutritional and medicinal value of specialty mushrooms, *J Food Protect*, 1991, 53: 883-894.
- Mattila P. Suonpaa K. and Piironen V. Functional properties of edible mushrooms, *Nutrition*, 2000, 16:694-696.
- Kanu P.J. Zhu K. Kanu J.B. Zhou H. and Qian H. Biological active components and nutraceuticals in sesame and related products; review and prospect, *Trends Food Science Technology*, 2007, 18:599-608.
- K. O. Soetan, C. O. Olaiya, and O. E. Oyewole, The importance of mineral elements for humans, domestic animals and plants: A review, *African Journal of Food Science* Vol. 4(5) pp. May 2010, 200-222.
- Inger Wretensjö, Lennart Svensson, W.W. Christie, Gas chromatographic-mass spectrometric identification of the fatty acids in borage oil using the picolinyl ester derivatives, *Journal of Chromatography A*, Volume 21,1, 1990, 89-97.
- Sesli E. and Tüzen M. Level of Trace Elements in The Fruiting Bodies of Macrofungi Growing in The East Black Sea Region of Turkey, *Food Chemistry*, 1999, 65: 453-460.
- Tüzen M. Sesli E. and Soylak M. Trace elements levels of mushroom species from East Black Sea Region of Turkey, *Food Control*, 2007, 18: 806-810.
- Dursun N. Özcan MM. Kaşık G. and Öztürk C. Mineral Contents of 34 Species of Edible Mushrooms Growing Wild in Turkey, *Journal of the Science of Food and Agriculture*, 2006, 86, 1087-1094.
- Ayaz FA. Torun H. Özel A. Çöl M. Duran C. Sesli E. And Çolak A. Nutritional value of some wild edible mushrooms from Black Sea Region (Turkey), *Turk J Biochem*, 2011, 36(3); 213-221.
- Yılmaz F. Işıloğlu M. and Merdivan M. Heavy metal levels in some macrofungi, *Turkish Journal of Botany*, 2003, 27: 45-56.
- Uzun Y. Genççelep H. Kaya A. and Akçay M.E. The Mineral Contents of some Edible Mushrooms, *Ekoloji*, 2011, 20, 80, 6-12.
- Yamaç M. Yıldız D. Sarıkürkçü C. Çelikkollu M. and Solak MH. Heavy Metals in Some Edible Mushrooms From The Central Anatolia, Turkey, *Food Chemistry*, 2007, 103 263-267.
- Genççelep H. Uzun Y. Tunçtürk Y. Demirel K. Determination of mineral contents of wild-growing edible mushrooms, *Food Chemistry*, 2009, 113:1033-1036.
- Falandysz J. Szymczyk K. Ichihashi H. Bielawski L. Gućia M. Frankowska A. and Yamasaki S. ICP/MS and ICP/AES elemental analysis (38 elements) of edible wild mushrooms growing in Poland, *Food Additives and Contaminants*, 2001, Vol. 18, No 6, 503-513.
- Mleczek M. Siwulski M. Stuper-Szablewska K. Rissman, I. Sobieralski K. and Golinski P. Accumulation of elements by edible mushroom species: Part I. Problem of trace element toxicity in mushrooms, *Journal Environmental Science and Health*, Part B, 2013, 48:69-81.
- Konuk M, Afyon A, Yağız D. Chemical composition of some naturally growing and edible mushrooms, *Pak J Bot*, 2006, 38(3): 799-804.

Correspondence:

Aydin Sukru Bengu

Vocational School of Health Services, Department of Medical Services and Technics Bingol University, Bingol, Turkey.

E-mail: abengu@bingol.edu.tr, aydinbengu75@gmail.com