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Fatty Acid Compositions of Five Wild Edible Mushroom Species Collected from Turkey

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Abstract: The fatty acids of five wild edible mushroom species (*Agrocybe cylindracea*, *Coprinus comatus*, *Lactarius deliciosus*, *Suillus collinitus* and *Tricholoma myomyces*) collected from different regions from Anatolia were determined. The fatty acids were identified and quantified by gas chromatography and studied using fruit bodies. Fatty acid composition varied among species. The dominant fatty acid in fruit bodies of all mushrooms was cis-linoleic acid (18: 2). Percentage of cis-linoleic acid in species varied from 36.29-66.72%. The other major fatty acids were, cis-oleic, palmitic and stearic acids, respectively. Fatty acids analysis of the mushrooms showed that the unsaturated fatty acids were at higher concentrations than saturated fatty acids.

Key words: Fatty acid, wild edible mushrooms, fruiting body

INTRODUCTION

There are nearly 12000 different species of mushrooms present in the nature, whereas less than 25 of them are accepted and consumed as food and only a few species have commercial value (Shin *et al*., 2007). Since they have important nutritional and pharmacological attributes, wild mushrooms are becoming more important in our diets (Barros *et al*., 2007; Okwulehie *et al*., 2007). Mushrooms generally have low fat contents and have low calories (Lee *et al*., 2011). Additionally, mushrooms have been known to have an effect on preventing several diseases such as cancer, hypercholesterolemia and hypertension (Tambekar *et al*., 2006; Aryantha *et al*., 2010). Generally lipid contents of mushroom species are low. It is known that average lipid contents of different mushroom species are changing among the values 1.75 and 15.5% in dry matter (Hong *et al*., 1988). According to Bobek *et al*. (1991), wild edible mushrooms have higher commercial values when compared to cultivated mushrooms since consumers prefer to consume wild species due to their characteristic flavor and texture. Therefore, it is necessary to investigate the levels of chemical and biochemical compounds in wild edible mushrooms, because many wild edible mushroom species are known to store high levels of several unsaturated fatty acids (Yilmaz *et al*., 2006; Chenghom *et al*., 2010).

Wang *et al*. (2001) reported that fatty acid compositions of different species of mushrooms were studied. According to Barros *et al*. (2007) major fatty acids present in mushrooms species like *Agaricus arvensis*, *Lactarius deliciosus*, *Leucopaxillus giganteus*, *Sarcodon imbricatus* and *Tricholoma portentosum* were linoleic acid and oleic acids. On the other hand 27.4% of the fat fraction of *Cordyceps sinensis* was polyunsaturated fatty acids (PUFA) (Li *et al*., 2006). Although, many types of wild mushrooms have been used as medicine because of their beneficial components and functional activities, consumers have not been able to consume these types of mushrooms because of their relative scarcity. According to Zacharia and Doshi (2004) there are many studies which are dealing with the cultivation techniques to commercialize these types of wild mushrooms (Zacharia and Doshi, 2004; Tripathy *et al*., 2009).

In this study, fatty acid composition of five wild edible mushroom species collected from different regions of Turkey were analyzed to evaluate their nutritional values.

MATERIALS AND METHODS

Samples: In this study, five of wild edible mushroom species *Agrocybe cylindracea* (DC.) Maire, *Coprinus comatus* (O.F. Müll.) Pers., *Lactarius deliciosus* (L.) Gray, *Suillus collinitus* (Fr.) Kuntze, and *Tricholoma myomyces* (Pers.) J.E. Lange) were analyzed for their fatty acid compositions. Origin and habitat information of these macrofungi is given in Table 1. As specified in the table, the macrofungi samples were collected from different

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Table 1: Fungarium numbers and locality information of five wild edible mushroom species

Species	Fungarium No.	Coordinates	Localities
Agrocybe cylindracea	1037	N 39°56', E 32°49'	Ankara
Coprinus comatus	2113	N 39°56', E 32°49	Ankara
Lactarius deliciosus	2434	N 40°36', E 31°17'	Bolu
Suillus collinitus	1068	N 41°04', E 33°44'	Derbent
Tricholoma myomyces	1561	N 41°08', E 33°50'	Saraycýk

regions of Anatolia and they were deposited in the Biology Department, Ankara University, Turkey.

Fatty acid composition: The dried mushroom samples were powdered down to ~1 mm particle size and used for fatty acid analysis by capillary gas-liquid chromatography with flame ionization detection (GLC-FID). The temperature of the injector was 250 and the detector was 270°C. Helium was used as carrier gas at an internal pressure of 120 kPa. The initial column temperature was held at 140°C for 5 min and then programmed to increase to 220°C at a rate of 4°C min^{-1} and then held at this maximum for 10 min. The split ratio was 1:50 and the injected volume was 1.2 μL. The results are expressed in relative percentage of each fatty acid, as were calculated by internal normalization of the chromatographic peak area. Fatty acid identification was made by comparing the relative retention times of FAME peaks with the Supelco 37 FAMEs mixture standards (standard 47885-U) used. Some fatty acid isomers were also identified with individual Supelco standards (Barros *et al*., 2007).

Statistical analysis: The data presented are the averages of the results of three replicates with a standard error of less than 5%.

RESULTS AND DISCUSSION

The fatty acid compositions of the five wild edible mushroom species that were analyzed are shown in Table 2. Although, fatty acid compositions of fruit bodies of all of *Agrocybe cylindracea*, *Coprinus comatus*, *Lactarius deliciosus*, *Suillus collinitus* and *Tricholoma myomyces* were found to be different, unsaturated fatty acid levels were higher than saturated in all of them. The carbon chain lengths of fatty acids were ranging from 4 to 24. Cis-linoleic acid was the major fatty acid in all these species, cis-oleic, palmitic and stearic acids were the other abundant fatty acids in all of them. Similar observations have been made in other mushrooms by Lee *et al*. (2011) and Barros *et al*. (2007).

All the mushrooms analyzed contained large quantities of essential fatty acid; cis-linoleic acid. Essential ones, such as cis-linoleic acid are known as the fatty acids that humans and other animals cannot synthesize, but require for their good health (Goodhart and Shils, 1980). Cis-linoleic acid (18:2) was found to be the highest fatty acid in the fruit bodies of all of the species examined, with its 66.72% ratio in *Agrocybe cylindracea,* 62.36% in *Coprinus comatus* and 46.10% in *Suillus collinitus*. These results are in agreement with the previous reports documenting that many mushroom species had also high proportions of unsaturated fatty acids, especially linoleic acid (Kalac, 2009; Ruess *et al*., 2002). It is known that, linoleic acid is the precursor of 1-octen-3-ol, which is the principal aromatic compound in most of the spp. known as the alcohol of fungi, probably contributing to the flavour of mushroom (Maga, 1981). The percentages of cis-oleic acid

Table 2: Composition of fatty acids in five wild mushrooms (dry basis, % of total fatty acid)

Fatty acids	LD	SC	AC	CC	TM
C4: 0 butyric acid	0.05	0.01	0.06	0.03	0.16
C6: 0 caproic acid	0.03	0.01	0.02	0.13	0.05
C8: 0 caprylic acid	1.73	0.06	1.18	1.24	2.42
C10: 0 capric acid	0.04	0.34	1.32	0.29	0.10
C11: 0 undecanoic acid	0.05	0.08	0.03	0.08	0.09
C12: 0 lauric acid	0.23	0.05	0.07	0.10	0.03
C13: 0 tridecanoic acid	0.01	0.06	0.01	0.04	0.01
C14: 0 myristic acid	0.21	0.24	1.30	0.83	0.13
C14: 1 myristoleic acid	0.02	0.00	0.05	0.02	0.03
C15: 0 pentadecanoic acid	0.60	0.70	0.37	0.44	0.59
C15: 1 pentadecanoic acid	0.04	0.04	0.02	0.35	0.01
C16: 0 palmitic acid	8.53	11.79	15.23	14.21	7.77
C16: 1 palmitoleic acid	0.21	0.96	0.62	0.86	0.49
C17: 0 margaric acid	0.29	0.17	0.18	0.12	0.07
C17: 1 heptadecenoic acid	0.04	0.11	0.06	0.04	0.11
C18: 0 stearic acid	8.27	3.37	5.52	4.82	3.13
C18: 1 tr-oleic acid	0.05	0.14	0.10	0.12	0.06
C18: 1 cis-oleic acid	41.38	32.59	1.74	9.29	45.26
C18: 2 tr-linoleic acid	ND	ND	0.02	0.01	0.01
C18: 2 cis-linoleic acid	36.29	46.10	66.72	62.36	36.98
C18: 3 linolenic acid	0.46	0.30	0.10	1.16	0.13
C20: 0 arachidic acid	0.24	0.23	0.21	0.14	0.16
C20: 1 eicosenoic acid	0.02	0.22	0.11	0.16	0.13
C20: 2 eicosadienoic acid	0.14	0.17	0.16	0.47	0.05
C21: 0 heneicosanoic acid	0.04	0.05	0.03	0.12	0.03
C20: 3 n = 3 cis-11, 14, 17-eicosatrienoic acid	ND	ND	0.01	0.07	0.02
C20: 4 arachidonic acid	ND	0.08	0.03	0.05	0.03
C20: 3 n = 6 cis-8,11, 14-eicosatrienoic acid	0.02	0.01	0.03	0.13	0.07
C22: 0 behenic acid	0.20	0.23	1.44	0.40	0.47
C20: 5 eicosapentaenoic acid	0.15	0.19	0.58	0.27	0.31
C22: 1 erucic acid	0.23	0.34	0.12	0.55	0.21
C22: 2 docosadienoic acid	0.10	0.17	1.09	0.09	0.03
C23: 0 tricosanoic acid	0.03	0.03	0.71	0.78	0.52
C24: 0 lignoceric acid	0.22	0.16	0.48	0.10	0.15
C24: 1 nervonic acid	ND	ND	0.03	ND	ND
C22: 6 docosahexaenoic acid	0.17	0.41	0.41	0.18	0.20
SFA (saturated fatty acids)	20.75	17.53	28.13	23.84	15.88
MUFA (monounsaturated fatty acids)	41.99	34.38	2.83	11.37	46.29
PUFA (polyunsaturated fatty acids)	37.32	47.42	69.13	64.76	37.77

LD: *Lactarius deliciosus*, SC: *Suillus collinitus*, AC: *Agrocybe cylindracea* CC: *Coprinus comatus*, TM: *Tricholoma myomyces*, ND: Not determined

in the fruit bodies of *Tricholoma myomyces*, *Lactarius deliciosus* and *Suillus collinitus* were 45.26, 41.38 and 32.59%, respectively in the present study. Fortunately, trans isomers of unsaturated fatty acids were detected at very low concentrations (0.01- 0.14%) in the studied mushrooms (Table 2), since a rapidly expanding literature documenting the importance of Trans Fatty Acids (TFAs) in human health, due to the increased risk of cardiovascular disease, where they are negatively correlated with plasma HDL-cholesterol concentration and positively correlated with plasma LDL-cholesterol level (Minamide and Hammond, 1985). It is also important to point here out that, in contrast to some other fungi (Diez and Alvarez, 2001; Longvah and Deosthale, 1998), none of other fatty acids with an odd number of carbon atoms have been detected in considerable amounts in the present study.

There are some studies in the literature reporting fatty acid compositions of some edible wild mushroom species. Szymczak (1978) studied on sixteen species of wild edible mushrooms found in Poland, and found that they contained 66-82% linoleic acid and 10-20% palmitic acid; whereas lauric, myristic, stearic, arachidic, oleic and palmitic acids were in smaller fractions. Linoleic and palmitic acids were found to be the predominant fatty acids of both glycolipids and phospolipids in *Pleurotus florida* (Kwon and Uhm, 1984). Saturated and monounsaturated fatty acids were 20.2 and 63.9% in *P. ostreatus*, respectively (Yilmaz *et al*., 2006). Linoleic and palmitic acids were 63.7 and 18.6% in *F. velutipes*, respectively (Lee *et al*., 2011).

CONCLUSION

Edible mushrooms can be regarded as healthy, low fat food, since low calorie and low fat diets are recommended to people with high blood cholesterol. The results presented above support the conclusion stating that mushrooms were perfect food with their low calories, low fat composition and high essential fatty acid levels (Yilmaz *et al*., 2006); high protein content increase the nutritional value of them (Agrahar-Murugkar and Subbulakshmi, 2005). Most of the studies on mushroom fatty acids are limited to certain mushroom species. The present results however, indicate that economically important wild edible mushrooms contain significant amounts of valuable fatty acids. Therefore, it can be proposed here that, further studies should be performed on fatty acid contents of other economically important and edible wild mushrooms.

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