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Organic elements and protein in some macrofungi of south east Anatolia in Turkey

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Abstract

The macrofungi specimens were collected from locations around Diyarbakir and Batman. Thirty five species of macrofungi were identified as belonging to 15 families in Diyarbakir and Batman provinces. Protein contents of *Boletus luteus*, *Armillaria tabescens*, *Helvella* sp., *Agaricus bisporus*, *Agrocybe aegerita* and *Tricholoma ustale* were 8.2–18.1, 7.2–10.6, 2.15–27.7, 26.5–51.2, 41.0–46.8, and 29.7–50.5 (% dry weight), respectively. The highest protein concentrations (% dry weight) were found to be in *Agaricus bisporus* (51.2) which was collected at the Campus of Dicle University and *T. ustale* (50.5) at the Gercus district in Yolağzı village. In conclusion, protein contents, and organic elements were found to be changeable according to growth region and species.
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Keywords: Macrofungi; Nature; Organic element; Rate of protein

1. Introduction

More than 2000 species of mushrooms exist in nature but only approximately 22 species are intensively cultivated, for commercial purposes, on ground or wood and utilizing particular environmental and nutritional conditions (Manzi, Aguzzi, & Pizzoferrato, 2001). Protein is an essential food, especially for animals and the human organism. The edible fungi grow naturally during the rainy season on dead pieces of wood, buried or on exposed roots of trees at different tags of decay (Alofe, Odu, & Illah, 1998; Kadiri & Fasidi, 1994).

In addition to their nutritional value, many edible large mushrooms have long been used in the Orient for medicinal purposes. Many non-edible species have also gained important medicinal usage (Chang & Buswell, 1996; Zhuang & Mizuno, 1999).

Wild mushrooms have been a very popular delicacy especially in some central European countries and yearly consumption may exceed 10 kg for some individuals (Svoboda, Zimmermannova, & Kalac, 2000). Fungi have a high proportion of good value protein, a low energy value (low fat concentration) some vitamins (belonging to the B group) and various aromatic substances (Vetter, 2003). Some data were recently published by our team on protein in edible mushrooms. An old Chinese proverb states that ''medicine and food have a common origin''. At present there are at least 270 species of mushroom that are known to have various therapeutic properties (Ying, Mao, Ma, Zong, & Wen, 1987). Even within the same species or variety, the proximate composition is affected by the cultivation substrate with respect to carbon and nitrogen sources and their ratios (Yildiz, Karakaplan, & Aydn, 1998). The protein concentrations in the cultivated mushrooms are 16.8–41.0 of (Diez & Alvarez, 2001; Fasidi & Ekuere, 1993; Manzi, Gambelli, Marconi, Vivanti, & Pizzoferrato, 1999; Rajarathnam, Bano, & Patwardhan, 1986; Sanmee, Dell, Lumyong, Izumori, & Lumyong, 2003; Yildiz et al., 1998).

Sporocarp composition for Thai fungi was generally in the range measured for sporocarps from other regions, but there were some notable differences (Sanmee et al., 2003).

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Table 1
Species of Macrofungi collected from Diyarbakr and Batman

No.	Class, family and species of macrofungi	Habitat of Diyarbakr and Batman	Edibility
	Ascomycetes (*De bary*)		
	Tuberaceae		
1	*Terfezia boudieri* Chatin	Campus of the Dicle University, underground of field	Edible
	Morchellaceae		
2	*Morchella conica* (Pers.)	Campus of the Dicle University, under poplar trees	Edible
3	*Morchella conica* (Pers.)	Campus of the Dicle University-around greenhouse, under poplar trees	Edible
4	*Morchella conica* (Pers.)	Campus of the Dicle University, under poplar trees	Edible
5	*Morchella conica* (Pers.)	Batman; around Sason River, under poplar trees	Edible
6	*Morchella esculenta* (Pers. ex St.)	Batman; Sason, Zafer district, meadow	Edible
	Helvellaceae		
7	*Helvella leucopus* (Pers.)	Batman; around Sason River, underpoplar trees	Edible
8	*Helvella leucopus* (Pers.)	Batman; around Kristal Park, under poplar trees	Edible
9	*Helvella leucopus* (Pers.)	Batman; around Batman River, under poplar trees	Edible
10	*Helvella crispa* Scop. ex. Fr.	Batman; Sason, Zafer district, under poplar trees	Edible
11	*Helvella leucopus* (Pers.)	Campus of the Dicle University, under poplar trees	Not edible
12	*Helvella leucomelaena* (Pers.) Nannf	Campus of the Dicle University, under poplar trees	Not edible
	Pezzaceae		
13	*Peziza-bodia confusa* (Korf.)	Campus of the Dicle University, under pine trees	Edible
	Basidiomycetes (*Classe*)		
	Agaricaceae		
14	*Agaricus bisporus* (Lange) Sing	Culture	Edible
15	*Agaricus bisporus* (Lange) Sing	Campus of the Dicle University, meadow	Edible
16	*Agaricus bisporus* (Lange) Sing	Dicle District, mesdow	Edible
17	*Agaricus bisporus* (Lange) Sing	Batman; Hilal district, meadow	Edible
18	*Agaricus campesteris* (L.) Fr.	Campus of the Dicle University, meadow	Edible
19	*Agaricus campestris* (L.) Fr.	Batman; Hilal district, meadow	Edible
20	*Agaricus xanthodermus* (Gen.)	Campus of the Dicle University, meadow	Poisonous
21	*Agaricus xanthodermus* (Gen.)	Batman; Hilal district, meadow	Poisonous
22	*Gomphidus glutinosus* (Schff.) Fr.	Campus of the Dicle University, meadow	Not edible
	Amanitaceae		
23	*Amanita vaginata* (Bull.: Fr.) Vitt.	Campus of the Dicle University, under poplar trees	Edible
24	*Amanita vaginata* (Bull.: Fr.) Vitt.	Batman; Gercüş, Yolağzı village, under poplar trees	Edible
25	*Amanita verna* (Bull.: Fr.) Roques	Campus of the Dicle University-around Social Facilities, meadow	Poisonous
26	*Amanita verna* (Bull.: Fr.) Roques	Batman; Hilal district, meadow	Poisonous
27	*Amanita virosa* (Fr.) Bertillon	Batman; Hilal district, meadow	Poisonous
	Coprinaceae		
28	*Coprinus atramentarius* (Bull . ex Fr.)	Kesikağaç village, meadow	Poisonous
29	*Coprinus atramentarius* (Bull.: Fr.) Fr.	Batman; around Kristal Park, meadow	Poisonous
30	*Coprinus atramentarius* (Bull.: Fr.) Fr.	Batman; Hilal district, meadow	Poisonous
31	*Coprinus atramentarius* (Bull.: Fr.) Fr.	Batman; around Batman River, meadow	Poisonous
32	*Coprinus micaceaeus* (Bull.: Fr.) Fr.	Campus of the Dicle University, on willow stump	Not edible
	Tricholomataceae		
33	*Armillaria tabescens* (Scop.) Sing	Kesikağaç village, on mulberry stump	Edible
34	*Armillaria tabescens* (Scop.) Sing	Ergani; Çayönü, on poplar stump	Edible
35	*Armillaria tabescens* (Scop.) Sing	Batman; Sason, Zafer district, on poplar trees	Edible
36	*Clitocybe squamulosa* (Pers.: Fr) P. Kumm	Campus of the Dicle University, meadow	Edible
37	*Tricholoma terreum* (Schaeff.: Fr.) P. Kumm	Around Deve Geçidi Dam, under poplar trees	Edible
38	*Tricholoma nudum* (Fr.) P. Kumm	Around Deve Geçidi Dam, under poplar trees	Edible
39	*Tricholoma ustale* (Fr.: Fr.) Kummer	Batman; Gercüş, Yolağzı village, meadow	Edible
40	*Tricholoma auratum* (Paul.: Fr.) Gillet	Batman; Gercüş, Yolağzı village, meadow	Edible
41	*Flammulina velutipes* (Curtis ex.Fr.) Sing	Old retry road of the Dicle University Campus, under pine trees	Edible
42	*Marismus oreades* (Bolt. ex Fr) Fr.	Dicle River-Around Sadi Bridge, meadow	Not edible
43	*Laccaria laceosa* (L. ex. Fr.) S. F. Gray	Batman: Sason, Zafer district, meadow	Edible

Table 1 (*continued*)

No.	Class, family and species of macrofungi	Habitat of Diyarbakr and Batman	Edibility
	Pleurotaceae		
44	*Pleurotus florida* Fovose	Culture	Edible
45	*Pleurotus ostreatus* var. *salignus* Konr. et Maubl	Culture	Edible
46	*Pleurotus ostreatus* (Jacq. Ex Fr.) Kummer var. salignus Konr. et Maubl.	Batman; Hilal district, on willow stump	Edible
47	*Pleurotus ostreatus* (Jacq. Ex Fr.) Kummer var. salignus Konr. et Maubl.	Batman; around Kristal Park, on poplar trees	Edible
48	*Pleurotus ostreatus* (Jacq. Ex Fr.) Kummer var. salignus Konr. et Maubl.	Batman; around Batman River, on poplar trees	Edible
49	*Pleurotus sajor caju*	Culture	Edible
50	*Pleurotus ostreatus* (Jacq. Ex Fr.) Kummer var. salignus Konr. et Maubl.	Campus of the Dicle University of picnic field, on poplar stump	Edible
51	*Pleurotus ostreatus* (Jacq. Ex Fr.) Kummer var. salignus Konr. et Maubl.	Kesikağaç village, under poplar trees	Edible
	Plutaceae		
52	*Volvariella speciosa* (Fr.) Singer	Campus of the Dicle University of picnic field, meadow	Edible
	Bolbitaceae		
53	*A. aegerita* (Brig.) Singer	Kesikağaç village, on mulberry stump	Edible
54	*A. aegerita* (Brig.) Singer	Around Sadi Bridge, on poplar stump	Edible
55	*A. aegerita* (Brig.) Singer	Highway Horticulture, on willow stump	Edible
	Strophoriaceae		
56	*Naematoloma fasciculare* (Huds.: Fr.) Karst	Campus of the Dicle University, on willow stump	Poisonous
57	*Naematoloma fasciculare* (Huds.: Fr.) Karst	Highway Horticulture, on willow stump	Poisonous
58	*Naematoloma fasciculare* (Huds.: Fr.) Karst.	Batman; around Batman River, on poplar stump	Poisonous
	Cortinariaceae		
59	*Inocybe fastigiata* (Schaeff.) Quel.	Batman; around Kristal Park, on poplar trees	Poisonous
	Boletaceae		
60	*Boletus luteus* (L ex Fr.) Kummer	Campus of the Dicle University, under pine trees	Edible
61	*Boletus luteus* (L ex Fr.) Kummer	Campus of the Dicle University of picnic field, under pine trees	Edible
62	*Boletus luteus* (L ex Fr.) Kummer	Batman; Hilal district, under pine trees	Edible
63	*Suillus bellini* (Inz.) Marchand	Batman; Gerc, Yolağzı village, on oak stump	Edible
	Russulaceae		
64	*Russula cyanoxanthas* Schiff. ex Fr.	Kesikağaç village, under poplar trees	Edible
65	*Russula rubroalba* (Sing.) Romang	Batman; Gercüş, Yolağzı village, meadow	Edible
66	*Russula rubroalba* (Sing.) Romang	Batman; Sason, Zafer district, meadow	Edible

The aims of our present work are to compare levels of protein and organic elements in mushroom fruiting bodies selected during 2001–2002 and to survey further mushroom species for the inorganic elements and protein concentrations.

2. Material and methods

2.1. Fungi

There have not been any previous studies on macrofungi growing in Diyarbakir (Yildiz & Ertekin, 1996). Therefore, between 2001 and 2003, macrofungus specimens were collected from the province of Diyarbakir. This study aims to analyse the macrofungi in Diyarbakir which contribute to Turkey's macrofungi flora. The specimens were photographed and then identified with the help of Bas, Kuyper, Noordeloos, and Vellinga (1990), Bon (1987), Guinberteam (1990), Heim (1969), Marchand (1971–1973), Moser (1983), Gücin (1990), Gücin, Işıloğlu, and Kaya (2000), Dermek (1984), Pacioni and Lincoff (1989).

2.2. Organic elements

The carbon and nitrogen (N) were determined by using a Carlo–Erba Element Analysis Instrument (Model EA 1108). The technique used for the determination of C and N is based on the quantitative "dynamic flash combustion" that converts all organic and inorganic substances into combustion products. The resulting combustion gases pass through a reduction furnace and are swept into the chromatographic column by the carrier gas (helium) where they are separated and detected by a thermal conductivity detector (TCD) which gives an output signal proportional to the concentration of the individual components of the mixture.

Table 2
Amount of N, C, H and protein in macrofungi collected from Diyarbakir and Batman

No.	N	C	H	Protein
1	4.75	37.11	5.28	29.7
2	2.44	29.26	4.42	15.2
3	2.31	35.06	5.09	14.4
4	5.16	39.18	6.19	32.3
5	3.62	34.30	5.18	22.6
6	4.29	35.43	5.35	26.8
7	0.56	8.36	1.22	3.49
8	3.23	30.65	4.77	20.2
9	0.34	3.66	0.64	2.15
10	1.24	11.81	1.56	7.8
11	4.36	62.90	7.80	27.3
12	2.14	33.27	4.93	13.3
13	6.56	47.31	8.33	41.0
14	6.33	38.85	6.19	39.6
15	8.20	34.60	5.22	51.2
16	7.18	34.88	5.02	44.9
17	4.25	25.72	3.84	26.5
18	6.04	32.54	4.73	37.7
19	7.30	37.04	5.18	45.6
20	5.10	37.92	5.41	31.9
21	4.98	35.01	5.28	31.1
22	2.13	30.66	3.47	13.3
23	7.23	36.97	5.47	45.2
24	4.08	42.03	6.47	25.5
25	3.24	36.40	4.49	20.3
26	4.58	38.00	5.64	28.6
27	4.60	33.86	4.99	28.7
28	3.83	48.33	6.36	23.9
29	3.34	39.76	5.54	20.9
30	4.12	39.60	5.54	25.8
31	1.57	33.14	4.35	9.83
32	5.30	35.88	4.68	33.1
33	1.32	58.55	7.30	8.27
34	1.15	39.33	4.49	7.20
35	1.68	26.68	3.92	10.5
36	3.24	32.02	4.28	20.3
37	7.43	37.56	5.75	46.5
38	4.98	40.57	7.62	31.1
39	8.08	37.07	5.47	50.5
40	4.75	37.11	5.28	29.7
41	4.56	37.89	5.26	28.5
42	4.07	32.75	4.23	25.4
43	5.65	30.42	4.54	35.3
44	4.66	39.55	5.82	29.1
45	5.54	41.73	6.13	34.6
46	2.88	31.76	4.56	18.03
47	4.26	37.25	5.61	26.6
48	2.88	39.27	5.92	18.03
49	4.05	37.26	5.29	25.3
50	4.13	39.00	5.80	25.8
51	6.42	37.17	5.54	40.6
52	5.64	30.15	4.42	35.3
53	7.48	60.46	8.01	46.8
54	6.56	47.31	8.33	41.0
55	6.97	41.02	5.87	43.6
56	3.14	42.96	5.58	19.6
57	4.17	51.29	6.65	26.1
58	2.40	21.75	3.16	15.0
59	4.05	35.43	4.96	25.3
60	2.89	41.06	6.28	18.1
61	1.57	36.86	5.34	9.84
62	1.31	44.38	6.33	8.20
63	2.58	48.57	5.97	16.1
64	6.58	51.89	7.07	41.1
65	7.89	35.38	5.00	49.3
66	4.90	35.16	5.22	30.7

Protein content was calculated by multiplying of N by 6.25.

3. Result and discussion

We identified 35 species of macrofungi belonging to 15 families in Diyarbakir and Batman province (Table 1). A group at samples that were collected from 66 different locations were analysed for the study of macrofungi species.

Amounts of N, C, H and protein of macrofungi collected from Diyarbakir and Batman are given in Table 2. No relationship between amounts of N, C, H and protein in the fruit body were determined. The present results are supported by values given in the literature Yildiz et al. (1998). Crude protein was calculated as $N \times 6.25$ (Delmas & Mamoun, 1983; Diez & Alvarez, 2001).

Protein content of some mushroom species, such as *Agaricus bisporus*, *Agrocybe aegerita* and *Tricholoma ustale* are higher than those of other species (Table 2). However, protein content of *Boletus luteus*, *Armillaria tabescens* and *Helvella* sp. are lower than those of other mushrooms. Table 2 shows that protein contents and organic elements were be changeable according to growth region and species. This result can arise from physical and chemical differences of growth regions and genetic structures of species. It has been reported that the C/N ratio of a growth region affects protein in mushrooms (Delmas & Mamoun, 1983; Diez & Alvarez, 2001; Yildiz et al., 1998; Yildiz & Karakaplan, 2003).

Same species samples, collected from different regions, contained different amounts of protein. However, different protein contents of different species in the same region may for genetic structure of the species.

It is seems that amounts of protein of natural *A. bisporus*, *A. aegerita* and *T. ustale* are higher than those of cultivated mushrooms, but some values are close (Delmas & Mamoun, 1983; Diez & Alvarez, 2001; Yildiz et al., 1998).

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