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CHEMICAL COMPOSITION OF SOME NATURALLY GROWING AND EDIBLE MUSHROOMS

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Abstract

Water, dried material, pH, protein, ash, lipid, cellulose, non-cellulose carbohydrate, Ca, Cu, Fe, K, Mg, Na, P, Zn contents of 15 edible and naturally growing mushrooms from Western Black Sea Region of Turkey have been analysed. Both organic and inorganic elements were analysed statistically by Pearson correlation analyse and some statistically meaningful values were obtained among the data obtained. Chemical analysis results also showed that mushrooms have large amount of protein and minerals, but lipid concentration is very low.

Introduction

Mushroom is one of the useful, delicious and mysterious member of the biosphere (Verma *et al*., 1987a, b). Because of their taste and fleshy construction, they have been paid the attention by mankind for ages. Today mushrooms are being considered as alternative food source to provide adequate nutrition to world's increasing population. It was reported by Bobek *et al*., (1991) that the consumption of mushroom-containing diet prevented serum cholesterol increase at the and of four week period and lowered by almost 40% as compared with control groups which have not had mushroom in their diet. Kabir & Kimura (1989) reported that dietary mushrooms have reduced the blood pressure in rats. Although edible mushrooms are very tasty and rich from the nutritional view point, they have not yet been evaluated by Turkish people. Some researches have been carried out by Turkish researches (Afyon *et al*., 1996; Afyon *et al*., 1997; Afyon & Konuk 1998; Afyon & Konuk 2000; Sesli & Tüzen 1999, Işıloğlu *et al*., 2001 a-b) on this subject.

The present study was aimed to determine and evaluate the chemical composition of 15 wild-grown and edible mushrooms viz., *Sarcospharea crassa, Pluteus salicinus*, *Sarcodon leucopus, Russula delica*, *Cantharellus cibarius*, *Tricholoma fracticum*, *Morchella rotunda*, *Morchella vulgaris*, S*uillus luteus, Lactarius deliciosus, Morchella costata, Agrocybe aegerita*, *Morchella deliciosa*, *Helvela leucopus*, *Morchella umbrina* from Western Black Sea region of Turkey.

Materials and Methods

Fresh samples of the mushroom were collected from the field in spring, summer and autumn between 1998-2000 regularly. After cleaning them manually to remove any extragenous materials the procedures of analyses were carried. The collected materials were dried at 65°C in oven until their weight became stable and powdered. Moisture content and pH values were determined from fresh material; total lipid, protein, ash, crude fibre, non-cellulose carbohydrate, Ca, Na, K, P, Mg, Fe, Zn and Cu values were determined from oven-dried powder.

For moisture content and dry material contents determination, either fresh or air-dried samples were left at 105°C until weighing became unchanged and calculated from the findings. For pH determination, 10 gr. of the chopped mushroom were added into 20-30 ml of water and homogenized by mean of pre-chilled mortar and pestle. The homogenate was poured into a measuring flask and volume was completed to 100 ml. This was then stirred vigorously for 30 min. and left in the fridge for 12 hours. After filtering the mixture, pH was determined from the filtrate by use of a Basic Digital LCD-II pH meter (Pasin *et al*., 1985, Afyon & Konuk 1998). Protein contents of the samples were determined by use macro Kjeldahl method. By use of this method nitrogen contents were determined first and this value was multiplied by 6.25 coefficient (Anon., 1984). Crude fibres were determined by the conventional method (Anon., 1984) and non-cellulose carbohydrate was determined by difference. Lipid contents were determined using the Soxhelet extraction (Anon., 1984). Ashes were determined by burning out of a 4 gr. of dried materials at 550°C for 6 hours (Pasin *et al*., 1985).

For mineral elements determination, 0.5 gr. of dried specimens of each sample were used. Phosphorus was measured by Olsen method according to the Black (1965). Ca, Mg, K, Na, Fe, Zn, Mn, and Cu were determined by Varian Vista Model ICP-AES apparatus (Soltanpour *et al*., 1995) following the extraction by 1 N CH_3COONH_4 (pH 7).

Results and Discussion

Biochemical analysis and statistical analysis showed that *Suillus luteus* has the highest water level (95.05%) and *Morchella deliciosa* has the lowest (77.13%), and dry material values were opposite of this data obtained from these species, 4.95% and 22.61%, respectively (Table 1 and 2). pH values in all the species were found to be between 5.45 (*Lactarius delicious*)-7.02 (*Helvella leucopus*).

The highest ash, Fe, and Mg levels were 32.51%, 29.4, and 31.5 ppm/1gr, respectively, in *Sarcospharea crassa*.. The highest protein level was observed in *Morchella deliciosa* as 38.11% and the lowest protein was observed in *Pluteus salicinus* as 10.72%. *Pluteus salicinus* has the highest carbohydrate level as the same with *Sarcodon leucopus* as 57.51%. On the other hand, it also showed to have the highest K and Na levels as 167, and 7.5 ppm/1gr oven-dried material, respectively.

Sarcodon leucopus showed to have the highest non-cellulose carbohydrate, and Cu, levels as 57.51% and 0.32 ppm/1 gr oven-dried material, respectively. It has also the lowest values of cellulose and phosphorus levels as 5.84% and 12.6 ppm/1 gr oven-dried matrial, respectively. *Tricholoma fracticum* has the lowest ash, Ca, Cu, Fe, levels among the species studied. Their values were, 6.5%, 2.1, 0.004, 0.94, ppm/1 gr dried materials, respectively. The lowest Zn level was observed in *Morchella rotunda*, 0.14 ppm/1 gr oven-dried material. *Morchella vulgaris* has the lowest amount of Mg and Na, as 2.36 and 0.8 ppm/1 gr dried material, respectively.

The highest cellulose and Ca levels was observed in *Lactarius delicious* as 21.2% and 124 ppm in 1 gr of dried material, respectively. The lowest lipid values was obtained from *Morchella costata* as 2.46 %, and the lowest carbohydrate was obtained from *Agrocybe degerita* as 36.30%. The highest Zn values was observed from *Morchella deliciosa*, 0.95 ppm in 1 gr of dried material of this species. *Helvella leucopus* has the highest amount of lipid and P, 6.67%, and 640 ppm in 1 gr of its oven-dried material. *Morchella umbrina.*has the lowest amount of K as 56 ppm/1 gr oven-dried material.

Tablo 1. Chemical constituents of some edile mushrooms from Western Black Sea Region of Turkey

No	Water		Dry mater															
	FM	AD	FM	AD	pH	Prot	Lipid	Ash	Cellu.	Chdr.	Ca	Cu	Fe	K	Mg	Na	P	Zn
1.	84,43	88,96	15,57	11,04	6,7	19,46	3,65	32,51	6,71	37,67	82,5	0,10	29,4	141	31,5	6,9	103	0,73
2.	95,02	94,75	4,98	5,25	6,7	10,72	2,63	14,53	14,61	57,51	17,2	0,07	5,02	167	14,3	7,5	115	0,58
3.	83,79	83,89	16,21	16,11	6.8	25,2	5,67	15,63	5,84	57,51	8,45	0,32	16,5	87,8	30,3	3,9	42,6	0,36
4.	87,13	84,91	12,87	15,09	6.49	27,69	3,15	8,56	7,43	53,17	3,91	0,20	2,54	99,	7,3	2,1	48,5	0,34
5.	88,77	90,37	11,23	9,63	6,75	18,2	3,25	15,7	7,46	55,39	4,57	0,05	8,54	53,8	11,1	2,0	22,9	0,15
6.	84,83	84,84	15,17	15,16	6,3	13,85	4,11	6,5	14,29	61,25	2,40	0,004	0,94	86,4	4,4	2,0	30,3	0,24
7.	85,51	86,21	14,49	13,79	6,5	20,84	3,60	10,67	10,8	54,09	8,68	0,06	5,36	49,9	5,1	1,9	58,2	0,14
8.	90,47	87,52	9,53	12,48	6,49	23,38	3,68	9,28	12,36	51,3	1,73	0,03	1,8	41,8	2,36	0,8	52	0,46
9.	95,05	95,50	4,95	4,50	6,0	23,88	5,08	7,00	13,35	56,9	5,94	0,08	5,18	88,9	6,9	1,9	60,2	0,48
10.	81,20	79,80	18,8	20,20	5,45	28,2	6,17	6,99	21,20	37,44	124	0,018	7,6	75,6	13,2	4,0	52	0,56
11.	80,47	79,06	19,53	20,94	6,45	29,78	2,46	18,63	6,55	42,58	64,8	0,16	28,5	115	16,6	6,1	140	0,50
12.	85,70	89,25	14,30	10,75	6.56	34,1	3,09	14,76	11,75	36,30	45,7	0,24	19,6	84,8	18,8	5,9	84,5	0,82
13.	77,39	75,15	22,61	24,85	6,45	38,11	2,83	12,06	6,74	40,26	32,9	0,16	11,4	130	13,8	2,9	153	0,95
14.	80,97	80,64	19,03	19,36	7.02	31,41	6,67	13,68	9,27	38,97	78,1	0,22	19,8	101	20,1	6,2	640	0,58
15.	80,75	78,47	19,25	21,53	6,38	31,4	4,30	8,10	7,62	48,58	10,5	0,188	5,51	56	8,9	2,4	78,4	0,57

Mushroom species shown in table are: 1. *Sarcospharea crassa*, 2. *Pluteus salicinus*, 3. *Sarcodon leucopus*, 4. *Russula delica*, 5. *Cantharellus cibarius*, 6. *Tricholoma fracticum*, 7. *Morchella rotunda*, 8. *Morchella vulgaris*, 9. *Suillus luteus*, 10. *Lactarius deliciosus*, 11. *Morchella costata*, 12. *Agrocybe aegerita*, 13. *Morchella deliciosa*, 14. *Helvela leucopus*, 15. *Morchella umbrina*

Abbreviations: FM=Fresh material; AD=Air dried; Prot=Protein, Cellu.=Cellulose; Chdr=Non-cellulose carbohydrate Protein, lipid, ash, cellulose and noncellulose carbohydrate values are given as **'% in oven-dried materials'**, and elements are **'ppm / 1gr oven-dried materials'**

The results shown are the means of triplicate determinations, deviations from the mean was within ± 8% in all cases.

Table 2. Pearson's Dual Correlation analyses of the data obtained from mushrooms examined.

Correlations

		WFM	WAD	DFM	DAD	PH	PROD	LIPID	ASH	CELLU	CHDR	CA	CU	FE	K	MG	NA	P	ZN
WFM	Pearson Correlation	1,000	,936**	-1,000**	-,936**	,024	-,656**	-,173	-,115	,304	,598*	-,486	-,364	-,427	,021	-,305	-,112	-,313	-,323
	Sig. (2-tailed)	,	,000	,000	,000	,931	,008	,537	,684	,271	,019	,066	,182	,113	,940	,269	,692	,257	,241
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
WAD	Pearson Correlation	,936**	1,000	-,936**	-1,000**	,119	-,669**	-,171	,134	,235	,455	-,355	-,304	-,192	,086	-,075	,061	-,286	-,255
	Sig. (2-tailed)	,000	,	,000	,000	,673	,006	,542	,634	,399	,088	,194	,271	,492	,759	,791	,829	,301	,360
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
DFM	Pearson Correlation	-1,000**	-,936**	1,000	,936**	-,024	,656**	,173	,115	-,304	-,598*	,486	,364	,427	-,021	,305	,112	,313	,323
	Sig. (2-tailed)	,000	,000	,	,000	,931	,008	,537	,684	,271	,019	,066	,182	,113	,940	,269	,692	,257	,241
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
DAD	Pearson Correlation	-,936**	-1,000**	,936**	1,000	-,119	,669**	,171	-,134	-,235	-,455	,355	,304	,192	-,086	,075	-,061	,286	,255
	Sig. (2-tailed)	,000	,000	,000	,	,673	,006	,542	,634	,399	,088	,194	,271	,492	,759	,791	,829	,301	,360
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
PH	Pearson Correlation	,024	,119	-,024	-,119	1,000	-,100	-,209	,503	-,700**	,086	-,295	,473	,353	,217	,398	,313	,430	-,032
	Sig. (2-tailed)	,931	,673	,931	,673	,	,722	,454	,056	,004	,761	,286	,075	,196	,436	,142	,255	,109	,911
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
PROD	Pearson Correlation	-,656**	-,669**	,656**	,669**	-,100	1,000	,139	-,115	-,276	-,668**	,320	,588*	,314	-,113	,143	-,008	,319	,570*
	Sig. (2-tailed)	,008	,006	,008	,006	,722	,	,620	,684	,319	,006	,245	,021	,254	,688	,612	,976	,246	,026
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
LIPID	Pearson Correlation	-,173	-,171	,173	,171	-,209	,139	1,000	-,245	,308	-,092	,355	,138	-,018	-,263	,200	-,042	,427	-,088
	Sig. (2-tailed)	,537	,542	,537	,542	,454	,620	,	,378	,264	,744	,194	,624	,950	,343	,475	,882	,112	,756
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
ASH	Pearson Correlation	-,115	,134	,115	-,134	,503	-,115	-,245	1,000	-,487	-,393	,359	,200	,818**	,497	,781**	,655**	,131	,295
	Sig. (2-tailed)	,684	,634	,684	,634	,056	,684	,378	,	,066	,147	,189	,475	,000	,059	,001	,008	,641	,286
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
CELLU	Pearson Correlation	,304	,235	-,304	-,235	-,700**	-,276	,308	-,487	1,000	,024	,289	-,608*	-,449	-,107	-,380	-,035	-,138	-,037
	Sig. (2-tailed)	,271	,399	,271	,399	,004	,319	,264	,066	,	,934	,297	,016	,093	,705	,163	,900	,623	,895
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
CHDR	Pearson Correlation	,598*	,455	-,598*	-,455	,086	-,668**	-,092	-,393	,024	1,000	-,823**	-,243	-,651**	-,198	-,442	-,498	-,424	-,732**
	Sig. (2-tailed)	,019	,088	,019	,088	,761	,006	,744	,147	,934	,	,000	,384	,009	,479	,099	,059	,115	,002
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
CA	Pearson Correlation	-,486	-,355	,486	,355	-,295	,320	,355	,359	,289	-,823**	1,000	-,001	,592*	,289	,486	,599*	,402	,474
	Sig. (2-tailed)	,066	,194	,066	,194	,286	,245	,194	,189	,297	,000	,	,998	,020	,297	,066	,018	,137	,074
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
CU	Pearson Correlation	-,364	-,304	,364	,304	,473	,588*	,138	,200	-,608*	-,243	-,001	1,000	,461	,155	,574*	,302	,321	,312
	Sig. (2-tailed)	,182	,271	,182	,271	,075	,021	,624	,475	,016	,384	,998	,	,084	,581	,025	,274	,244	,257
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
FE	Pearson Correlation	-,427	-,192	,427	,192	,353	,314	-,018	,818**	-,449	-,651**	,592*	,461	1,000	,414	,818**	,723**	,377	,441
	Sig. (2-tailed)	,113	,492	,113	,492	,196	,254	,950	,000	,093	,009	,020	,084	,	,125	,000	,002	,166	,100
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
K	Pearson Correlation	,021	,086	-,021	-,086	,217	-,113	-,263	,497	-,107	-,198	,289	,155	,414	1,000	,502	,741**	,244	,531*
	Sig. (2-tailed)	,940	,759	,940	,759	,436	,688	,343	,059	,705	,479	,297	,581	,125	,	,057	,002	,381	,042
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
MG	Pearson Correlation	-,305	-,075	,305	,075	,398	,143	,200	,781**	-,380	-,442	,486	,574*	,818**	,502	1,000	,722**	,275	,412
	Sig. (2-tailed)	,269	,791	,269	,791	,142	,612	,475	,001	,163	,099	,066	,025	,000	,057	,	,002	,321	,127
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
NA	Pearson Correlation	-,112	,061	,112	-,061	,313	-,008	-,042	,655**	-,035	-,498	,599*	,302	,723**	,741**	,722**	1,000	,441	,506
	Sig. (2-tailed)	,692	,829	,692	,829	,255	,976	,882	,008	,900	,059	,018	,274	,002	,002	,002	,	,100	,054
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
P	Pearson Correlation	-,313	-,286	,313	,286	,430	,319	,427	,131	-,138	-,424	,402	,321	,377	,244	,275	,441	1,000	,285
	Sig. (2-tailed)	,257	,301	,257	,301	,109	,246	,112	,641	,623	,115	,137	,244	,166	,381	,321	,100	,	,303
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
ZN	Pearson Correlation	-,323	-,255	,323	,255	-,032	,570*	-,088	,295	-,037	-,732**	,474	,312	,441	,531*	,412	,506	,285	1,000
	Sig. (2-tailed)	,241	,360	,241	,360	,911	,026	,756	,286	,895	,002	,074	,257	,100	,042	,127	,054	,303	,
	N	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

When we look at the relation between the variables (with 95% reliability) by Pearson's dual correlation analysis; there are meaningful relation between Cu and Zn; Cu and Mg; Mg and Na; and among Fe, Mg, and Na; Ca, Fe, Mg and Na; K, Na and Zn. There were statistically meaningful relation in both organic and organic-inorganic components: For example, among the water contents, protein and carbohydrates; protein and carbohydrate, Cu and Zn; ash, cellulose, Fe, Mg and Na; carbohydrates, Ca, Fe and Zn; and between cellulose and Cu (Table 2).

All the results obtained form this study are not different from values reported within Europe and Turkey (Seeger, 1982; Tyler, 1982, Afyon *et al*., 1996; Afyon *et al*., 1997; Afyon & Konuk 1996; Afyon & Konuk 1998; Afyon & Konuk 2000).

These results suggest that mushrooms are very good nutrition source for mankind who looks for new and alternative food and nutrition source all the time. Mushrooms are very poor in lipid and very rich in protein, ash, fibre, and minerals (Table 1). They could be very useful for vegeterians and contain some essential amino acids which are found in only animal proteins (Verma *et al*., 1987a). When they are supplemented with mushroom it could be very helpful in eliminating dependence on animal protein to overcome the amino acid deficiency. According to the data obtained from this research, *Sarcospharea crassa, Morchella costata, Helvella leucopus* are very good iron sources. They could also be very useful for those who suffer from anaemia since they are very poor in lipid and reduce the cholesterol, HDL, LDL, VLDL in animals (Bobek *et al*., 1991). All the mushrooms examined could be the best nutrition for those who suffer from hyperlipidemia.

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