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Contents of nutrients and dietary fibre in wild and cultivated mushrooms

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The basic composition and the contents of amino acids and fatty acids and eight minerals of 13 wild and 2 cultivated mushrooms and the content of dietary fiber were estimated. On a dry matter basis, the protein content of the mushrooms studied (total N x 6.25) was 12 % - 35 %, the lipid content 1.2 % - 8.9 %, and the ash content 6 % - 13 %. The total essential amino acid content (excluding Try) was 2.6 % - 8.2 % of the dry matter.

The fatty acid composition of mushrooms resembled the general composition of vegetable fats, the major components being oleic acid and linoleic acid.

The mineral composition was complex; it seems that mushrooms are good sources of Cu and fairly good sources of Zn as compared with other foodstuffs, provided that the availability of those minerals is normal.

The mean content of dietary fibre in mushrooms was 29 % (13-39 %), which is much higher than the crude fibre content usually given in food composition tables. Mushrooms seem to be a fairly good source of diatery fibre.

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I. Contents of amino acids, fatty acids and minerals in 13 wild and 2 cultivated mushroom species

The methods used were described in an earlier publication (Kreula et al. 1976), together with data obtained for 11 mushroom species. The species included in the study here reported were: *Boletus edulis, Albatrellus ovinus, Ramaria flava, Gyromitra esculenta, Craterellus cornucopioides, Cantharellus cibarius, C. tubaeformis, Armillariella mellea, Coprinus comatus, Leccinum versipelle, Lactarius rufus, L. trivialis, L. torminosus, Flammulina velutipes* and *Pleurotus ostreatus*. The last two species were cultivated in the laboratory.

For the sake of clarity the results obtained for 5 of the species and the mean values for all 15 mushroom species are presented in Tables 1-4.

In Table 1 the basic composition of the mushrooms and that of potato tubers (Souci et al. 1969) are given. The mean contents of protein, fat and ash in the 15 mushroom species were 23% (12-35%), 4.5% (2-9%) and 8.5% (5-13%), respectively, on a dry matter basis. Compared with mushrooms potato contains less protein and fat but the ash content is similar.

Table 2 shows the contents of essential amino acids, excluding tryptophan as it was not determined in this study, in the mushrooms. For comparison, mean values of data given by Souci et al. (1969) for mushrooms and potato are included.

The total amounts of essential amino acids in mushrooms varied from 3 to 8%, the mean being 5.3% on a dry matter basis. The content of methionine was the lowest of all. In the various mushroom species the contents of individual amino acids varied considerably; for example the lysine content from 0.4 to 1.5% and the leucine content from 0.6 to 1.8%. Our data and those obtained from the literature were quite similar. As compared with mushrooms, the contents of essential amino acids in potato are somewhat low.

Table 3 shows the fatty acid composition in the mushrooms. For comparison, data for potato tubers (Lepage 1968) and mushrooms (Shaw 1967) are given. The fatty acid composition of mushrooms varied considerably, but resembled the general composition of vegetable fats in that the amounts of oleic and linoleic acids were comparatively large: the average figure for oleic acid was 30% (3-51%) and for linoleic acid 41% (13-84%) of the total amounts of fatty acids. The results are in agreement with those obtained by Shaw (1967). The fatty acid composition of mushrooms resembled that of potato except that in potato the oleic acid content was low and the linolenic acid content high.

The composition of the lipid in mushrooms is not of much significance from a nutritional point of view since their lipid content on a wet weight basis is only 0.2-0.5%.

Table 4 gives the contents of minerals in the mushrooms. For comparison, corresponding data for potato (Souci et al. 1969) and mushrooms (Hinneri 1975, Kurkela 1972, Sassi 1976) are given.

The mineral contents in the mushrooms were very much the same as those given in the literature. When comparing the contents of minerals in potato with those in mushrooms it is observed that there are no essential differences in magnesium, sodium, potassium and iron. The content of calcium in potato is somewhat higher

than in mushrooms, but the contents of manganese, copper and zinc are much lower than in mushrooms. There were wide variations in the contents of minerals in the 15 mushroom species: for example,copper varied from 4 to 85 mg/kg and manganese from 8 to 72 mg/kg.

It seems that mushrooms are good sources of Cu and fairly good sources of Zn provided that their availability is not notably different from that in other foodstuffs. It was noted earlier that the general composition of cultivated mushrooms did not differ essentially from that of wild mushrooms (Kreula et al. 1976).

Table 1. Basic composition of certain mushroom species

	Protein	Fat	Ash
	% of d.m.		
Boletus edulis	22	1.7	6.2
Gyromitra esculenta	31	3.4	10.2
Cantharellus cibarius	17	3.9	12.8
Lactarius torminosus	28	7.2	6.7
Pleurotus ostreatus	22	2.6	8.4
Mean of 15 mushroom species	23	4.5	8.5
Potato tubers (Souci et al.1969)	9	0.7	6

Table 2. Contents of essential amino acids (% of dry matter) in certain mushroom species. Tryptophan was not determined

Species	Ile	Leu	Val	Met	Phe	Thr	Lys	Total
Boletus edulis	0.9	0.9	0.7	0.4	0.5	0.6	0.8	4.8
Gyromitra esculenta	1.1	1.6	1.4	+	1.1	1.0	1.4	7.6
Cantharellus cibarius	0.5	0.8	0.6	0	0.5	0.5	0.7	3.6
Lactarius torminosus	0.8	1.5	1.1	0.3	1.0	1.2	1.1	7.2
Pleurotus ostreatus	0.9	1.4	1.0	0.3	0.9	0.9	1.5	6.9
Mean of 15 mushrooms	0.7	1.1	0.8	0.2	0.7	0.8	0.9	5.3
Mushrooms (Souci et al. 1969)	0.5	1.1	0.7	0.1	0.7	0.8	0.9	4.8
Potato -"-	0.5	0.6	0.5	0.2	0.4	0.4	0.5	3.1

Table 3. Fatty acid composition (% w/w) of certain mushroom species

Species	$C_{10:0-17:1}$	$C_{16:0}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$	$C_{20:0-24:0}$
Boletus edulis	3.5	10.2	0.9	15.1	62.6	6.1	4.6
Gyromitra esculenta	3.9	13.1	-	8.1	72.9	0.5	1.6
Cantharellus cibarius	4.8	9.1	3.8	41.2	37.0	1.2	3.0
Lactarius torminosus	1.4	2.8	53.2	18.7	21.6	0.5	1.7
Pleurotus ostreatus	2.7	14.3	1.7	14.8	60.6	0.7	5.1
Mean of 15 mushrooms	3.9	8.8	5.9	30.3	41.3	1.3	8.8
Mushrooms (Shaw 1967)	3.8	15.8	7.7	25.1	48.5		
Potato (Lepage 1968)	-	18.7	4.3	0.7	47.7	28.5	

Table 4. Contents of minerals in certain mushroom species

Species	Ca	Fe	Mn	Zn	Cu	Mg	Na	K
	mg/kg d.m.					g/kg d.m.		
Boletus edulis	150	74	16	66	25	0.5	0.9	26
Gyromitra esculenta	120	140	26	110	85	1.0	0.8	44
Cantharellus cibarius	220	93	29	110	46	1.1	0.6	53
Lactarius torminosus	306	61	10	142	22	1.3	0.4	27
Pleurotus ostreatus	159	147	13	170	25	2.7	0.4	49
Mean of 15 mushrooms	223	95	25	92	34	1.2	0.6	37
Mushrooms (Hinneri 1975, Kurkela 1972, Sassi 1976)	367	64	17	117	37	0.9		
Potato (Souci et al. 1969)	591	41	7	1	7	1.5	0.9	24

II. Contents of dietary fibre in 11 mushroom species

Recently there has been growing interest in the "true" content of fibre in foods. Therefore we made a preliminary study of the contents of dietary fibre in mushrooms. We used the method of Elchazly & Thomas (1976), which measures water-insoluble dietary fibre, as follows. Dry mushroom powder was extracted with petroleum-ether and the fat-free material was autoclaved for 1 h and digested first with the enzyme taka-diastase and then with trypsin. After centrifugation the residue was washed successively with HCl, water, ethanol, acetone and ether. The oven-dried residue was weighed, ashed, and the weight of the ash substracted from that of the residue. For comparison, the contents of dietary and crude fibre (Valtion maatalouskemian laitos 1967) in wheat bran and carrot were also estimated. The composition of dietary fibre was not determined in this study.

The mushrooms in this study were: *Agaricus sp., C. cibarius, C. comatus, G. esculenta, Kuehneromyces mutabilis, Lactarius rufus, L. thejogalus, L. torminosus, Leccinum versipelle, Russula flava* and *P. ostreatus*. The mushrooms were of different ages but all were fit to eat.

Table 5 shows the contents of water-insoluble diatery fibre and crude fibre in mushrooms, wheat bran and carrot.

The dietary fibre content in mushrooms varied from 13 to 39%, the mean value being 29%, contents in wheat bran and carrot were 30% and 10% respectively. In mushrooms and bran the contents of crude fibre were markedly lower than those of dietary fibre, whereas the difference between crude and dietary fibre contents in carrot was small.

Elchazly & Thomas (1976) found dietary fibre contents of 12.2% in carrot, 6.6% in potato and 17.1% in cabbage; the corresponding contents of crude fibre were 8.3, 1.8 and 12.8%.

Table 5. Content of dietary fibre and crube fibre in certain mushroom species

Species	Dietary fibre	Crude fibre
	% of d.m.	
Agaricus species	19	4.7*
Cantharellus cibarius	39	11.2*
Corpinus comatus	13	
Gyromitra esculenta	26	2.7*
Kuehneromyces mutabilis	29	
Lactarius rufus	29	7.8
L. thejogalus	34	
L. torminosus	32	
Leccinum versipelle	33	5.2*
Russula flava	38	
Pleurotus ostreatus I	22	
P. ostreatus II	34	
Mean value	29	6.3
Wheat bran	30	10.5
Carrot	10	7.4

* Souci et al. 1969

Our results and those of other investigators (e.g. Elchazly & Thomas 1976, Trowell 1976, Asp et al. 1977) show that crude fibre contents given in food composition tables are erroneously low and do not represent the "true" content of fibre in foods.

Dietary fibre is not a chemical entity but a mixture of several types of polysaccharide and lignin. Its composition and physical properties vary with the food in question. Therefore no single method can be regarded as adequate for all types of food.

The contents of water-insoluble dietary fibre in mushrooms reported here were obtained by the enzymatic method of Elchazly & Thomas (1976) and may differ from data obtained with other methods. However, they provide a basis for the calculation of intakes of dietary fibre from common mushrooms.

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