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Data on sodium content of common edible mushrooms

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Abstract

Sodium contents of fruit bodies of some common edible mushroom species were analysed from the samples (total number: 153) gathered from different habitats of Hungary. The average sodium content of the different mushroom taxa varies between 100 and 400 ppm, and seems to be practically independent of habitat, nutrition type (saprotrophic, xylophagous, or mycorrhizal) and of the taxonomic position of the fungi. The low and relative constant sodium level is of very great nutritional benefit to the consumer. This is the first comparative analysis of Na of the common edible mushroom species.

Keywords: Sodium content; Sporocarp; Higher edible mushroom

1. Introduction

Sodium (Na) is an essential macro element, especially in animals and the human organism. The concentration of Na has an important physiological effect on different organs and cellular mechanisms and especially on the K/Na pump of cell membranes. Increase or decrease of the concentration, uptake or removal of Na ions have important roles in different physiological processes and in the normal activities of organs. The Na contents of blood and tissues are largely influenced by the Na contents of foods and drinks, i.e. sodium level of foods is of real physiological importance. In the case of some diseases (e.g. high blood pressure) a high intake of Na has a direct and negative effect on physiological parameters of patients. The Na concentration of consumed foods depends both on the original Na level of the crude basic materials and on the later treatments (conservation, cooking, storage). Na levels of foods of animal and of plant origin are well documented in different food chemical, dietetic tables or books. The Na contents of plants vary between 200 and 2000 ppm fresh weight. Whole milk has a Na content of 400–600 ppm, 3000–5000 ppm values are characteristic of hamburger and different types of chips, 10,000–22,000 ppm is the Na range of some meats and meat products. The higher fungi are of increasing importance in modern nutrition and food science although some chemical information is missing. Fungi have a high proportion of good value proteins, a low energy value (low fat concentration), some vitamins (belonging to B-group) and various aromatic substances. Some data were recently published by our team on mineral compositions of higher, edible mushrooms (Vetter, 1989a, 1989b, 1990a, 1990b, 1993a, 1994a, 1994b, 1997, 1999; Vetter & Berta, 1997; Vetter, Siller, & Horváth, 1997). Analyses of higher mushrooms were undertaken to estimate and compare the concentrations of different mineral elements (including the poisonous ones). A second, general aim was to investigate the possibility of bioaccumulation of the different mineral elements. Such accumulation has been described in some cases (B: in *Mycena* species—Vetter, 1995; Zn: in *Russula atropurpurea*—Vetter et al., 1997; Cd: in *Agaricus* species, in *Macrolepiota procera*—Vetter, 1994a; Se: in *Boletus* species—Vetter, 1993b). These data confirmed, nor literature reports (Cd, As, V) and novel results for some elements (B, Zn).

The aim of these investigations was (a) to analyse the sodium level of some common edible mushroom species, (b) to determine the occurrence or the absence of accumulating species (or other taxa) and (c) to determine the nature of the regulating factors.

2. Materials and methods

The mushroom samples were gathered from different sites (mainly from the mountains) of Hungary,

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1990–1998. After cleaning and drying, the fruit bodies were milled. The samples (200 mg of mushroom powder) were digested in closed teflon bombs in triplicate (2 cm^3 HNO_3 + 2 cm^3 H_2O_2 (30%) at 1.56×10^5 Pa pressure, 20 min. The material was filtered, diluted and the Na contents were determined by inductively coupled plasma spectroscopy (ICP). The Na contents of samples were characterised by arithmetical means (in ppm of dry matter) and by standard deviation (±S.D.).

3. Results and discussion

The results of the Na determinations in the gathered edible mushrooms can be seen in alphabetical order of the taxa in Table 1 and the averages of the taxa in Table 2. The numbers of samples of the same taxon are different, most taxa being characterised by numerous samples derived from different habitats of Hungary.

The fruit bodies of *Agaricus* species (characterized by six species and 14 samples) contain, on average, 396 ppm sodium. Three samples of *A. bisporus* (the cultivated champignon) have significantly higher sodium contents (849–957 ppm) than those of wild-growing *Agaricus* species (*A. arvensis, A. campestris, A. esettei, A. haemorroidarius* and *A. squamulifer*), although the latter were gathered from totally different habitats of Hungary. The data of Tóásó, Schmidt, and Fodor (1995) have a tendency similar to the Na level of the cultivated *A. bisporus*. The differences probable arise from the higher ion content of the cultivation substrate and the higher uptake intensity of the cultivated mushroom varieties.

The common edible wood-decaying species *Armillaria mellea* ($n = 17$) contains, on average, 334 ppm of Na (lowest: 74 ppm, highest: 851 ppm). The species *Craterellus cornucopioides* is characterized with 200 ppm of sodium. *Lactarius deliciosus*—one of the most valuable edible mycorrhizal species—has a moderate Na content (163 ppm). The two *Lepista* species, (*L. nuda and L. nebularis*) have 265 and 228 ppm of Na and these values do not differ significantly. *Lycoperdon perlatum* samples ($n = 12$) (this species belongs to the class Gasteromycetes) are characterized by 173 ppm of Na. Fruit bodies of two common *Macrolepiota* species (*M. procera* and *M. rhacodes*) contain 176 and 211 ppm of Na, respectively.

Pleurotus ostreatus—oyster mushroom—fruit bodies have a relatively high Na content (396 ppm). The *Xerocomus* group (*X. armeniacus, X. chrysentheron, X. porosporus* and *X. subtomentosus*) have an average Na level of 233 ppm. Sodium concentrations of the analysed common edible mushroom species are fairly consistent; the changes of different samples of the same species are not important, although they were gathered from different habitats from Hungary and at different times.

Table 1
Sodium contents of some edible mushroom species (ppm) [dry material (DM) and the standard deviation ±SD]

Mushroom species	Site of gathering	Na content ppm ±S.D.
Agaricus arvensis Schff.:Fr	Mt. Börzsöny	230±15.0
	Mt. Bakony	259±21.5
A. bisporus Lange Sing.	cultivated, from market	957±30.1
	cultivated, var. 333	861±23.3
	cultivated, var. 229	850±24.9
A. campestris L.:Fr	Mt. Börzsöny	342±15.6
A. esettei Bon	Miskolc/1, Mt. Zemplén	220±8.2
	Tatabánya/2, Mt. Vértes	247±7.7
	Miskolc/2, Mt. Zemplén	142±2.9
	Rákospalota (Budapest)	257±6.0
	Mt. Mátra	166±7.4
A. haemorrhoidarius Schulz.: Kalchbr.	SBK (Budapest)	316±9.3
	Hárskút, Mt. Bakony	218±20
A. squamulifer (Moell.) Pil.	Hárskút, Mt. Bakony	350±11
Armillaria mellea (Valh.:Fr.) Karst.	Kamara wood (Budapest)	460±23
	Mt. Mátra	339±34
	Tatabánya, Mt Vértes	256±12.6
	Miskolc/1, Mt. Zemplén	635±18
	Miskolc/1, Mt. Zemplén	312±7.8
	Miskolc/2, Mt. Zemplén	153±6.6
	Mt. Budai	852±36.6
	Tatabánya/4, Mt. Vértes	154±3.1
	Tatabánya/1, Mt. Vértes	674±6.4
	Miskolc/3, Mt. Vértes	540±27.8
	Tatabánya/4, Mt. Vértes	206±46
	Herend, Mt. Bakony	74.3±6.7
	Hárskút, Mt. Bakony	124±10
	Farkasgyepû, Mt. Bakony	185±13
	Mt. Bakony	417±25
	Normafa, Mt. Budai	556±30.3
	Miskolc, Mt. Zemplén	398±11
Camarophyllus pratensis (Pers.:Fr.) Kummer	Mt. Mátra	205±9.8
Clitocybe odora (Bull.:Fr.) Kummer	Tatabánya/2, Mt. Vértes	461±10.8
	Miskolc/1, Mt. Zemplén	215±16
	Miskolc/1, Mt. Zemplén	195±9.6
	Tatabánya/2, Mt Vértes	346±12
	Mt. Pilis	385±14.5
Craterellus cornucopioides (L.) Pers.	Tatabánya/2, Mt. Vértes	139±6.1
	Mt. Bakony/1	441±10.4
	Mt. Mátra	94.5±2.0
	Herend, Mt. Bakony	105±5.8
	Farkasgyepû, Mt. Bakony	242±5.9
	Loipersdorf	122±5.6
Fistulina hepatica (Schaeff.) Fr.	Tatabánya, Mt. Vértes	155±2.6
	Mt. Bükk	240±10
	Tatabánya, Mt. Vértes	82.9±4.7
	Tatabánya, Mt. Vértes	275±17

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Table 1 (*continued*)

Mushroom species	Site of gathering	Na content ppm ±S.D.
Flammulina velutipes (Curt.:Fr.) Sing.	Érd/1, (near to Budapest)	478±18.7
	Érd/2 (near to Budapest)	470±12.7
Gomphidius glutinosus (Schff.) Fr.	Miskolc/3, Mt. Zemplén	237±9.3
	Mt. Mátra	214±11
Hericium coralloides (Scop.:Fr.) S.F. Gray	Tatabánya/2, Mt. Vértes	185±12
	Normafa, Mt. Budai	230±12.1
	Normafa/2, Mt. Budai	105±8.0
	Normafa/3, Mt. Budai	131±5.8
Hirneola (*Auricularia*) *auricula-judae* (Bull.:Fr.) Wettst.	Miskolc/3, Mt. Zemplén	187±9.9
	Farkasgyepû, Mt. Bakony	214±5.2
	Normafa, Mt. Budai	369±29.9
Hydnum repandum L.:Fr.	Mt. Mátra	116±5,5
	Õrség (West-Hungary)	232±11.7
Hygrophorus eburneus (Bull.:Fr.) Fr.	Normafa, Mt. Budai	349±8.8
	Mt. Bakony	589±28
Hypholoma capnoides (Fr.:Fr.) Kummer	Mt. Pilis	230±16
	Mt. Pilis/2	207±11.9
	Miskolc/3, Mt. Zemplén	125±2.5
	Pilisszentkereszt, Mt. Pilis	429±8.7
	Mt. Bükk	380±49
Kuehneromyces mutabilis (Schff.:Fr.)	Farkasgyepû, Mt. Bakony	188±7.5
Lactarius deliciosus Fr.	Miskolc/3, Mt. Zemplén	253±17.6
	Herend, Mt. Bakony	95.9±4.6
	Farkasgyepû, Mt. Bakony	160±6.4
	Miskolc/3, Mt. Zemplén	144±7.5
Laetiporus sulphureus (Bull.:Fr.) Murrill	Mt.Pilis	310±11.4
Lepista nuda (Bull.:Fr.) Cke.	Tatabánya/2, Mt. Vértes	120±9
	Mt. Börzsöny	207±7.5
	Mt. Bakony/1	423±14.1
	Mt. Bakony/3	372±16
	Herend, Mt. Bakony	248±1.6
	Farkasgyepû, Mt. Bakony	172±6.5
	Farkasgyepû, Mt. Bakony	280±13.7
	Õrség (West Hungary)	193±7.1
	Hûvösvölgy (Mt. Budai)	384±8.1
Lepista nebularis Fr.	Mt. Bükk	169±9.2
	Mt. Börzsöny	292±15.9
	Mt. Bakony/1	377±11.6
	Mt. Bakony/2	273±10.6
	Mt. Mátra	179±6.1
	Farkasgyepû, Mt. Bakony	163±14.4
	Miskolc/2, Mt. Zemplén	82.4±3.3
Lepista gilva (Pers.:Fr.) Roze	Miskolc/1, Mt. Zemplén	167±6.4
	Miskolc/2, Mt. Zemplén	234±6.9
	Miskolc/2, Mt. Zemplén	1376±8.3

Table 1 (*continued*)

Mushroom species	Site of gathering	Na content ppm ±S.D.
Lycoperdon (*Calvatia*) *excipuliformis* (Scop.:Pers.) Perdeck	Mt. Bakony/2	391±13.5
Lycoperdon perlatum Pers.: Pers.	Miskolc/1, Mt. Zemplén	115±9
	Miskolc/1, Mt. Zemplén	149±3.5
	Miskolc/1, Mt. Zemplén	181±7.7
	Miskolc/3, Mt. Zemplén	137±6.2
	Mt. Pilis	195±8.1
	Miskolc/3, Mt. Zemplén	59.3 ±3.7
	Tatabánya/1, Mt. Vértes	304±17.9
	Mt. Mátra	73.5±4.0
	Herend, Mt. Bakony	150±4.6
	Mt. Bakony	474±59
	Miskolc/2, Mt. Zemplén	65.7±3.2
Macrolepiota procera (Scop.:Fr.) Sing.	Miskolc/1, Mt. Zemplén	215±9.5
	Wood Kamara, Mt. Budai	241±12.5
	Miskolc/2, Mt. Zemplén	256±18.8
	Wood Halmi (Budapest)	172±13
	Wood Kamara Mt. Budai	100±6
	Mt. Bakony/2	451±21.1
	Mt. Pilis	140±5.6
	Miskolc/2, Mt. Zemplén	242±10.3
	Tatabánya/4	94.2 ±2.0
M. rhacodes (Vitt.) Sing.	Miskolc/2, Mt. Zemplén	159±6.8
	Mt. Pilis	192±9.9
	Dobogókõ Mt. Pilis	193±9.9
	Miskolc/3, Mt. Zemplén	256±10.4
	Mt. Mátra	168±4.9
	Normafa, Mt. Budai	147±6.5
	Farkasgyepû, Mt. Bakony	178±5.1
	Farkasgyepû, Mt. Bakony	137±22
	Miskolc/3, Mt. Zemplén	215±6.7
Morchella conica Pers.	Mt. Budai	357±21
Pleurotus ostreatus (Jacq.:Fr.) Kummer	Szarvaskút, Mt. Bakony	191±7.6
	Gemenc	335±7.8
	Csévharaszt	417±5.9
	Csévharaszt	642±17
Pleurotus pulmonarius (Fr.) Quél.	Normafa, Mt. Budai	310±10.3
	Miskolc/2, Mt. Zemplén	393±21.1
Polyporus squamosus (Huds.) Fr.	SBK (Budapest)	258±12.4
	Tatabánya/4, Mt. Vértes	195±9.0
	Tatabánya/4, Mt. Vértes	390±10.5
Psathyrella candolleana (Fr.) Mre.	Miskolc/1, Mt. Zemplén	486±8.8
	Wood Kamara (Budapest)	369±9.1
	SBK (Budapest)	283±6.5
	Wood Kamara (Budapest)	270±13
	SBK (Budapest)	284±6.5
	Tatabánya/2, Mt. Vértes	501±15.3
	Tatabánya/1, Mt. Vértes	581±26.0

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Table 1 (*continued*)

Mushroom species	Site of gathering	Na content ppm ±S.D.
Suillus grevillei (Klotzsch) Sing.	Mt. Pilis	232±11.9
	Mt. Pilis	134±51
Tricholoma terreum (Schff.:Fr.) Kummer	SBK (Budapest)	365±22.8
	Herend, Mt. Bakony	443±27.5
	SBK (Budapest)	510±12
Xerocomus armeniacus (Quél.) Quél.	Wood Halmi (Budapest)	84.1±7
X. chrysentheron (Bull.) Quél.	Miskolc/2, Mt. Zemplén	177±6.7
	Wood Halmi (Budapest)	89.3±20
	Mt. Börzsöny	402±7.1
	Miskolc/1, Mt. Zemplén	155±9.3
X. porosporus Imler	Miskolc/1, Mt. Zemplén	105±8.4
	Mt. Börzsöny	365±8.9
	Mt. Bakony/2	475±14.2
X. subtomentosus (L.) Quél.	Mt. Börzsöny	252±11.2

Mt.: mountains; SBK: Botanical Garden of Soroksár (Budapest).

The relative stability of the sodium level in higher mushrooms is the first conclusion of our work. The sodium contents found are in good agreement with the data of Falandysz and Bona (1992) for *Agaricus* species (average content 360 ppm; in the present work 396 ppm). The sodium level of *Armillaria mellea* was found to be 100 ppm in Poland (Falandysz, Danisiewicz, & Bona, 1992) and 372 ppm in Hungary (Table 2). According to earlier data on 10 wood-decaying species, their average Na content was 428 (Vetter, 1991). The Na level of the taxa seems to be independent of the nutrition and/or ecological type of the mushroom. The mycorrhizal *Lactarius deliciosus* or the saprophytic *Macrolepiota rhacodes* have practically the same Na level (182 and 163 ppm). The xylophagous *Pleurotus ostreatus* and the saprophytic *Agaricus* genus and the *Psathyrella candolleana* have the same Na content (396 ppm for all these taxa). The mushroom species have low and stable Na contents. Accumulation of this element has been neither documented by our work nor by work of other investigators, although the bioaccumulation of some minerals in fruit bodies is a relative frequent phenomenon (Vetter, 1993b, 1995; Vetter et al., 1997).

Table 2
The average Na contents of the analysed, more remarkable, common mushroom taxa (species and genus)

Mushroom	Number of samples (*n*)	Na content (ppm) (arithmetical mean ±SD)
Agaricus spp.	14	396±275
Armillaria mellea	17	372±222
Craterellus cornucopioides	6	190±133
Fistulina hepatica	4	189±111
Hericium coralloides	4	182±87
Hypholoma capnoides	5	274±126
Lactarius deliciosus	4	163±6,5
Lepista nebularis	7	219±99,6
Lepista nuda	9	265±105
Lycoperdon perlatum	11	173±121
Macrolepiota procera	9	212±108
Macrolepiota rhacodes	9	182±36,7
Pleurotus ostreatus	4	396±188
Psathyrella candolleana	7	396±126
Xerocomus spp.	9	233±147

The potassium content of the analysed mushrooms—in accordance with earlier data (Vetter, 1994b) and with the data from Sweden (Tyler, 1980), Ukraine (Solomko, Grodzinskaja, Paschenko, & Pchelintseva, 1986), Italy (Senatore & Basso, 1994)—also shows a relative stability and a low fluctuation within the species. The stable and low Na content of higher mushrooms—according to the present data—seems to be a very useful property from a food chemical point of view. The benefit of the low sodium concentration is a positive characteristic of the common edible higher mushrooms. It seems to be logically predicatable that the substrates (e.g. soil, wood) of different common edible mushroom species from different habitats contain different sodium levels. The sodium concentration of fruit bodies, however, changes only between narrow limits, corresponding to the regulated character of uptake and storage of the sodium.

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