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Composition of Lipids and Proteins of Several Species of Molluscs, Marine and Terrestrial, from the Adriatic Sea and Serbia

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ABSTRACT

*Results of the analysis of lipids, proteins and amino acids as well as calculation of nutritive value parameters in samples of two sea shellfish (*Venus verucosa *and* Mytilus galloprovincialis*), a marine snail (*Monodonta turbinata*) and two terrestrial snails (*Helix pomatia *and* Helix nemoralis*) are presented. Lipid analysis revealed a high relative content of cholesterol among the other identified and unidentified sterols. Of significant nutritional importance is a high content of polyunsaturated fatty acids with more than 20 C atoms. Hydrolysed proteins contain all essential amino acids. Calculated from amino acids, pure proteins represent more than 36% and 54% of dry matter of shellfish and snails, respectively. In the case of snails a large difference between crude proteins (determined by Kjeldahl's method) and pure proteins (calculated from amino acid content) indicates the presence of other nitrogen-containing material in considerable quantities. Nutritive values indicate high biological value of proteins in shellfish, very similar to the biological values of other meat sources. Biological value of the snail's protein is lower and similar to soya protein.*

INTRODUCTION

Molluscs are animals with soft bodies; some of them are used as human food. Most popular in the gourmet community are oysters, mussels and some snails, but the data on the biological value of their proteins and

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analysis of lipid composition are insufficient and controversial. Lipid analysis might provide a theoretical contribution. It is well known that lipid compositions of lower animals are complicated and one may expect that lipids from molluscs have polyunsaturated fatty acids with more than 20 C atoms.

The main goal of our investigation is to determine the nutritive value of some sea shellfish and the snail from the Adriatic Sea and snails from the terrestrial part of Serbia because these data are not available despite the frequent use and export of these foods.

MATERIALS AND METHODS

Two sorts of marine shellfish (*Venus verucosa* and *Mytilus galloprovincialis*) and a marine snail (*Monodonta turbinata*) were purchased from the owner of a local oysterbank near Split. Two sorts of terrestrial snails (*Helix pomatia* and *Helix nemoralis*) were found at places near Belgrade. Only edible parts were analysed.

Water was estimated gravimetrically from fresh material. Freeze-dried and ground soft bodies were used for the following analysis:

—crude proteins according to Kjeldahl,
—amino acids were identified and their content determined on an Amino-Acid Analyser (Jeol 6AH) after acid hydrolysis by 6M HCl during 24 h at 110°C in sealed ampoules under nitrogen according to FAO recommendation (FAO, 1970),
—mineral materials and lipids were estimated gravimetrically,
—lipids were extracted by methanol:chloroform mixture (2:1) (Kates, 1972) and saponification of lipids was done by KOH in methanol. Unsaponifiable material was separated and extracted by petrol ether. After subsequent acidification fatty acids were separated from the water part, methyl esters were prepared and identified and determined by gas chromatography (Varian 1460 gas chromatograph with flame ionisation detector) (Christie, 1982),
—sterols were extracted from unsaponifiable material by chloroform and analysed by gas chromatography as trimethylsilyl derivatives.

Calculation

Parameters for calculation of nutritive value of proteins (BV, PER) were taken from Blok and Mitchel's tables based on the essential amino acid contents in hydrolysed proteins (FAO, 1970).

RESULTS AND DISCUSSION

The contents of water, crude proteins, lipids and mineral materials in analysed samples of marine shellfish and marine and terrestrial snails are presented in Table 1.

The content of dry matter in edible parts of analysed animal bodies is very low (less than 25%). Crude proteins represent about half of this material. In terrestrial snails this content is rather high (more than two-thirds of dry material). This does not necessarily mean that nutritive values of these molluscs must be higher because nutritive value depends on the content of essential amino acids in those proteins. Sea snail (*Monodonta turbinata*) crude protein content is more similar to that of marine shellfish than to terrestrial snails. Results of other authors (Bonomi *et al.*, 1986) suggest that shellfish from other places contain similar amounts of crude proteins but less lipids than samples presented in this paper. High contents of mineral materials are also important for nutritive value of this kind of food.

Identification and quantitation of sterols in analysed samples indicate high differences among samples and between shellfish and snails in both qualitative and quantitative terms as presented in Tables 2 and 3.

Results presented in Tables 2 and 3 are important for human health because molluscs used as gourmet food contain more than 50% (snails) or even 95% (shellfish) of total sterols as cholesterol. Total sterols of total lipids (calculated as an unsaponifiable material) are between 11·21% (*Mytilus galloprovincialis*) and 31·60% (*Monodonta turbinata*). According to those values, back-calculation shows that cholesterol content in fresh food is from 0·0730% (*Venus verucosa*) to 0·1752% (*Helix pomatia*). Analysed by gas chromatography some sterols are unidentified and should be analysed by other techniques especially in the case of shellfish where some of them

TABLE 1
Contents of Water, Crude Protein, Lipid and Ash in Shellfish and Snails

Sample	*Water* (%)	*Crude protein* (% *DM*)	*Lipid* (% *DM*)	*Ash* (% *DM*)
Mytilus galloprovincialis	77·92	44·27	9·61	8·14
Venus verucosa	79·71	48·87	5·43	12·90
Monodonta turbinata	82·79	51·23	2·85	nd
Helix pomatia	81·93	70·62	6·65	4·40
Helix nemoralis	82·66	71·75	7·95	4·45

DM = dry matter; nd = not done.

TABLE 2
Content of Sterols (in %) in Shellfish Lipids

Sterols	Mytilus galloprovincialis	Venus verucosa
Cholesterol RT: 1·00	50·83	46·88
Unidentified RT: 1·15	0	17·90
Unidentified RT: 1·21	33·89	0
Unidentified RT: 1·31	0	21·73
Stigmasterol RT: 1·42	11·70	0
Sitosterol RT: 1·61	3·56	7·67
Unidentified RT: 1·78	0	5·79

RT = retention time in relation to cholesterol.

TABLE 3
Contents of Sterols (% of Total Sterols) in Snail Lipids

Sterols	Monodonta turbinata	Helix pomatia	Helix nemoralis
Cholesterol	97·06	94·79	96·61
Unidentified RT:	0	0·56	0·57
Campesterol	0	1·45	1·01
Unidentified RT:	2·7	3·19	1·49

RT = retention time in relation to cholesterol.

represent more than 25% of total sterols. Results of fatty acids analysis are presented in Table 4.

Lipids from molluscs from the Adriatic Sea and terrestrial Serbia contain lower amounts of saturated fatty acids (20·43–39·73) than 50% as stated in the literature (Pastoriza *et al.*, 1981); even snails contain around only 20%. Polyunsaturated fatty acids with more than 20 C atoms represent 21·40–30·60% of total fatty acids, indicating that this food can be used for nutrition of atherosclerosis patients irrespective of total lipid content (Mahmoud *et al.*, 1980). In terms of specific fatty acid content there are differences between molluscs from the Adriatic Sea and those from terrestrial places. Myristic and palmitic acids are mainly present in lipids of marine molluscs although both marine and terrestrial snails contain more stearic acids than lipids from shellfish. Total unsaturated fatty acid content (60·27–79·57%) in analysed molluscs is rather high compared to the lipids of higher animals. The amino acid composition of the proteins of the analysed molluscs is presented in Table 5.

In the proteins of analysed molluscs, all essential amino acids are present (absence of tryptophan is caused by destruction of this amino acid during

TABLE 4
Content (in%) of Identified Fatty Acids in Lipids

Fatty acid	Mytilus gallopr.	Venus verucosa	Monodonta turbinata	Helix pomatia	Helix nemoralis
$C_{14:0}$	3·90	2·80	2·30	1·48	1·11
$C_{14:1}$	1·02	0·89	2·68	0	0·26
$C_{16:0}$	18·06	20·68	17·85	6·01	6·44
$C_{16:1}$	10·68	10·02	5·41	1·70	1·04
$C_{17:0}$	0	0	2·07	1·25	1·23
$C_{18:0}$	4·82	6·45	12·22	11·12	13·13
$C_{18:1}$	8·90	14·57	16·46	14·38	15·39
$C_{18:2}$	3·82	3·40	2·95	19·57	18·79
$C_{18:3}$	2·38	0·61	1·85	0·97	2·58
$C_{20:0}$	4·97	5·99	5·29	0·57	0·51
$C_{20:1}$	2·84	0	0	2·76	2·41
$C_{20:2}$	0·96	1·91	0·55	10·86	12·77
$C_{22:1}$	0	0	0	2·71	2·61
Total PUFA 20	30·60	26·18	21·76	21·40	25·25

PUFA 20 = polyunsaturated fatty acids with more than 20 C atoms.

TABLE 5
Amino Acid Composition of Proteins of Marine and Terrestrial Molluscs

Amino acid	Venus verucosa (*%DM* (*%P*))	Mytilus galloprovinc. (*%DM* (*%P*))	Helix pomatia (*%DM* (*%P*))
Lys	2·85 (7·74)	3·02 (7·18)	4·68 (8·56)
His	0·53 (1·44)	0·65 (1·54)	2·18 (8·32)
Arg	3·05 (8·29)	3·10 (7·37)	4·52 (8·32)
Asp	4·30 (11·69)	4·46 (10·60)	6·21 (11·42)
Thr	1·36 (3·69)	1·52 (3·61)	1·25 (2·30)
Ser	2·25 (6·11)	2·47 (5·87)	3·48 (6·41)
Glu	5·23 (14·21)	6·57 (15·62)	9·75 (17·93)
Pro	1·44 (3·91)	1·34 (3·18)	2·35 (4·33)
Gly	3·57 (9·70)	4·58 (10·88)	1·84 (3·39)
Ala	3·90 (10·60)	4·47 (10·62)	1·92 (3·54)
Val	2·11 (5·73)	2·57 (6·11)	6·14 (11·30)
Met	3·55 (9·65)	3·98 (9·46)	5·61 (10·31)
Ile	1·83 (4·97)	2·42 (5·75)	2·23 (4·10)
Leu	3·00 (8·15)	4·39 (10·43)	4·90 (9·02)
Tyr	1·91 (5·19)	2·03 (4·82)	5·37 (9·87)
Phe	2·00 (5·43)	2·00 (4·75)	2·33 (4·29)

%DM = % dry matter; %P = % of proteins g/16 g N.

TABLE 6
Nutritive Value Parameters of Proteins

Parameter	Venus verucosa	Mytilus galloprovinc.	Helix pomatia
LAA X	42·88	33·91	54·10
BV	74·82	80·51	67·71
PER	2·40	2·70	2·04

LAA = limiting amino acid; BV = biological value; PER = protein efficiency ratio.

hydrolysis). If pure protein content is calculated from amino acid nitrogen, similar results are obtained as in determination of crude proteins (42·06% versus 44·27%) in the case of *M. galloprovincialis* whereas in *V. verucosa* and *H. pomatia* a large difference (36·78 versus 48·87% and 54·40 versus 70·62%, respectively) between those two procedures indicates the presence in considerable quantities of other nitrogen-containing material. Parameters of the nutritive value of proteins of marine shellfish and one terrestrial snail are presented in Table 6.

In the case of the two shellfish, the limiting amino acid (X) is isoleucine whereas in the case of the snail it is methionine.

From the calculated nutritive value of the analysed samples it is possible to conclude that proteins of shellfish are similar in their biological values to the meats of other animals, whereas the biological value of the snail's protein is much lower and similar to soya protein (BV = 68).

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