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Quality Indicators of Snail Meat Grown in Different Conditions

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Abstract: Snail meat is used daily in the human diet. Snails are used in human nutrition daily in some regions of the world. According to measurable attributes of proteins and lipids quality, snails fall into the middle category of this source of nutrients. The paper describes nutritive attributes of snail's quality from the aspect of macro and micro nutrients. In the composition of essential amino acid leucine and lysine are dominant, and tryptophan is missing. Essential fatty acids are relatively high in snails, especially linolenic and arahidonic acid, but some polyunsaturated omega-3 fatty acids, such as EPA. Out of mineral material copper, iron and magnesium take an important place. With regard to methods of diet and residence snail meat can be loaded to certain heavy metals, residues of radioactive substances and pesticides. These are reasons to control the snails before processing in order to increase safety of the obtained product.

Key words: snail meat, quality, nutritive attributes

Introduction

The growing needs for food, especially those of animal origin, require intensive conventional and unconventional animal production. To meet the needs of the most valuable food ingredients, respectively in proteins of animal origin, snail meat is also used. Snail meat is most commonly used as a specialty, but it is becoming increasingly important alternative food in many countries. Snail meat is very nutritious food. It is used in the human diet for centuries. As a treat in the diet it was used by the Greeks and Romans who were passionate breeders of snails. Thanks to an acceptable taste and high digestibility snail meat has become requested food on the EU market today. Its chemical composition is similar to the meat of cattle for slaughter, and due to low fat content belongs to the group of low-calorie food. In relation to beef and poultry meat, snail meat contains slightly more water and ash, and less protein and fat content. Due to the very low fat content, the meat of snails meets the demands of modern nutrition. Numerous studies about this ingredient, that aimed to explore its nutritional value, have contributed to increasing consumption of snail meat. Today, on the market we may find meat of snails collected from nature and snail meat reared on the farm.

Snail meat for human consumption

Usage of snail meat for human consumption dates back to prehistoric times, namely the Stone Age. Snails, in addition to several other species of mollusks, occupy an honored place in the history of human nutrition. From the fifties the consumption of snail meat and products based on this meat, especially in central Europe, the U.S. and Canada, has increased significantly. Parisians during the Christmas and New Year holidays, eat about 200 tons of snails, and during the year 25 000 tons. In the UK, snails are often called "wall fish", but in human nutrition are less represented than in continental. However, the consumption of snail

meat, in comparison with other kinds of meat, is still very small. In rural areas, consumption of snail meat is more inspired by cultural customs rather than social status of consumers (Cheney, 1988; Ebenso, 2003; Lubell, 2004). In recent years in our country there is a significantly increased interest in the production and marketing of snail meat (Biljana Pećanac, 2005; Olgica Dragićević, 2005; Dragićević i Baltić, 2005).

Snail meat, for its nutritive value, occupies a prominent place. It can be seen from its chemical composition. In addition to acceptable sensory characteristics, snail meat has an advantage over other types of meat and according to the composition. The fat content in the meat of snail 0,4-1,23%. At the same time in the fish meat fat content is 2,2-22,3%, cattle 4,0-25,0 % and chicken 4,0-11,5%. This meat has a low energy value (60-80 kcal per portion) (Novelli et al., 2002; Avanjina, 2004; Mašić, 2004; KLT, 2004), and rich in minerals, amino acids and fatty acids (Yildirim, 2003).

From comparative review of energy value of different types of meat, it can be observed that snail meat from the *Helix* genus has significantly lower energy value 83,0±4,4 (kcal/100 g) in relation to the species of fish: carp fattened 113 (kcal/100 g), carp 121 (kcal/100 g), grass carp 117 and trout 117 (kcal/100 g); poultry meat 129 (kcal/100 g) and pork meat 278 (kcal/100 g) (Novelli et al., 2002).

Snail meat is tender, juicy and tasty, it has good digestibility (about 96%), and can be compared with fish meat and casein (Čaklovica, 1987). Besides a fine structure, typical smell and taste, it's rich in protein, low in fat and a good source of vitamins and minerals (Cheney, 1988). Due to a special way of preparing meat of snails, which includes a large amount of spices and sauces, it is considered as a difficult to digest. For the production of meat and snail meat products, it can be used: large vineyard snail and related snails which have white meat, the Bosnian snail meat is gray and Macedonian snail meat has a dark brown color.

Vineyard snail meat and related snail has a softer texture and firm consistency, and the pH of the meat is 6.75 (Čaklovica, 1983). Aroma and taste are typical, and color is light grayish, with yellow and light brown shades.

On usable part of snail remains 20-38%, it depends on market demand, and separation procedure of visceral pouches from foot (Ajayi et al., 1978; Martin, 1984).

Proteins of snail meat

Snail meat is a high-quality proteins food. Its protein content corresponds to other types of meat (Yildirim, 1996). Protein levels vary within wide limits depending primarily on feeding and harvesting season of snail meat, etc. Snail meat proteins have a high biological value, because in their composition are represented almost all of the essential amino acids in significant quantities and favorable relationships specifically leucine, isoleucine, phenylalanine, valine, lysine and threonine.

By the content of histidine, glutamic acid, aspartic acid and threonine, snail meat is ahead of chicken, beef and fish. It can be argued that the snail meat in content of essential amino acids is at a satisfactory level (Timermans, 1969). In the diet of population now three amino acids are largely missing: tryptophan, lysine and methionine. They represent a limiting factor for conversion of food, therefore it is necessary that the sources of protein in human nutrition are correctly distributed (Grujić, 2000). Protein content of the snails reared on farms and snails from nature is not different (Gomot, 1998).

As for digestibility, snail meat proteins are harder to digest than meat proteins vertebrates, and little easier than the proteins of marine mollusks. Tests have shown that the preparation method of snail meat significantly enhances their digestibility (Avanjina, 2004).

Lipids in snail meat

Levels of fat and cholesterol in meat snail are very low which gives it an advantage over other types of cattle meat for slaughter (Urošević i Jović Jelica, 1973; Pfeifer et al., 1975). Analyzed snail muscle mass has minimal amounts of fat (triglycerides). Thanks to the low percentage of fat, with a high content of omega fatty acids, snail meat is acceptable in terms of modern nutrition. It is believed that it has beneficial effect on increasing of life expectancy and reducing opportunities for human cancer (Yildirim, 2003). This can be explained by the fact that this type of polyunsaturated fatty acids induces a decrease in blood triglycerides and blood pressure, and regulates the activity of proteokinase which slows down metastatic tumors (Baltić et al., 2003).

Snail meat does not contain lauric acid which increases the amount of cholesterol in the blood.

Content and ratio of individual fatty acids, in different species of snails from the Helix genus, derived from nature, are almost identical (Novelli et al., 2002). However, according to Gomota (1998) research, there are significant differences in the fat content in meat of different species of snails.

Snails, regardless of suitability for land life, have a fatty acid composition similar to that of fish (tuna and salmon).

Mineral matter content

The content of some trace elements in snail meat shows that it is a solid source of microelements. This can be partly attributed to the origin and shells development process (mostly composed of phosphate and calcium). Hundred grams of fresh mass of snail feet (approximately 20 individuals) meet about 60% of the daily requirement for calcium and a quarter of the demand for iron (INRAN, 1997).

Trace elements in the meat of snails are moving at approximate values given for other types of meat. There were differences in the content of calcium (Ca), which was 2 to 20 times higher than in the fish meat, beef and poultry. Phosphorus (P) is two times lower than in those kinds of meat (Ebenso, 2003). According to Balzano et al. (2001), the calcium is in the meat of snails found in quantities that are more than 10 times greater than the value of other types of meat, and comparable with the amounts of calcium in certain kinds of fatty cheeses. Calcium and phosphorus are in reciprocal relationship somewhat higher than optimal for absorption in the human gut (Avanjina, 2004).

Among other minerals, it should be noted, there are relatively significant amounts of iron and copper (Adeyeye, 1989). It is known that the absorption of iron from food is higher, if it is an organic Fe, which is found in food of animal origin. Daily needs for iron are 10-30 mg/day.

A high copper content is in connection with special physiology of snails and the physiology of the entire group of gastropods. Hemocyanin, the respiratory pigment that carries oxygen, contains copper at gastropods (Balzan et al. 2001). Among the animals that contain hemocyanin, snails occupy the first place in the amount of copper (Avanjina, 2004). The recommended daily requirement for copper is as follows: adults 2.0-3.0 mg/day, children 1.0-2.0 mg/day, and babies 0.5-1.0 mg/day (Grujić, 2000).

The content of zinc (Zn) is approximate or slightly lower than the content of other types of meat (Balzan, 2001). In quantities less than 150 mg/day zinc is not toxic. Optimal daily needs for this element are about 6 mg, while the RDA provides a greater value (Grujić, 2000).

Snail meat contains also other trace elements; Ba, Al, Sr, Bo, Mo, etc. (Secer and Eken, 1993; Cadart, 1995; Grisse, 1991; Yildirim, 1996).

Other Ingredients

In addition to these nutritional and mineral substances snail meat is a valuable source of vitamin C and vitamin B_{12} (Montagne, 1997). Extracts of animal tissues, which can be defined as carbohydrates, are a heterogeneous group that is dominated by glycogen.

The relatively large amount of extract in the snail meat compared to other animals, according to some authors, is related to the specificity of these *Pulmonats* to deposit more energy reserves in the form of the polysaccharide than in the form of fat (Avanjina, 2004).

Materials and methods

Snail samples for chemical analysis originate from snails collected from nature and farmed. After grading and processing two sub-groups were formed from each of these (calibration P-6 and P-12) to determine the chemical composition (water, fat, protein, ash). Within each of the two subgroups sensory tests were performed for evaluation differences in acceptability.

Chemical analysis

To examine the contents of water, fat, protein and ash the following procedures were used:

- Water - determination of mass loss during drying the homogenized sample at 105±1°C to constant weight (BAS ISO 1442)
- Protein - Kjeldahl method, using the device of "Tecator" (BAS ISO 937)
- Fats - by Soxhlet method, extraction of fat from the dried sample by petroleum, distillation and drying at 105±1°C to constant weight (BAS ISO 1443)
- Ashes - by direct combustion at temperatures 550ºC to constant weight (BAS ISO 936)
- Calcium – by Complexometery (AOAC 971.27)
- Phosphorus – by Spectrophotometery (AOAC 986.24).

The research results

The results of testing chemical quality parameters of snails from the wild and farmed snails are separately presented below.

Chemical quality parameters of snails from nature

The results of this part of survey are presented in Table 1. The average water content (77.28±0.66%) in snail samples from nature size P-12 (weight of edible part 3 to 5 grams) was statistically significantly lower ($p<0.001$) than the average water content (79.06±0.62%) in snail samples from nature, whose size of shells is P-6 (weight of edible part 7-9 grams). In samples from wild snail size P-12 average pro-

tein content (17.22±0.26%) was statistically significantly higher ($p<0.001$) than the average protein content (16.53±0.31%) in snail samples from nature size P-6. The average fat content (1.71±1.48) in snail samples from nature size P-12 was statistically significantly higher ($p<0.05$) than the average fat content (1.48±0.12%) in snail samples from nature size P-6. The average ash content, calcium and phosphorus (2.1±0.16; 0.72±0.7; 0.13±0.01) in snail samples from nature size P-12 did not differ significantly ($p>0.05$) from the average content of ash, calcium and phosphorus (1.97±0.14%; 0.72±0.07%; 0.13±0.01%) in snail samples from nature size P-6.

Table 1: Average chemical content in snail samples from nature with different shell size (%)

Sample	$\overline{X}$	Variation measures				
		S_d	S_e	I_v X_{max}	I_v X_{min}	C_v %
Ap-1	77.28 ^{x}	0.66	0.25	78.12	76.42	0.85
Bp-1	79.06 ^{y}	0.62	0.23	79.91	78.36	0.79
Ap-2	17.22 α	0.26	0.10	17.56	16.88	1.49
Bp-2	16.53 β	0.31	0.12	16.9	16.12	1.85
Ap-3	1.71 ^{a}	0.20	0.08	1.94	1.36	11.92
Bp-3	1.48 ^{b}	0.12	0.04	1.61	1.3	7.86
Ap-4	2.10	0.16	0.06	2.34	1.9	7.76
Bp-4	1.97	0.14	0.06	2.18	1.8	7.35
Ap-5	0.72	0.07	0.02	0.80	0.63	9.14
Bp-5	0.72	0.07	0.03	0.81	0.62	10.05
Ap-6	0.13	0.01	0.004	0.15	0.12	8.88
Bp-6	0.13	0.01	0.003	0.14	0.12	5.25

Remark: *applies to all tables*

A = P -12

B = P - 6

$p<0.001$

Remark: *applies to all tables*

a, b	$p<0.05$
x, y	$p<0.01$
α, β	$p<0.001$

LEGEND:

Ap-1, Bp-1-Water content

Ap-2, Bp-2- Proteins content

Ap-3, Bp-3- Fat content

Ap-4, Bp-4- Ash content

Ap-5, Bp-5- Calcium content

Ap-6, Bp-6- Phosphorus content

Chemical quality parameters of snails from farm breeding

The results of this part of the survey are presented in Table 2. The average water content (77.63±0.38%) in samples of farmed snails size P-12 (weight of edible part 3 to 5 grams) was statistically

significantly lower ($p<0.01$) than the average water content (78.49±0.46%) in samples of farmed snails whose size of shells is P-6 (weight edible part 7-9 grams). In samples of farmed snails size P-12 the average protein content (16.14±0.3%) was statistically significantly higher ($p<0.001$) than the average protein content (15.02±0.31%) in samples of farmed snails size P-6. The average fat content (1.25±0.15%) in samples of farmed snails size P-12 did not differ significantly ($p>0.05$) from the average fat content (1.17±0.08%) in samples of farmed snails size P-6. The average ash, calcium and phosphorus content (2.49±0.14%; 0.88±0.05%; 0.14±0.008%) in samples of farmed snails size P-12 did not differ significantly ($p>0.05$) from the average content of ash, calcium and phosphorus (2.47±0.13%; 0.95±0.08%; 0.14±0.008%) in snail samples from nature size P-6.

Table 2: Average chemical content in snail samples from farm breeding with different shells size (%)

Sample	$\overline{X}$	Variation measures				
		S_d	S_e	I_v		C_v %
				X_{max}	X_{min}	
Af-1	77.63 ^{x}	0.38	0.15	78.12	77.02	0.50
Bf-1	78.49 ^{y}	0.46	0.18	78.91	77.8	0.59
Af-2	16.14 $^{\alpha}$	0.34	0.13	16.61	15.66	2.11
Bf-2	15.02 $^{\beta}$	0.31	0.12	15.54	14.68	2.06
Af-3	1.25	0.15	0.06	1.42	1.04	11.63
Bf-3	1.17	0.08	0.03	1.26	1.04	6.86
Af-4	2.49	0.14	0.05	2.68	2.28	5.59
Bf-4	2.47	0.13	0.05	2.66	2.26	5.17
Af-5	0.88	0.05	0.02	0.94	0.80	5.44
Bf-5	0.95	0.08	0.03	1.08	0.86	8.51
Af-6	0.14	0.008	0.003	0.15	0.13	5.51
Bf-6	0.14	0.008	0.003	0.15	0.13	5.83

LEGEND:

Af-1, Bf-1- Water content

Af-2, Bf-2- Proteins content

Af-3, Bf-3- Fat content

Af-4, Bf-4- Ash content

Af-5, Bf-5- Calcium content

Af-6, Bf-6- Phosphorus content

Statistical significance of difference between the average content of chemical parameters of snail quality from wild and fa rmed snails

Tables 3 and 4 show the results of statistical significance of difference between the average content of chemical quality parameters of investigated in wild and farmed snails.

Between the average content of protein, fat, ash and calcium in snails meat of wild and farmed snails, size P-12, there was a statistically significant difference ($p<0.001$). Between the water content and phosphorus in snail meat of wild and farmed snails, size P-12 there wasn't a statistically significant difference ($p>0.05$).

Table 3: The statistical significance of difference between the average content of chemical quality parameters investigated in wild and farmed snails, size P-12

Parameter	Nature ±Sd	Farm±Sd	Statistical significance
Water	77.28±0.66	77.63±0.38	p>0.05
Proteins	17.22±0.26	16.14±0.34	p<0.001
Fat	1.71±0.20	1.25±0.15	p<0.001
Ash	2.10±0.16	2.49±0.14	p<0.001
Calcium	0.72±0.7	0.88±0.05	p<0.001
Phosphorus	0.13±0.01	0.14±0.008	p>0.05

Between the average content of protein, fat, ash and calcium in snail meat of wild and farmed snails, size P-6 there was a statistically significant difference ($p<0.001$). Between water content and phosphorus in snail meat of wild and farmed snails, size P-6 there wasn't a statistically significant difference ($p>0.05$).

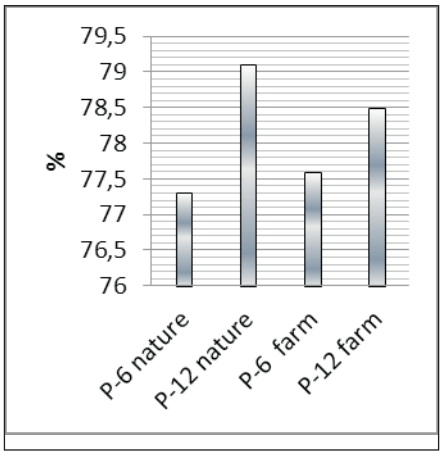
Table 4: The statistical significance of difference between the average content of chemical quality parameters investigated in wild and farmed snails, size P-6

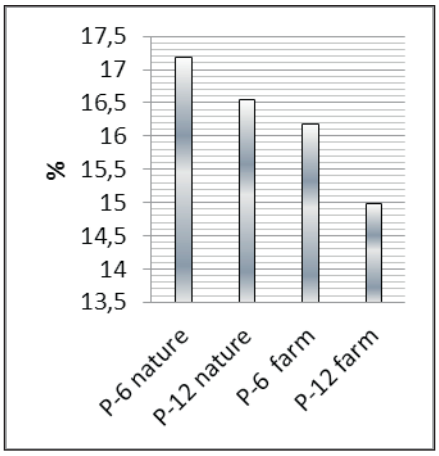
Parameter	Nature ±Sd	Farm±Sd	Statistical significance
Water	79.06±0.62	78.49±0.46	p>0.05
Proteins	16.53±0.31	15.02±0.31	p<0.001
Fat	1.48±0.12	1.17±0.08	p<0.001
Ash	1.97±0.14	2.47±0.13	p<0.001
Calcium	1.72±0.07	0.95±0.08	p<0.001
Phosphorus	0.13±0.01	0.14±0.008	p>0.05

Discussion

Snail meat is in its basic chemical composition different from cattle for slaughter and fish meat by a somewhat higher water content (75.0-79.5%), lower fat content (0.4-1.23%), slightly lower protein content (16.5-18.3%), and significantly higher ash content (1.4-3.6%). The results of water content are shown in Figure 1. They show that the water content in the investigated group of snails is moving from 77.28±0.66 to 79.06±0.62. This is in agreement with the results of references (Urošević i Jović Jelica, 1973; Pfeifer et al., 1975).

Snail meat has a slightly lower protein content than meat of cattle for slaughter. Our results show that the protein content in the investigated group of snails is moving from 15.02±0.31 to 17.22±0.26 (Figure 2). The lowest obtained value (15.02±0.31) from our tests is lower than in cited literature. Snail meat proteins have satisfactory amino acid composition and contain significant quantities of essential amino acids,





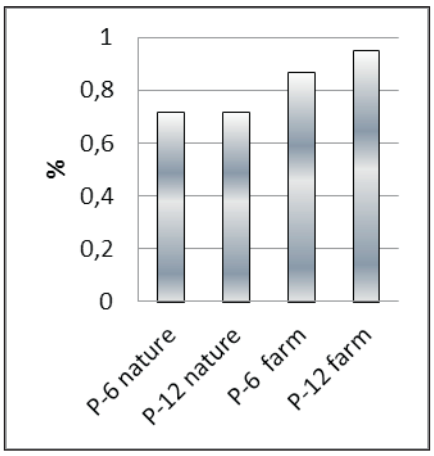


Figure 1: The average water content in snail meat with various shell sizes from the nature and farmed

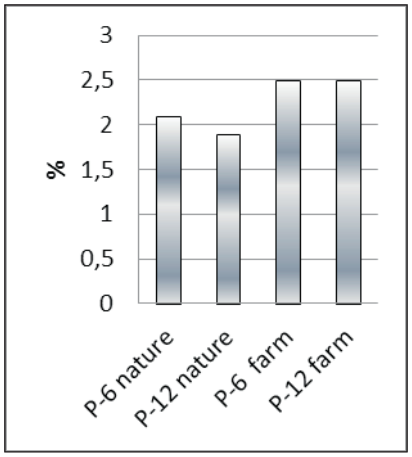
Figure 2: The average proteins content in snail meat with various shell sizes from the nature and farmed

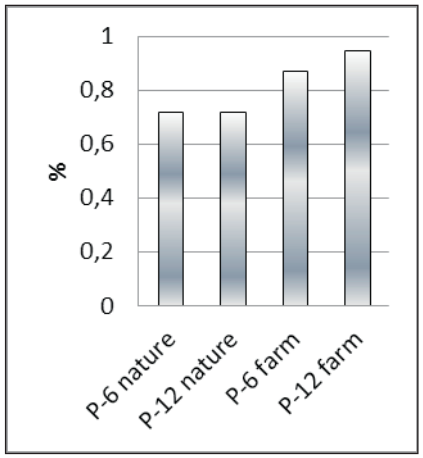
Figure 3: The average fat content in snail meat with various shell sizes from the nature and farmed

specifically leucine, isoleucine, phenylalanine, valine, lysine and threonine. Snail meat proteins are more digestible than meat proteins of cattle for slaughter, and less digestible than fish meat proteins.

Snail meat is a kind of food that is characterized by low fat content (from 0.4 to 1.23%) which classifies it as low calorie food. It is valued in the modern diet. Our results show that the fat content in the investigated group of snails is from 1.17±0.08 to 1.71±0.20% (Figure 3) which is compared with literature data slightly higher. Snails have a fatty acid composition very similar to fish meat: low content of saturated and monounsaturated fatty acids, and high content of polyunsaturated fatty acids. Concerning saturated fatty acids in very small quantities are represented myristic (C 14:0) and palmitic (C 16:0). At these fatty acids that raise cholesterol levels in the blood, directed the attention to prevention of cardiovascular disease by applying proper nutrition.

Opposite tendency have a long chain fatty acids such as linoleic (C 18:3) omega-3 fatty acid, arachidonic (C 20:4) omega-6 fatty acid and eicosapentaenoic (C 20:5) omega-3 fatty acid. They attributed the important prophylactic function primarily in cardiovascular diseases. There is information that the lipid content of *H. pomatia* declines with age. This phenomenon is specific for snails, considering that other farm animals have increased lipid content with age.





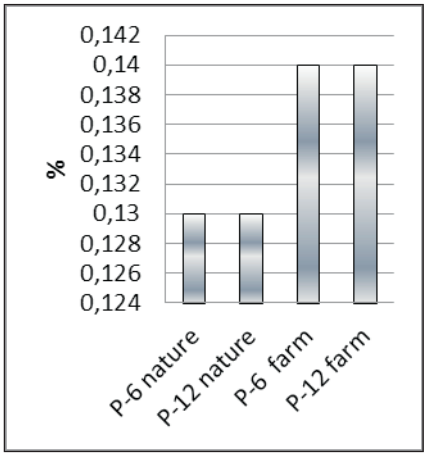


Figure 4: The average ash content in snail meat with various shell sizes from the nature and farmed

Figure 5: The average calcium content in snail meat with various shell sizes from the nature and farmed

Figure 6: The average phosphorus content in snail meat with various shell sizes from the nature and farmed

According to the literature, snail meat contains between 1.4 and 3.6% of ash which is more than in meat of cattle for slaughter and fish meat. Our results show (Figure 4) that the ash content ranges from 1.97±0.14 to 2.49±0.14% which is in accordance with literature data. Ash content data indicate a high content of mineral matter.

This can partly be attributed to the origin of the shells in the development process (largely composed of phosphate and calcium) in the development of animal. Among the highest concentration of minerals are calcium and phosphorus (Figure 5 and Figure 6) which is in a reciprocal relationship, somewhat higher than that it is considered optimal to be absorbed in the intestines. Data on the content of calcium and phosphorus from our results are consistent to those from the literature.

Conclusions

Based on the test results, the following conclusions can be made:

1. The average water content in snail meat of wild snails, mass of feet 3-5 g, was significantly lower ($p<0.001$) than the average water content in snail meat, mass of foot 7-9 g. The average protein and fat content in wild snails, mass of feet 3-5 g, was statistically significantly higher ($p<0.001$, i.e. $p<0.05$) than the average protein and fat content, mass of feet 7-9 g. There wasn't a statistically significant difference between the content of ash, calcium and phosphorus from the wild snails with different mass of feet.
2. The average water content in farmed snails, mass of feet 3-5 g, was significantly lower ($p<0.01$) than the average water content in snail meat, mass of feet 7-9 g. The average protein content in farmed snails, mass of feet 3-5 g, was statistically significantly higher ($p<0.001$) than the average protein content in snails, mass of feet 7-9 g. There wasn't a statistically significant difference between the content of fat, ash, calcium and phosphorus from the wild snails with different mass of feet.
3. Snails from nature, regardless of the size of shells, have a higher content of protein and fat than farmed snails. There was no difference in the content of water and phosphorus in snails from the wild and farmed. The ash content was higher in farmed snails, regardless of the size of shells. The calcium content in wild snails, foot weight 3-5 g, is higher than the calcium content in farmed snails. The calcium content in wild snails, foot weight 7-9 g, is lower than the calcium content in farmed snails.

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