TECHNOLOGICAL AND NUTRITIONAL QUALITY OF BROOK TROUT

C.E. Nistor[1*], Iulia Vărzaru[2], A. Usturoi[1], G.V. Hoha[1], B. Păsărin[1]

[1]Faculty of Animal Sciences, University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania
[2]INCDBNA Baloteşti, Romania

Abstract

The research was carried out on a batch of 50 specimens of brook trout, the fish coming from a salmonid exploatation from Suceava County. The studied trout's were sacrificed, measured and then samples (lateral muscles) were taken, which were subjected to determinations for chemical composition, content in collagen, histological studies and the rate of losses in different processes (frying and frying preceded by flouring).

Following the analysis of the results we can conclude that the analyzed fish material has shown a good maintenance status, the trout fillets having a balanced chemical composition, with a very strong correlation between the meat content in amino acids and the protein content, as well as a good manufacturing and superior capitalization.

Key wors: brook trout, chemical composition, superior capitalisation

INTRODUCTION

Trout meat has outstanding sensory features a high biological and nutritional value, due to significant protein content, slightly digestible, which doesn't produce adverse side effects on human health. In addition, fish meat also has a strong quantitative valence and plays an important role in ensuring daily protein requirements [21-23], [25], [27], [35].

Chemical composition of trout meat is influenced by a number of factors such as breed, age, nutrition, fishing season, environment, salinity and water temperature[8], [15], [25], [28], [34], [36].

The aim of the present study was to identify chemical composition, content in collagen, histological studies and the rate of losses in different processes (frying and frying preceded by flouring).

MATERIAL AND METHOD

The research was carried out on a batch of 50 specimens of brook trout, the fish coming from a salmonid exploatation in Suceava County. Fish samples were kept on ice in isothermal box, until they arrived to the laboratory and immediately frozen and stored at -18ºC until analyses.

In order to calculate growth indexes and coefficients, were determined several parameters, namely: total length, standard length, head length, caudal peduncle length, body height and thickness of the body

Based, on somatic measurements can be calculated several corporal indexes, which provides information regarding maintenance status as well as their adaptability to the assured environmental conditions [19], [29].

Biometric data are used to determine growth in length of fish and to determine the general physiological condition and is obtained by measurements taken with special instruments (ihtyometers) or other measuring instruments (ruler, callipers) [29].

These measurements are:

- ✓ body weight (M) – established through weighting;
- ✓ total length of body (L) – it is measured from the top of the snout till the top of the lobs of caudal fin;
- ✓ standard length of body (l) – also named standard length or length without the caudal fin, it is measured from the top of snout till the base of caudal fin;

*Corresponding author: is_cata@yahoo.com
The manuscript was received: 07.10.2019
Accepted for publication: 18.12.2019

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)

- ✓ maximum height of body (H) - it is measured in the highest area of body, from ventral line to the dorsal line;
- ✓ maximum circumference of body (C) – it is measured at the level of maximum thickness and maximum height, respectively before dorsal fin;
- ✓ length of the head (lc) - represents the distance from top of snout to the posterior edge of operculum bone;
- ✓ length of caudal peduncle (lp) – it is measured from the posterior extremity of anal fin to the base of caudal fin;
- ✓ maximum thickness of body (G) – it is measured in the area were body have the greatest thickness;

Based on the somatic measurements could be calculated a series of corporal indexes which offers information regarding fishes maintenance state and corporal shape of body (profile index, thickness index, Fulton coefficient, Kiselev index, fleshy index I and II, [19], [29].

Meat technological features refers to: water retaining capacity, meat hydration capacity, retaining or releasing capacity of juice, losses rate by maturation and storage, losses rate by boiling or frying, meat resistance, those ones being influenced by physical-chemical and morph-structural proprieties [30].

For determination of collagen content from trout meat was utilised a Food-Check meat automatic analyser.

Muscle fibre diameter was determined by inclusion technique in paraffin and staining with haematoxylin-eosin [29]. Histological examination and interpretation of data was performed using Leica DM 750 microscope equipped with Leica Las Software Version V4.2 2012, equipped with microphotography system.

To determine the physical-chemical composition of trout meat were gathered samples from side musculature of fishes.

Determination of water and dry matter was realized through the method of drying in oven, which is the most used indirect method and suppose the drying of sample in oven at +105°C, till reaching a constant weight, in according to SR ISO 1442:2010.

Protein determination consists in decomposing the analyzed sample by heating with sulphuric acid in the presence of catalysts to reduce organic nitrogen to ammonium ions which can be determined by distillation/titration.

Determination of lipids content was realized using Soxhlet method, which consists in fat extraction from the analyzed sample using petrol ether according to SR ISO 1443:2008.

Ash was determined by calcinations at 550ºC in calcinations oven according to SR ISO 936:2009.

Quantitative determination of amino acids was carried out in two stages in agreement with SR EN ISO 13903/2005 and AOAC Official Methods of Analysis (2019).

Amino acids were separated by high performance liquid chromatography using the HPLC Surveyor Plus Thermo Electron chromatographic system on a reversed-phase Hypersil BDS C18 (Thermo Electron) column, the reading being in the ultra-violet (338 nm). A Hypersil BDS (Base Deactivated Silica) C18 column with silica gel, with dimensions of 4.6 mm and a particle size of 5 µm. A gradient elution method is used, the chromatographic conditions being the following flow rate: 1 mL/min; injected volume: 25 µL; wavelength to be read: 336 nm; column temperature: 25°C.

The software used for statistical analysis was SPSS. We calculated the average, standard deviation and coefficient of variation.

RESULTS AND DISCUSSIONS

Research has debuted with biometric determinations: body weight (M), body length (standard length) (ls), maximum body height (H), maximum body circumference (C), length of the head (lc), caudal peduncle length (lp), and maximum thickness of body (G) (table 1).

Based on data obtained by measurements and weightings' for brook trout specimens, were obtained values close to those presented in the literature [4], [19], which shows that the studied specimens had adequate development.

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)

Table 1 Biometric measurements at brook trout (*Salvelinus fontinalis)*

Specification	*Salvelinus fontinalis* (n=10)	
	$\bar{X} \pm s_{\bar{x}}$	V%
Body weight – M (g)	264.80±10.33	8.12
Standard length– ls (cm)	24.87±0.11	4.68
Maximum height – H (cm)	7.06±0.11	6.67
Heads' length – lc (cm)	5.41±0.14	8.82
Maximum circumference – C (cm)	16.93±0.22	6.88
Length of caudal peduncle – lp (cm)	5.08±0.11	7.14
Maximum thickness of body (G) (cm)	2.97±0.09	6.88

Values obtained by calculating indexes and growth coefficients (table 2) are similar with those from the literature, resulting that the analyzed specimens had a good maintenance condition [4], [19].

Table 2 Indices and coefficients of fish maintenance

Specification	$\bar{X} \pm s_{\bar{x}}$	**V%**
Profile index	3.53±0.06	6.16
Thickness index	41.55±1.49	11.33
Kiselev index	1.48±0.03	5.30
Fulton coefficient	1.72±0.05	10.23
Fleshy index I	21.77±0.74	8.02
Fleshy index II	20.43±0.33	5.18

For the analysed breed, it was observed that the highest collagen percentage was found in costal hip axial muscles (table 3), confirming the data from literature regarding the low proportion of collagen in fish meat, fact which makes that this one to be easier to be cooked [31].

Table 3 Collagen content of the studied muscles gathered from the studied trout

Breed	**n**	**Analysed muscles**	**Collagen %**	
			$\bar{X} \pm s_{\bar{x}}$	**V%**
Brook trout	10	EC	3.95±0.92	2.01
	10	HC	4.16±0.41	2.21

Histological structure of meat is illustrated by a series of specific indicators such as: large diameter (DM), small diameter (Dm), mean diameter, ratio between diameters (DM/Dm), and also square area per transversal section. The obtained values fall into the limits mentioned in the literature (table 4).

Table 4 Thickness of the muscular fibre in side muscles from brook trout

Breed	**Large diameter (μ)**	**Small diameter (μ)**	**Mean diameter (μ)**	**Ratio DM/Dm (x/1)**	**Square area per transversal section of muscular fibre (μ^2)**
Brook trout	80.72±6.56	70.16±5.63	75.44±3.42	1.14/1	4886.49±8.66

The chemical composition of brook trout meat, is influenced by genetic and environmental factors such as water quality and temperature its pH, oxygen content, technological factors such as feeding, type of food used, season, age and size of the fish [3], [9], [11], [13], [15], [17-18], [25], [33-35], [38-39].

Water content of fillet had an average value (Table 5) of73.22% for brook trout

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)

samples values which fall within the limits from literature [1], [4-7], [9], [12], [14], [17], [24-26], [33], [37-39].

Table 5 Proximate composition of brook trout meat

Specification		*Brook trout*
Water (%)	$\bar{X} \pm s_{\bar{x}}$	73.22±0.31
	V%	1.04
Dry matter (%)	$\bar{X} \pm s_{\bar{x}}$	26.78±0.31
	V%	4.22
Proteins (%)	$\bar{X} \pm s_{\bar{x}}$	19.98±0.27
	V%	5,69
Fats (%)	$\bar{X} \pm s_{\bar{x}}$	5.60±0,23
	V%	13.39
Ash (%)	$\bar{X} \pm s_{\bar{x}}$	1.20±0.01
	V%	4.01

As it can be observed from these data the dry matter content had an average value of 26.78% for brook trout samples.

Protein content had an average value of 19.98% for brook trout, values similar to those mentioned in the specialty literature [1], [4-7], [9], [12], [14], [17], [20-21], [24-26], [33], [37], [39].

The fat content of the analyzed trout's fillet was 5.60%, values that places them in the category of fish with a medium lipid content (4–8%), the obtained data being within the limits mentioned in the specialty literature [1],[4-5], [7], [9], [12], [14], [17], [20], [24-25], [33], [37-39].

Regarding the ash content we obtain an average value of 1.20% for brook trout samples, values similar to those mentioned in literature.

Amino acid composition of the brook trout meat is given in Table 6.

Table 6 Amino acid composition of trout meat (% from dry sample)

Amino acid	**Brook trout**
Aspartic acid (Asp)	6.77±1.25
Glutamic acid (Glu)*	9.24±0.44
Serine (Ser)	3.06±1.34
Glycine (Gly)*	4.38±2.14
Threonine (Thr)E	3.56±0.48
Arginine (Arg)*	5.60±2.35
Alanine (Ala)*	4.65±1.12
Tyrosine (Tyr)	2.85±2.68
Valine (Val)E	3.65±1.69
Phenylalanine (Phe)E	3.34±0.34
Isoleucine (Iso)E	3.60±0.54
Leucine (Leu)E	6.56±1.88
Lysine (Lys)E	5.81±2.64
Cysteine (Cys)	0.74±1.48
Methionine (Met)E	0.79±0.28
Essential amino acids $\sum_{EAA}$	27.31±1.45
Delicious amino acids $\sum_{DAA}$	23.87±0.54
Non essential amino acids $\sum_{NEAA}$	37.28±1.25
Total amino acids $\sum_{TAA}$	64.59±1.89
$\sum_{EAA}/\sum_{TAA}$	0.42±1.28
$\sum_{EAA}/\sum_{NEAA}$	0.73±1.94
$\sum_{DAA}/\sum_{TAA}$	0.36±1.65

*denotes delicious amino acids; EAA – essential amino acids; NEAA – non-essential amino acids; TAA – total amino acids; Histidine and Tryptophan were not determined

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)

The protein compositions of the examined trout samples contain high levels of glutamic acid (9.24%), followed by aspartic acid, leucine and lysine results in according with those obtained by Iwasaki, and Harada, (1985); Farmanfarmaian and Sun, (1999); Beklevik et. al., (2005), Sabetian, Mryam et. al., (2012), Kaya et. al., (2014), Sirakov (2015), Simeanu Cristina et. al., 2017, Wang and Han (2017). The lowest level in decreasing amounts was registered in the case of cysteine (0.74%).

The ratio between EAA and TAA had an average value of 0.73. These results showed that the EAA/TAA and EAA/NEAA ratios were comparable to the reference values of nearly 40% and above 60%, respectively, recommended by the FAO/WHO, which indicates that brook trout meat may be considered a high-quality source of protein.

The muscle protein, suggests that brook trout is an ideal nutritional food source.

Losses resulted by frying

Regarding losses resulted by frying, could be remarked that at meat gathered from brook trout specimens was a losses percentage rate of 25.69% (table 7).

Table 7 Losses recorded by frying the trout's meat

Specification		Brook trout
Initial weight of samples (g)	$\bar{X} \pm s_{\bar{x}}$	230.42±4.34
	V%	7.69
Final weight of samples (g)	$\bar{X} \pm s_{\bar{x}}$	171.22±3.48
	V%	6.67
Losses (g)	$\bar{X} \pm s_{\bar{x}}$	59,2±4.42
	V%	2.78
Losses (%)	$\bar{X} \pm s_{\bar{x}}$	25.69±6.29
	V%	2.27

Losses resulted by frying preceded by flouring

Through flouring and frying of trout meat were recorded mean losses of 20.89%. Flour consumption for this operation was of 2.34 % (table 8) from the total weight of processed meat.

Table 8 Losses recorded by frying the trout's flouring meat

Specification		Brook trout
Initial weight of the floured samples (g)	$\bar{X} \pm s_{\bar{x}}$	234.57±3.24
	V%	3.13
Flower consumption (g)	$\bar{X} \pm s_{\bar{x}}$	5.51±0.73
Final weight of samples (g)	$\bar{X} \pm s_{\bar{x}}$	189.92±2.23
	V%	4.25
Losses (g)	$\bar{X} \pm s_{\bar{x}}$	50.16±2.12
	V%	3.41
Losses (%)	$\bar{X} \pm s_{\bar{x}}$	20.89±0.59
	V%	2.17

Processing of trout meat by frying preceded by flouring recorded average losses with 4.8% less than in the case of frying (without flouring).

CONCLUSIONS

The values of the calculated main indexes reflect a corresponding increase, a better use of nutrition, correlated with good maintenance and health of the studied specimens.

For the analysed breed, it was observed that the highest collagen percentage was found in costal hip axial muscles.

The values obtained after chemical analysis fall into the limits cited in the literature, highlighted that brook trout has a good nutritional value.

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)

The protein compositions of the examined trout samples contain high levels of glutamic acid, followed by aspartic acid, leucine and lysine.

The ratio between EAA and TAA had an average value of 0.73. These results showed that the EAA/TAA and EAA/NEAA ratios were comparable to the reference values of nearly 40% and above 60%, respectively, recommended by the FAO/WHO, which indicates that brook trout meat may be considered a high-quality source of protein.

Processing of trout meat by frying preceded by flouring recorded average losses with 4.8% less than in the case of frying (without flouring).

The present study demonstrate that brook trout meat is a highly source of protein and contains essential amino acids for promoting good health.

REFERENCES

[1] Alçiçek, Z., Atar, H.H.,: The effects of salting on chemical quality of vacuum packed liquid smoked and traditional smoked rainbow trout (*Oncorhynchus mykiss Walbaum, 1792*) fillets during chilled storage. *Journal of Animal and Veterinary Advances*, 2010, 9 (22): 2778 – 2783.

[2] Beklevik G, Polat A, Ozogul F.,: Nutritional value ofsea bass (*Dicentratchus labrax*) fillets during frozen (-18ºC) storage. Turk J Vet Anim Sci., 2005, 29:891-895.

[3] Buchtova, H., Svobodova, Z., Križek, M., Vacha, F., Kocour, M.,Velišek, J.,:Fatty acid composition in intramuscular lipids of experimental scaly crossbreds in 3 year old common carp (*Cyprinus carpio L.).Acta Veterinaria Brno*, 2007, 76, S73–S81.

[4] Bud, I., Mireşan, Vioara,: Contributions concerning the quality indices appreciation in main aquatic organisms, which fall under human consumption. *AACL Bioflux* 1, 2008, p. 73 - 83.

[5] Celik, M., Gocke, M., Basusta, N., Kucukgulmez, A., Tasbozan,O., Tabakogly, S.,:Nutritional quality of rainbow trout (*Oncorhynchus mykiss*) caught from the Ataturk Dam lake in Turkey. *Journal of Muscle Foods*, 2008, 19, 1,50–61.

[6] Corser, P.I., Torres Ferrari, G., Gónzalez, E., Barboza, Y., Márquez Salas, E.,: Caracteristicas fisico-quimicas de la carne de trucha (*Oncorhynchus mykiss*). *Revista cientifica, FCV - LUZ*, 1999, Vol 9, No.1., 27 - 32.

[7] Đinović-Stojanović, Jasna, Vranić, Danijela, Trbović, D., Matekalo–Sverak, V., Spirić, D., Spirić, Aurelija,: Proximate composition and cholesterol content in comercial important freshwater fish species from Serbia. *Međunarodna konferencija i sajam tehničkih i tehnoloških dostignuća Akvakultura i ribarstvo"*. 2011, Poljoprivredni fakultet, Beograd.Zemun, Srbija.

[8] Erdem, M.E., Baki, B., Samsun, S.,: Fatty acid and amino acid compositions of cultured and wild sea bass (*Dicentrarchus labrax L., 1785*) from different regions in Turkey. *Anim Vet Advan*, 2009, 8(10):1959-1963.

[9] Fallah, A.A., Saei-Dehkordi, S.S., Nematollahi, A.,:Comparative assessment of proximate composition, physicochemical parameters, fatty acid profile and mineral content in farmed and wild rainbow trout (*Oncorhynchus mykiss*). *International Journal of Food Science & Technology*, 2011, 46, 767–773.

[10] Farmanfarmaian, A, Sun, LZ.,: Growth hormone effects on essential amino acid absorption, muscle amino acid profile, retention and nutritional requirements of striped bass hybrids. *Genet Anal Biomol*; 1999, 15:107-113.

[11] Fauconneau, B., Chmaitilly, J., Andre, Sylvie, Cardinal, M., Cornet, Josiane, Vallet, J.L., Dumont, J.P., Laroche, M.: Chemical composition and cellularity of muscle and adipose tissues. Sciences des Aliments, 1993, 13:173-187.

[12] Fauconneau, B., Alami-Durante, H., Laroche, M., Marcel, J. and Vallot, D.: Characteristics of the flesh of rainbow trout II, Physical and sensory assessment, *Aquaculture*1993b.

[13] Fauconneau, B., Alami-Durante, H., Laroche, M., Marcel, J.,Vallot, D.: Growth and meat quality relations in carp. *Aquaculture*, 1995, 129, 265–297.

[14] García-Macías, J.A., Núñez González, F.A., Chacón-Pineda, O., Alfaro-Rodríguez, Rosa, Hayde, Espinosa-Hernández, M.R.,: Calidad de canal y carne de trucha arco iris, *Oncorhynchus mykiss*Richardson, producida en el noroeste del Estado de Chihuahua. *Hidrobiológica*, 2004, 14 (1): 19-26.

[15] Ionescu, Aurelia, Zara, Margareta, Gurău, Gabriela, Aprodu, Iuliana, Vasile, Aida, Pălțânea, Elpida,:*Procesarea industrială a peştelui.* Editura Fundaţiei Universitare „Dunărea de Jos" Galaţi, 2006.

[16] Iwasaki, M., Harada, R.,: Proximate and amino acid composition of the roe and muscle of selected marine species. *J. Food Sci*., 1985, 50: 15851587.

[17] Kaya, Y., Erdem, M.E., Turan, H. Monthly differentiation in meat yield, chemical and amino acid composition of wild and cultured brown trout (*Salmo Trutta Forma Fario Linneaus*, 1758). *Turk. J. Fish. Aquat*. Sci., 2014, 14: 479486.

[18] Menoyo, D., Lopez. Bote, C.J., Diaz, A., Obach, A., Bautista, J.M.,: Impact of n-3 fatty acid chain lenght and n-3/n-6 in Atlantic salmon (*Salmo solar*) diets. *Aquaculture*, 2007, 276, 248–259.

[19] Mireşan Vioara, Cocan D., Constantinescu R., Răducu Camelia, Feştilă Iulia, Sărmas I.,: Using

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)

body size indices for selection of future rainbow trout breeding (*Oncorhynchus mykiss*, Wallbaum 1792), Editura Bulletin UASVM Animal Science and Biotehnologies, 2010.
[20] Mocanu (Creţu), Mirela, Cristea, V., Dediu, Lorena, Docan, Angela, Plăcintă, Săndiţa, Antache, Alina, Coadă, M.T.,: The biochemical evaluation of aquaculture rainbow trout meat, in condition of probitics administration. *Lucrări ştiinţifice. Seria Zootehnie*, 2012.
[21] Novikov, D., Dieuaide-Noubhani, M., Vermeesch, JR., Fournier, B., Mannaerts, G.P., Van Veldhoven, P.P.,: The human peroxisomal multifunctional protein involved in bile acid synthesis: activity measurement, deficiency in Zellweger syndrome and chromosome mapping, *BBA-Mol Basis Dis*, 1997, 360:229. 240.
[22] Osibona, A.O., Kusemiju, K., Akande, G.R.,: Fatty acid composition and Amino acid profile of two freshwater species, African cat fish (*Clarias gariepinus*) and tilapia (*Tilapia zillii*). *Afri. J. Food Agri Nut Develop*, 2009, 9(1):608. 621.
[23] Pariser, E.R., Wallerstein, M.,: Fish protein concentrate: Lessons for future food supplementation. *Food Policy*, 1980, 5:298. 305.
[24] Plavša, N., Baltić, M., Sinovec, Z., Jovanović, B., Kulišić, B.,Petrović, J.,: Uticaj ishrane obrocima različitog sastava na kvalitet mesa kalifornijske pastrmke (*Oncorhynchusmykiss* Walbaum). Savremeno ribarstvo Jugoslavije-monografija, radovi saopšteni na IV *Jugoslovenskom simpozijumu "Ribarstvo Jugoslavije*"-Vrašac, 2000, Beograd.
[25] Sabetian, Mryam, Somayeh, Torabi, Delshad Sohrab, M., Houmani, R.I., Abbasali, M.,: Identification of Fatty Acid Content, Amino Acid Profile and Proximate Composition in Rainbow Trout. *Journal of American Science*, 2012, 8(4).
[26]Savić, N., Mikavica, D., Grujić, R., Bojanić, V., Vučić, G,Mandić, Snježana, Đurica, R.,: Hemijski sastav mesa dužičaste pastrmke (Oncorhynchus mykiss Wal.) iz ribnjaka Gornji Ribnik. *Tehnologija mesa*, 2004, 45, 1–2,45–49
[27] Segal, Rodica,:*Principiile nutriţiei*. Editura Academica, 2002, Galaţi.
[28] Shirai, N., Terayama, M., Takeda, H.,: Effect of season on the fatty acid composition and free amino acid content of the sardine (*Sardinops melanostictus)*. *Comp Biochem Phys B*, 2002, 131:387. 393.
[29] Simeanu Cristina, Păsărin B., Simeanu D., The study of some morphological characteristics of the sturgeon species of *Polyodon spathula* in different development stages. Lucrări Ştiinţifice, seria Zootehnie, 2010 vol. 54(15)," Iaşi, page 244-247.
[30] Simeanu, Cristina Simeanu D., Păsărin B.,:Technological features of meat gathered from *Polyodon spathula* sturgeon breed, Lucrări Ştiinţifice-Seria Zootehnie, 2013,vol. 60: 209-215.
[31] Simeanu D., Creangă Șt., Simeanu Cristina: Research on the meat quality produced by *Polyodon Spathula* sturgeons' species related to human nutritional requirements. *Research Journal of Biotechnology*,2015,Vol. 10 (6) June, pp. 36-43.
[32] Simeanu Cristina, Simeanu D., Popa Anca, Usturoi Al., Bodescu D., Dolis M.G.,: Research Regarding Content in Amino-acids and Biological Value of Proteins from *Polyodon spathula* Sturgeon Meat. *Revista de chimie*, 2017, vol. 68, no. 5, pp. 1063-1069.
[33] Sirakov, I.,: Flesh quality in rainbow trout (*Oncorhynchus mykiss W.)* and brown trout (*Salmo truttam. fario L.)* cultivated in recirculation aquaculture system. *Int.J.Curr.Microbiol.App.Sci*2015, 4(1): 50-57.
[34] Solvik, S.L., Rustad, T.,: Effect of season and fishing ground on the activity of lipases in byproducts from cod (*Gadus morhua*). *LWT–Food. Sci. Technol*., 2005, 38:867. 876.
[35] Tocher, D.R., Bell, J.G., McGhee, F., Dick, J.R., Fonseca-Madrigal, J.,: Effects of dietary lipid level and vegetable oil on fatty acid metabolism in Atlantic salmon (*Salmo salar L.)* over the whole production cycle. *Fish Physiol Biochem*, 2003, 29:193. 209.
[36] Toppe, J., Albrektsen, S., Hope, B., Aksnes, A.: Chemical composition, mineral content and amino acid and lipid profiles in bones from various fish species. *Comp Biochem Phys B*, 2007, 146:395. 401
[37] Vranić, Danijela, Trbović, D., Đinović-Stojanović, Jasna, Teodorović, V., Spirić, Aurelija, Milijašević, M., Petronijević, R.,:Mlađ i konzumna kalifornijska pastrmka (*Oncorhynchus Mykiss*): hemijski i masnokiselinski sastav. 14. Međunarodni simpozijum tehnologije hrane za životinje. 12. *Međunarodni simpozijum"NODA*", Novi Sad, Zbornik radova, 2010, 51–57.
[38] Vranić, Danijela, Đinović-Stojanović, Jasna, Spirić, Aurelija,:Rainbow trout (*Oncorhynchus Mykiss*) from aquaculture. meat quality and importance in the diet. *International 56th Meat Industry Conference*, Beograd, 2011, p. 122-133.
[39] Wang X., Han Y.,: Comparison of the proximate composition, amino acid composition and growth-related muscle gene expression in diploid and triploid rainbow trout (*Oncorhynchus mykiss)* muscles. *J. Elem*., 2017, 22(4): 1179-1191.
*** SR EN ISO 13903/2005 - Nutreţuri. Determinarea conţinutului de aminoacizi.
*** SR ISO 1443:2008 - Carne şi produse din carne. Determinarea conţinutului de grăsime totală.
*** SR ISO 936:2009 - Carne şi produse din carne. Determinarea cenuşii totale.
*** SR ISO 1442:2010 - Carne şi produse din carne. Determinarea umidităţii. Metoda de referinţă.
*** 2019 – Official methods of analysis of the OAIC International, 21st Edition, Association of Official Analytical Chemists, Washington DC, USA.

Article licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (http://creativecommons.org/licenses/by-nc-sa/4.0/)