Research Regarding Mineral Content Of Rainbow Trout Meat Differentially Feed

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Abstract

Rainbow trout is one of the most spread non-native breeds at world level, being originally both from Asia and also from North America. Growing rhythm of these breeds is net superior to other trout breeds from Romania, reaching at the age of four years a weight of 400-500 g. In growing and development of fishes, environmental conditions plays a very important role, because in aquatic environment could be founded different substances necessary for a normal growing and development of organisms. Trout meat contains important quantities of minerals, which are essential for human health, those ones being influenced by a series of factors such as: breed, season, age and nutrition. From this point of view the current paper aimed to highlight the way in which quality of administered feed influence the content of trout muscles in minerals. Biological material was represented by a number of 30 rainbow trout individuals of three different ages. Quantitative determinations for calcium, zinc, sodium and magnesium were realized using an atomic absorption spectrophotometer and determination of phosphorous from trout meat was realized using a spectrophotometer. At the end of research from those five analyzed minerals, the greatest values were founded in case of phosphorous (P) which were between 110.46 and 225.40 mg/kg⁻¹, on the last rank being placed zinc (Zn) with mean values which varied from 0.74 to 0.99 mg/kg⁻¹.

Keywords: meat, musculature, minerals, rainbow trout

INTRODUCTION

Fish meat always represented a basic product in human nutrition, assuring over 15% from the total of proteins consumed by humans. During mankind evolution, fish contributed in a considerable way to assure the necessary for animal protein. Together with other animal origin products, fish meat have a high nutritional value, being very often utilized in human nutrition, being at the same time a source of raw materials for other economical activities (Bulancea *et al.*, 2009; Macovei, 2008; Banu *et al.*, 2007).

Rainbow trout is one of the most spread non-native breeds at world level. This breed is originally from the affluent of Pacific Ocean both in Asia as well as in North America (Jonsson *et al.*, 1993; Păsărin, 2007; Pagu *et al.*, 2012). Growing rhythm of the breed is superior to other trout breeds from Romania, reaching at the age of four years a weight

of 400-500 g (Păsărin *et al.*, 2004; Bud *et al.*, 2007; 2010).

Knowing physical-chemical composition of fish musculature is very important because due on it could be made appreciations on general physiological state of fishes as well as on capitalization efficiency of administrated food. So physical-chemical composition is the main element based on which we could evaluate the nutritive value of fish meat (Mocanu *et al.*, 2012). Trout meat contains important quantities of minerals, which are essential for human health (Przybyl *et al.*, 1997; Ćirković *et al.*, 2002). Content of trout meat in minerals is influenced by a series of factors such as: breed, season, age and assured alimentation (Luczynska *et al.*, 2006).

In growing and development of fishes, environmental conditions play a very important role, because in aquatic environment could be found

different substances necessary for organisms' growing and development (Jara *et al.*, 1999). Also an adequate alimentation is considered a key factor for optimization of economic increase and quality of salmonid production. Diets must be formulated and presented function of fish demands. So if those demands are not fulfilled production will be compromise (Pagu, 2013).

MATERIALS AND METHODS

Biological material utilized for realization of the current paper was represented by 30 rainbow trout (*Oncorhynchus mykiss*) individuals of both sexes, but with different ages, which were reared in two trout fisheries from Neamț County. To reach the proposed goals, from the biological material which were subjected to the current study during 2013 were settled up six experimental batches L_1 , L_2 , L_3 , L_4 , L_5 and L_6 each with 5 individuals per batch, on three age categories, 2nd summer (Pc_{1+}), 3rd summer (Pc_{2+}) and 4th summer (Pc_{3+}).

During research trout from experimental batches were differentially feed, so rainbow trout from batches L_1 , L_3 , L_5 were reared in ground ponds with natural feed and also with artificial feed. Feeding of trout was manually made, with extruded granulated foddors, having a protein level between 40-45% raw protein, feed being administrated in one meal per day (10 o'clock in the morning), and the daily administrated feed, function of fish weight and water temperature, represented up to 1.2% from corporal mass of trout.

Individuals of rainbow trout from batches L_2 , L_4 , L_6 were reared in concrete ponds, consumption feed being represented by extruded granular foddors with a protein level between 40-45% raw proteins. Foddors were daily administrated in 2 meals, (at 10 am and at 16 pm). Daily quantity of administrated feed represented between 0.3 and 1.8% from the trout corporal mass. The three type of extruded granular foddors (F_1 , F_2 and F_3), utilized for nutrition of biological material were differentiated by the protein content of 42%, 40% respectively 45% (Tab. 1).

Working methods. Determination of total phosphorous concentration (P) from samples of rainbow trout meat (*Oncorhynchus mykiss*) was realized using spectrophotometer method (ISO 13730:1996; SR ISO 2294:2009). In calcinations crucibles were weighted 1 g of sample, were burnt in oven at 550°C. Over obtained ashes were added a solution of hydrochloric acid for dissolution, then filtered and marked at sign with double-distilled water 50 ml in jars. Part of each filtered solution was introduced in test tube together with vanadium-molybdenum reagent. After homogenization, solutions were leaved in repose for 10 minutes for developing of yellow coloration.

Absorbance measurement was realized using a Shimadzu UVmini-1240 spectrophotometer at a 430 nm wavelength with a control solution. Etalon curve was pointed in 5 points by preparation from standard phosphorus solution of some solutions with different phosphorus concentrations, 5, 10, 20, 30 and 40 mg/L. Phosphorous concentrations

Tab. 1. Chemical composition of utilized foddors for rainbow trout feeding

Specification	F_1	F_2	F_3
Feed batches	L_1, L_2	L_3, L_4	L_5, L_6
Granulation (mm)	4	6	8
Raw protein (%)	42.0	40.0	45.0
Lipids (%)	22.0	24.0	12.0
Raw ash (%)	5.0	5.0	-
Raw cellulose (%)	3.0	3.0	2.0
Phosphorus (%)	0.8	0.8	1.0
Calcium (%)	0.7	0.7	-
Sodium (%)	0.2	0.2	-
Iron (mg/ kg)	40.0	40.0	-
Zinc (mg/ kg)	90.0	90.0	-
Copper (mg/ kg)	5.0	5.0	6.0

expressed g/kg DM, were calculated function of sample weighted mass and realized dilutions.

Quantitative determinations of calcium (Ca), zinc (Zn), sodium (Na) and magnesium (Mg), were realized by atomic absorption spectrophotometer with thermal and electro-thermal atomization, using a Shimadzu AA-6300 atomic absorption spectrophotometer, in according with SR EN 14082:2003 and STAS 10542:1-86.

Rainbow trout meat samples had the same stages of weighting, burning, solubilisation, and filtration and quoted at sign in special glasses like at phosphorous determination method. A quantity from filtered solution was diluted in double-distilled water and after that was added a buffer solution and a 6M hydrochloric acid.

Working method consists in calcinations of meat samples at 550°C, dissolution, precipitation, filtration and dilution of samples at a desired volume, followed by aspiration in the air-acetylene flame of atomic absorption spectrophotometer.

Spectrophotometer is adjusted at a wave length of 285.2 nm, is successively spraying etalon-solutions, sample solution and control solution, washing the device with the next solution which will be measured; the operation is three times repeated. It is represented the calibration curve putting on Y-scale mean adsorbents and on X-scale concentration corresponding for each mineral in µg/ml. Burning of trout meat samples were made in an electric oven at +550°C.

Into a porcelain crucible, previous adjusted at a constant weight, were measured a quantity of around 2 g from analyzed sample. Crucible with sample was burned on a gas bulb flame till a complete carbonization of sample, after that was introduced in calcinations oven at a temperature of +550°C, where was kept for 4-5 hours. Was took off the oven, chilled in desiccators, and weighted at analytical balance. Crucible with sample was reintroduced in oven for 1-1½ hours, at the same temperatures, operations repeating till a constant weight (Vacaru-Opriş *et al.*, 1994; Cucu, 2009; SR ISO 936:2009).

Relation for calculus:

$$\% \text{ Ash} = (m_1 - m_2) / m \times \frac{(m_1 - m_2)}{m} \times 100$$

where: m_1 = mass of crucible with ash (g);
 m_2 = mass of empty crucible (g);
 m = mass of analyzed product (g).

The obtained data were statistical processed, calculating: arithmetic mean, variance, standard mean deviation, variability coefficient, and difference signification was establish with Fischer test.

RESULTS AND DISCUSSION

The obtained data regarding corporal mass of studied rainbow trout individuals didn't show the existence of significant statistical differences between batches, the obtained mean values being presented in *Table 2*.

The obtained results following weighting of 2nd summer rainbow trout individuals highlight small differences between batches L_1 and L_2 , obtained mean values being of 172.57 ± 7.20 g respectively of 165.33 ± 6.49 g. Also inside each batch it is a high homogeneity, variation coefficient V% having values situated under 10% in both cases. At rainbow trout individuals Pc_{2+} , obtained mean values after weighting were 264.01 ± 6.54 g at batch L_3 and 249.53 ± 6.80 g at rainbow trout individuals from batch L_4 . Analyzed character was homogenous, obtained values for variation coefficient being in both cases smaller than 10% (V%=5.54 and 6.09). Weightings effectuated on rainbow trout individuals of 4th summer enlightened mean values of 480.06 ± 31.71 g for batch L_5 and 472.40 ± 17.62 g for batch L_6 . Analyzed character had a high homogeneity at batch L_6 and was less homogenous in the case of individuals from batch L_5 , case in which the value of variation coefficient was 14.77%. Analysis on corporal mass on rainbow trout individuals from all six batches highlighted the fact that the highest mean values for this character was recorded for rainbow trout reared in ground ponds, which were feed with natural and artificial food.

Content in phosphorous (P), calcium (Ca), magnesium (Mg), sodium (Na) and zinc (Zn) from rainbow trout meat is expressed in mg/kg⁻¹ from wet weight of rainbow trout meat. Phosphorous was founded with very significant statistical differences between L_1 and L_2 , respectively between L_5 and L_6 and non-significant between L_3 and L_4 (*Tab. 3*).

In according with data from table 3 content in phosphorous was between 110.46 ± 3.76 and 188.35 ± 5.58 mg/kg⁻¹, as were recorded for 2nd summer rainbow trout, 197.42 ± 6.50 and 206.52 ± 6.31 mg/kg⁻¹ for individuals of 3rd

Tab. 2. Mean corporal mass (g) and signification between the mean of studied batches

Specification	Experimental batches	n	$\bar{X} \pm s_{\bar{X}}$ (g)	V%	Min. (g)	Max. (g)
Pc ₁₊	L ₁	5	172.57±7.20	9.33	153.29	190.04
	L ₂	5	165.33±6.49	8.78	149.07	181.39
Signification between batches' mean			L ₁ vs. L ₂ = n.s.; F(0.5578) < F α (5.3176) for 1:8 GL			
Pc ₂₊	L ₃	5	264.01±6.54	5.54	249.17	282.81
	L ₄	5	249.53±6.80	6.09	229.31	268.14
Signification between batches' mean			L ₃ vs. L ₄ = n.s.; F(2.3524) < F α (5.3176) for 1:8 GL			
Pc ₃₊	L ₅	5	480.06±31.71	14.77	405.45	574.09
	L ₆	5	472.40±17.62	8.38	418.50	516.72
Signification between batches' mean			L ₅ vs. L ₆ = n.s.; F(0.0445) < F α (5.3176) for 1:8 GL			

Tab. 3. Rainbow trout meat content in phosphorous

Specification	Experimental batches	n	$\bar{X} \pm s_{\bar{X}}$ (mg/kg ⁻¹)	V%	Min. (mg/kg ⁻¹)	Max. (mg/kg ⁻¹)
Pc ₁₊	L ₁	5	110.46±3.76	7.61	101.50	121.54
	L ₂	5	188.35±5.58	6.62	174.11	205.41
Signification between batches' mean			L ₁ vs. L ₂ = ***; F(134.1069) > F α (25.4147) for 1:8 GL			
Pc ₂₊	L ₃	5	197.42±6.50	7.36	185.41	222.11
	L ₄	5	206.52±6.31	6.84	187.45	223.43
Signification between batches' mean			L ₃ vs. L ₄ = n.s.; F(1.0077) < F α (5.3176) for 1:8 GL			
Pc ₃₊	L ₅	5	194.04±2.30	2.66	187.42	201.74
	L ₆	5	225.40±3.19	3.16	215.49	232.45
Signification between batches' mean			L ₅ vs. L ₆ = ***; F(63.5747) > F α (25.4147) for 1:8 GL			

Tab. 4. Content of rainbow trout meat in calcium

Specification	Experimental batches	n	$\bar{X} \pm s_{\bar{X}}$ (mg/kg ⁻¹)	V%	Min. (mg/kg ⁻¹)	Max. (mg/kg ⁻¹)
Pc ₁₊	L ₁	5	26.28±1.95	16.56	19.89	32.14
	L ₂	5	34.43±1.61	10.45	29.85	39.14
Signification between batches' mean			L ₁ vs. L ₂ = *; F(10.4102) > F α (5.3176) for 1:8 GL			
Pc ₂₊	L ₃	5	28.68±0.92	7.14	25.45	31.14
	L ₄	5	35.49±1.74	10.97	31.89	41.45
Signification between batches' mean			L ₃ vs. L ₄ = **; F(11.9585) > F α (11.2586) for 1:8 GL			
Pc ₃₊	L ₅	5	36.19±1.59	9.82	31.11	41.10
	L ₆	5	40.02±1.42	7.93	34.89	43.11
Signification between batches' mean			L ₅ vs. L ₆ = n.s.; F(3.2369) < F α (5.3176) for 1:8 GL			

summer respectively between 194.04±2.30 and 225.40±3.19 mg/kg⁻¹, for rainbow trout individuals of 4th summer. The greatest values obtained for phosphorous were recorded for rainbow trout batches reared in concrete ponds, which were feed with extruded granulated fodders with a protein level between 40-45% raw proteins into two daily meals. Studied character (phosphorous)

was homogenous, obtained values for variation coefficient oscillated between 2.66 and 7.61 %. In our research determinations effectuated on calcium content in musculature of rainbow trout revealed significant statistical differences between batches L₁ and L₂, distinct significant between batches L₃ and L₄, respectively insignificant between batches L₅ and L₆ (Tab. 4).

Tab. 5. Content of rainbow trout meat in magnesium

Specification	Experimental batches	n	$\bar{X} \pm s_{\bar{X}}$ (mg/kg ⁻¹)	V%	Min. (mg/kg ⁻¹)	Max. (mg/kg ⁻¹)
Pc ₁₊	L ₁	5	17.36±1.12	14.45	15.44	21.14
	L ₂	5	13.76±0.59	9.58	11.74	15.18
Signification between batches' mean			L ₁ vs. L ₂ = *; F(8.0741) > F α (5.3176) pt. 1:8 GL			
Pc ₂₊	L ₃	5	18.87±0.77	9.08	16.89	21.14
	L ₄	5	15.19±0.44	6.48	14.11	16.78
Signification between batches' mean			L ₃ vs. L ₄ = **; F(17.2810) > F α (11.2586) pt. 1:8 GL			
Pc ₃₊	L ₅	5	16.65±0.50	6.75	15.78	18.60
	L ₆	5	17.12±0.86	11.25	14.11	19.02
Signification between batches' mean			L ₅ vs. L ₆ = n.s.; F(0.2238) < F α (5.3176) pt. 1:8 GL			

Tab. 6. Content of rainbow trout meat in sodium

Specification	Experimental batches	n	$\bar{X} \pm s_{\bar{X}}$ (mg/kg ⁻¹)	V%	Min. (mg/kg ⁻¹)	Max. (mg/kg ⁻¹)
Pc ₁₊	L ₁	5	12.24±1.33	24.21	9.89	17.41
	L ₂	5	8.83±0.24	6.11	7.89	9.25
Signification between batches' mean			L ₁ vs. L ₂ = *; F(6.4143) > F α (5.3176) for 1:8 GL			
Pc ₂₊	L ₃	5	11.38±0.40	7.86	10.35	12.78
	L ₄	5	9.56±0.23	5.44	8.78	10.21
Signification between batches' mean			L ₃ vs. L ₄ = **; F(15.3780) > F α (11.2586) for 1:8 GL			
Pc ₃₊	L ₅	5	9.34±0.68	16.36	8.11	11.85
	L ₆	5	8.97±0.37	9.27	7.78	10.12
Signification between batches' mean			L ₅ vs. L ₆ = n.s.; F(0.2260) < F α (5.3176) for 1:8 GL			

Tab. 7. Content of rainbow trout meat in zinc

Specification	Experimental batches	n	$\bar{X} \pm s_{\bar{X}}$ (mg/kg ⁻¹)	V%	Min. (mg/kg ⁻¹)	Max. (mg/kg ⁻¹)
Pc ₁₊	L ₁	5	0.74±0.02	5.02	0.69	0.79
	L ₂	5	0.92±0.04	8.59	0.78	0.97
Signification between batches' mean			L ₁ vs. L ₂ = **; F(21.7349) > F α (11.2586) for 1:8 GL			
Pc ₂₊	L ₃	5	0.78±0.04	10.44	0.65	0.85
	L ₄	5	0.83±0.05	12.92	0.66	0.95
Signification between batches' mean			L ₃ vs. L ₄ = n.s.; F(0.6340) < F α (5.3176) for 1:8 GL			
Pc ₃₊	L ₅	5	0.76±0.06	16.83	0.55	0.89
	L ₆	5	0.99±0.05	10.38	0.87	1.14
Signification between batches' mean			L ₅ vs. L ₆ = *; F(9.4564) > F α (5.3176) for 1:8 GL			

Mean values obtained for batches L₁ and L₂ were of 26.28 and 34.43 mg/kg⁻¹, for batches L₃ and L₄ 28.68 and 35.49 mg/kg⁻¹, and for 4th summer individuals from batches L₅ and L₆ the recorded mean values were 36.19 respectively 40.02 mg/kg⁻¹. For calcium content in rainbow trout meat effectuated research show a high

homogeneity of character for batches L₃, L₅ and L₆, values of variation coefficient being under 10%, respectively a mean homogeneity for individuals from batches L₁, L₂, L₄, where the values of variability coefficient passed the limit of 10%. Statistical differences recorded for magnesium content were insignificant between batches L₅ and

L_6 , significant between batches L_1 and L_2 , the ones recorded between batches L_3 and L_4 was distinct significant (Tab. 5).

Regarding magnesium content of rainbow trout meat, this was situated between 13.76 ± 0.59 and 17.36 ± 1.12 mg/kg⁻¹ for individuals of 2nd summer, between 15.19 ± 0.44 and 18.87 ± 0.77 mg/kg⁻¹ for individuals of 3rd summer, respectively between 16.65 ± 0.50 and 17.12 ± 0.86 mg/kg⁻¹ for individuals of 4th summer. Studied character was homogenous inside batches L_2 , L_3 , L_4 and L_5 , case in which value of variation coefficient didn't pass the value of 10%, which indicate a high homogeneity inside those batches and for batches L_1 and L_6 variation coefficient over-passed the limit of 10% which show a medium homogeneity. At the end of determination of rainbow trout meat in sodium content for all those six experimental batches, the recorded statistical differences were significant between L_1 and L_2 , distinct significant between L_3 and L_4 , respectively insignificant between L_5 and L_6 (Tab. 6) Obtained mean values for this parameter were between 8.83 ± 0.24 mg/kg⁻¹, recorded at batch L_1 and 12.24 ± 1.33 mg/kg⁻¹ recorded at batch L_2 . The highest mean values were recorded at rainbow trout individuals reared in concrete ponds, feed with extruded granulated fodders with a protein level between 40-45% raw proteins in two daily meals, in comparison with the results obtained for rainbow trout individuals reared in ground ponds, which were smaller.

Obtained value for variation coefficient at batch L_1 passed 20%, indicated a low homogeneity inside this batch, for batch L_5 value of variation coefficient was 16.36%, which indicates an average homogeneity for this batch. Comparing from statistical point of view the data obtained for zinc content in rainbow trout meat were enlightened statistical distinct significant differences between L_1 and L_2 , insignificant between L_3 and L_4 , respectively significant between L_5 and L_6 (Tab. 7).

Zinc (Zn) was ranked last from the concentration point of view, with reduced values which didn't passed 0.92 mg/kg⁻¹ at rainbow trout individuals of 2nd summer, 0.83 mg/kg⁻¹ at rainbow trout individuals of 3rd summer, respectively 0.99 mg/kg⁻¹ at rainbow trout individuals of 4th summer. Variation coefficient was specific, both for a high homogeneity (batches L_1 and L_2), also for a medium homogeneity (batches L_3 , L_4 , L_5 and L_6).

CONCLUSION

The current paper highlight the fact that mineral content in rainbow trout meat is higher at individuals reared in concrete ponds, which were feed with extruded granulated fodders with a protein level between 40-45% raw protein in two daily meals which represented up to 1.8% from corporal mass of trout, in comparison with the rainbow trout individuals reared in ground ponds feed with natural food and also with extruded granulated fodders with a protein level between 40 and 45% raw protein, in a single daily meal which represented up to 1.2% from corporal mass of trout. At the end of the study from those five analyzed minerals, the highest mean values were founded in case of phosphorous (P), which were between 110.46 and 225.40 mg/kg⁻¹, and ranking last was zinc (Zn) with mean values which varied between 0.74 and 0.99 mg/kg⁻¹.

Mean content of mineral substances in analyzed rainbow trout meat was of 1.1-1.2%, trout meat being considered an important source of phosphorous and calcium.

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