Biochemical Composition of Indigenous and Imported Trout and Salmon

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Abstract
As wild fish are a finite resource, the role of aquaculture in providing the necessary fish per capita is becoming increasingly important.
Atlantic salmon (*Salmo salar*) and rainbow trout *(Oncorhynchus mykiss*) are species of interest to Romanians, rich in omega-3 polyunsaturated fats and a good source of protein, while being low in calories and saturated fats.
The purpose of this study was to examine and compare the biochemical composition, respectively the nutritional value, of Atlantic salmon and rainbow trout obtained from Romanian aquaculture and from import, that can be found on the Romanian market.
The results of this study confirm similarities regarding the biochemical composition of salmon obtained in Romanian aquaculture with wild Atlantic salmon.
Rainbow trout bred in trout farms in different areas in our country, can be considered a valuable food source for human consumption.

Keywords: biochemical composition, *Oncorhynchus mykiss*, *Salmo salar*

1. Introduction

Consumer interest in foods with health benefits has increased. As wild fish are a finite resource, the role of aquaculture in providing the necessary fish per capita is becoming increasingly important.
Atlantic salmon (Salmo salar) and rainbow trout (*Oncorhynchus mykiss*) are species of interest to Romanians, rich in omega-3 polyunsaturated fats and a good source of protein, while being low in calories and saturated fats.
Salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*) are part of the salmonid family (*Salmonidae*) and are fish of great economic value.

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Trout is a fresh water fish, while salmon is anadromous (which lives in the sea, but during reproduction migrates in fresh waters).
The purpose of this study was to examine and compare the biochemical composition, respectively the nutritional value, of Atlantic salmon and rainbow trout obtained from Romanian aquaculture and from import, that can be found on the Romanian market.
This study provides valuable information about the biochemical composition, respectively the nutritional value of the fish for consumption, enabling the consumer to make informed choices, and producers to improve technologies in order to obtain quality and safe products for the consumer.

2. Materials and methods

Depending on the origin, indigenous or import, two batches of salmon (*Salmo salar*) and two

batches of rainbow trout (*Oncorhynchus mykiss*) were analyzed.

Farmer H 111, NT 167, ST 423 type import salmon, was delivered refrigerated from Norway. It was transported in heat-sealed bags and stored in thermal insulation boxes filled with ice.

Indigenous salmon was obtained from an embryonic spawning sturgeon fish farm purchased from Norway. Norway being one of the largest producers of salmon has regulations regarding the use of antibiotics in sturgeon breeding in aquaculture [1], this being a matter of interest.

Frozen imported trout was selected from the options available in grocery stores, the supplier being a farm in Turkey.

The analyzed indigenous trout was represented by trout grown in recirculating system in a lowland area of SE Romania and trout grown in land basins in a trout farm located in NE Romania, in the Bistrița River Basin, fed by its tributaries.

The water analysis was carried out according to the work protocols established in the standard methods of surface water analysis [2].

The analysis of meat samples was performed using the procedures indicated by the standard methods of analysis of fish meat.

To control the concentration of ABVT (nitrogen content of volatile nitrogenous bases), the distillation of deproteinized extract by perchloric acid was used as a reference method.

The moisture was determined by Standard Official Methods of the AOAC (1990).

The total ash was determined by Furnace Incineration described by AOAC (1990).

The crude proteins content of the samples was determined using the Kjeldahl method of AOAC 17th edition, 2000, Official Method 928.08 Nitrogen in Meat (Alternative II), which involved protein digestion and distillation, where F (conversion factor), is equivalent to 6.25.

The total fats were determined using the Soxhlet method, equipped with Gerhardt Brand Multistate Controller, with modified ether extraction methods AOAC 960.39.

Statistical analysis

All analyses were performed in triplicate from the average sample. Data are presented as mean ± standard deviation (SD). Comparison of several samples was done using the ANOVA test - Single factor followed by T test. Significance was defined as $p<0.05$.

3. Results and discussion

Physico-chemical analyses of water

Water quality is an important factor affecting the health and performance of fish in aquaculture production systems.

The power supply for the recirculating salmon and trout farming system is a drilled well. The analysis of water physico-chemical parameters in the supply source can be found in table 1 and demonstrates much higher values than the allowed values for hardness, alkalinity but especially of chlorides which are approximately 20 times higher than the allowed limits. These values are explained by the presence of a saline and alkaline soil, characteristic of the area where the farm is located. These exceeded values were favorable to the growth of salmon, being an anadromous fish.

From a physico-chemical point of view, the water source for trout reared in soil basins supplied with river water, corresponds to the physiological needs of the species (Table 1).

The biochemical composition

Freezing and refrigeration are operations that extend the fish shelf life. For fish imported frozen (trout) or chilled (salmon), the freshness has been verified by analysis of volatile compounds such as trimethylamine and easily hydrolyzable nitrogen, products formed as a result of the destructive activities of microorganisms and are considered freshness indicators for quality monitoring of aquatic products (Table 2).

The imported specimens were subjected to laboratory examination to control the parameters that characterize the freshness according to ORDER no. 329 of July 25, 2002 of the Minister of Agriculture, Food and Forests for approval of the Veterinary Sanitary Norm on veterinary sanitary conditions for production and marketing of fishery products. The values obtained for these parameters are in accordance with the species and legal provisions in force and in accordance with the national procedure. According to the Decision of the European Commission (95/149 / EC) and Commission Regulation (EC) No 2074/2005 and STAS 9736-85/A1: 1997, the maximum permissible value of easily hydrolysable nitrogen for frozen fish (*Salmo salar*) is 35 mg nitrogen/100 g frozen ocean fish.

Table 1. The values of the physico-chemical parameters of the water in the supply source for the growth of salmon and trout

Analyzed parameters	U.M.	Water source for salmon and trout reared in recirculating system	Water source for trout reared in soil ponds	Acording Bud. I., 2007 for salmonids		Maximum values allowed according to Order no. 161/2006 for the second quality class	Maximum values allowed by the specialized literature
				Average	Limits		
Dissolved oxygen	mg/l	6.63±0.85	7.45±1.65	11	3–20	10	15
pH	uPh	7.50±1.11	7.34±1.30	7.5	7–8	6.5-8.5	
Ammonia	mg/l	0.01±0.002	0.005±0.002	<0.5	-	-	0.2
Amonium, ($N\text{-}NH^{4+}$)	mg/l	0.35±0.12	0.15±0.08			2	-
Nitrites, ($N\text{-}NO_2$)	mg/l	0.015±0.002	0.022±0.003	<1	-	0.03	-
Nitrates, ($N\text{-}NO_3$)	mg/l	0.25±0.025	0.10±0.025	<0.5	-	3	-
Total hardness	dGH	32.44±1.65	9.7±1.95	10	8–16	-	20
Alkalinity	ml	15.53±1.15	1.95±0.5	-	-	-	6
Bicarbonates (HCO_3^-)	mg/l	265.22±13.10	122.2±15.0	-	-	-	600
Carbonates (CO_3^{2-})	mg/l	Not present	Not present	-	-	-	20
Calcium (Ca^{2+})	mg/l	128.32±5.25	26.7±2.40	-	-	100	160
Magnesium (Mg^{2+})	mg/l	98.12±3.45	3.50±1.4	0.8	0.6–1.0	50	50
Ca^{2+}/Mg^{2+}		1.30±0.6	7.62±2.01	-	-	-	5
Chloride (Cl^-)	mg/l	918.5±10.33	0.53±0.02	<5.0	-	50	40

Table 2. Chemical parameters that describe the freshness of imported salmon and trout

Biochemical parameters	UM	Reference standard	Farm salmon, imported from Norway	Farm trout, imported from Turkey
TVB-N Total volatile basic nitrogen	mg/100g	STAS 6513–78, Ord. MAAP 191/20010.45	14.59±1.07	10.23±0.98
TMA-N Trimethylamine nitrogen	mg/100g	STAS 6513-78	0.24±0.09	0.15±0.03

The specimens selected for biochemical analysis have similar weights so that the results can be comparable.

Fish is one of the most valuable sources of high quality protein available to man, therefore a profile of its composition is essential for the consumer.

Fish protein is an easily digestible protein with a high biological value and contains all the essential amino acids in the required proportion. In addition, fish protein is rich in nonprotein amino acids (taurine), which has a unique role in neurotransmission.

The amount of protein in salmon reared in recirculating system in Romania is 2.52 g% higher compared to the amount of protein identified in imported salmon (Table 3).

The protein content of salmon reared in Romanian aquaculture (19.86±0.54 g%) is significantly higher than the protein of salmon fed diets in which fishmeal has been replaced with vegetable proteins [3].

The fat content of salmon reared in recirculating system in Romania differs greatly (6.89 g%) compared to the fat content identified for imported salmon, the latter being 3.11 times fatter (Table 3). Salmon reared in Romania had a lower lipid concentration (3.26±0.18 g%) than farm salmon (16.6%) and higher than wild salmon (6.4%) analyzed by M. Coreen et al. 2005 [4].

The biochemical composition of salmon obtained in Romanian aquaculture is similar to that of wild Atlantic salmon [5].

As the fat content increases, the water content decreases and vice versa. The sum of the two components (moisture and fat) is quite constant at about 80%. The energy value of salmon reared in Recirculating Aquaculture Systems (RAS) - Romania is lower, the product can be used in low calorie diets.

Table 3. The composition of farmed salmon from Romania and imported farmed salmon

Biochemical parameters	Salmon indigenous reared in RAS (5 samples)	Salmon of import (Norvegia) (5 samples)
Weight, (g)	0.980±0.32	1,156±0,28
Moisture, (g%)	75.71±0.35	71.55±0.45
Proteins, (g%)	19.86±0.54	17.34±0.15
Fats, (g%)	3.26±0.18	10.15±0.57
Ash (g%)	0.975±0.03	0.81±0.21
M/P	3.81±0.13	4.31
Energy value** kcal/100g	111.74	165.48

*M/P=Moisture, (g%)/ Proteins, (g%)

**calories conversion factors used; for proteins 4.1 kcal/g; for lipids 9.3 kcal/g; for carbohydrates 4.1 kcal/g

After the moisture, protein and fat content, the next constituent of fish meat is ash. Fish meat is a good source of minerals, being bio available, which means that they are easily assimilated by the human body. The amount of ash is similar for all analyzed specimens regardless of origin.

The salmon specimens obtained in Romanian RAS have similar fat concentrations to those identified by Stefanie Colombo and Mazal, in 2020, analysing specimens of wild salmon from the Pacific [6].

Fish fat provides much of the energy and essential fatty acids for human diets [7].

Data referring to the biochemical composition of imported and indigenous trout are presented in table 2. The results clearly indicate that there are no variations of the main biochemical constituents.

The maximum moisture content of 76.98% was found in imported trout, but the differences are insignificant ($p>0.05$) between imported and indigenous trout. The values are similar to those identified by Imtiaz et al., 2020, studying the influence of protein diets on the biochemical composition of rainbow trout, *Oncorhynchus mykiss* grown in the Himalayan Indian region [8].

It was found that the protein content varied from 18.05±0.25 g% for imported trout, to 18.65±0.52 g% for trout reared in soil ponds and to 18.89±0.75 g% for trout reared in RAS, the differences being insignificant ($p>0.05$) between imported and indigenous trout. All three values are significantly lower than the protein concentration in trout meat reared in a tropical area [9].

The ratio between humidity and protein concentration has a lower value for salmon reared in RAS, which highlights a better state of maintenance and a high nutritional value [10].

The highest fat content of 3.54±0.25 g% and 3.55±0.25 g% was observed for indigenous trout reared in RAS and imported trout, while for trout reared in soil basin the value was 3.05±0.23 g%, the differences between the analysed samples being insignificant ($p>0.05$), but significantly smaller than the trout reared in a tropical area (5.46-8.70) [9].

Table 4. The composition of trout farmed in Romania and imported farmed trout

Biochemical parameters	Indigenous trout		Import trout (5 samples)
	RAS (5 samples)	Soil basin (5 samples)	
Weight, (g)	0.31±0.95	0.28±0.85	0,24±0.95
Moisture, (g%)	76.50±0.41	76.86±0.95	76.90±0.65
Proteins, (g%)	18.89±0.75	18.65±0.52	18,05±0.25
Fats, (g%)	3.54±0.25	3.05±0.23	3.55±0.25
Ash (g%)	1.13±0.03	1.35±0.15	1.37±0.21
M/P*	3.97±0.19	4.12±0.41	4.26±0.2
Energy value (kcal/100g)	110.32	104.83	107.02

*M/P=Moisture, (g%)/ Proteins, (g%)

**calories conversion factors used; for proteins 4.1 kcal/g; for lipids 9.3 kcal/g; for carbohydrates 4.1 kcal/g

4. Conclusions

- This study confirms similarities regarding the biochemical composition of salmon obtained in Romanian aquaculture with wild Atlantic salmon.
- Research on salmon reared in RAS Romania confirms obtaining a safe and nutritious salmon available to Romanians in a sustainable manner.
- Rainbow trout cultivated in our country, in the 2 presented variants - soil ponds supplied with river water and RAS (Recirculating Aquaculture Systems) supplied with water from a drilled well can be considered a valuable food source for human consumption.
- Research directions should focus on a better understanding of the acceptability of farmed salmon production in Romania, as well as on the metabolism, health and nutrition of farmed salmon fed on diets that improve the nutritional quality of fillets for consumers.

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