Journal of Food Quality and Hazards Control 6 (2019) 37-40

Meat Quality of Rainbow Trout (*Oncorhynchus mykiss*) and Brown Trout (*Salmo trutta fario*) Farmed in Bulgaria

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HIGHLIGHTS

- Water holding capacity of rainbow trout meat (9.49±3.86%) was better than that of brown trout meat (15.85±1.11%).
- Cooking loss in rainbow trout (31.78±6.17%) was lower than that of brown trout meat (44.48±4.20%).
- Rainbow trout meat exhibited better technological properties; however, brown trout meat nutritional value was superior.

Article type
Short communication

Keywords
Fish Products
Meat
Food Quality
Food Analysis
Bulgaria

Article history
Received: 15 Dec 2018
Revised: 19 Jan 2019
Accepted: 3 Feb 2019

Acronyms and abbreviations
WHC=Water Holding Capacity

ABSTRACT

Background: Fish meat is outlined with high nutritional value having essential amino acids, unsaturated fatty acids, mineral and vitamins. In this short report, we compared the meat quality of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) farmed in Bulgaria.
Methods: Ten fishes from each species were purchased from a fish farm and their morphological parameters were determined. The technological properties of meat were analyzed such as water holding capacity and cooking loss as well as chemical composition such as water content, protein, fat, dry matter, and ash. Results were processed by STATISTICA 6.0 software.
Results: Higher values were significantly determined in brown trout for standard body length ($p<0.05$), body height ($p<0.001$), and body width ($p<0.01$); while differences in total body length were not relevant ($p>0.05$). Water holding capacity of rainbow trout meat (9.49±3.86%) was considerably better ($p<0.001$) than that of brown trout meat (15.85±1.11%). Cooking loss in rainbow trout (31.78±6.17%) was lower ($p<0.001$) than that of brown trout meat (44.48±4.20%). Protein, fat, and dry matter contents were higher in brown trout ($p<0.001$). No statistically significant differences were found out with respect to ash content ($p>0.05$).
Conclusion: Meat of rainbow trout cultivated in Bulgarian farm exhibited better technological properties than that of cultivated brown trout; however, nutritional value of brown trout meat was superior.

Introduction

Fish meat is outlined with high nutritional value having essential amino acids, unsaturated fatty acids, mineral and vitamins. Nevertheless, it is easily spoiled due to the high pH and water activity as well as high contents of unsaturated fatty acids and free amino acids which are responsible for its susceptibility to microbial and oxida-

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To cite: Zhelyazkov G., Stratev D. (2019). Meat quality of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) farmed in Bulgaria. *Journal of Food Quality and Hazards Control*. 6: 37-40.

DOI: 10.18502/jfqhc.6.1.457 Journal website: http://www.jfqhc.com

tive degradation (Alasalvar et al., 2011).

Rainbow trout (*Oncorhynchus mykiss*) is among the most frequently farmed species in the world, as it grows rapidly, becomes easily adapted to various environmental conditions and has a high economic and nutritional value (Coşkun et al., 2016). Brown trout (*Salmo trutta fario*) is spread in Europe, North America, Africa, Asia, Australia, New Zealand, and Papua New Guinea. Brown trout is important for recreational and commercial fishing, and is also farmed in aquaculture systems (Rawat et al., 2011). The major goal of this brief report was to determine the quality of meat from rainbow trout as well as brown trout distributed in Bulgaria.

Materials and methods

Sampling

Ten samples of rainbow trout and 10 samples of brown trout were purchased from a fish farm in Bulgaria where they were fed three times a day with "Aqua garant UNI" extruded trout feed with granule size of 6 mm. Feed was produced by Garant-Tiernahrung Gesellschaft m.b.H. (Austria), and its nutritional content is presented in Table 1. The fishes were ethically euthanized at the farm based on standard guideline (Yanong et al., 2007) and transported in a cool bag at 3 °C to the lab of the Aquaculture Unit of the Trakia University, Bulgaria.

Morphological traits of rainbow trout and brown trout

Linear measurements were done by the protocol of Demchenko and Tkachenko (2017), measuring total body length (longitudo totum corporis-L), standard body length (longitudo corporis-l), body height (altitudo corporis maxima-H), body width (latitudo corporis-D), and intestinal and stomach length. Individual live body weight, carcass weight, and visceral weight were determined with precision of 0.1 g.

Technological properties of rainbow trout and brown trout meat

Fishes were filleted and technological properties of their meat were analyzed. Water Holding Capacity (WHC) was determined by the method of Balev et al. (2017). Values were expressed as percentage of released water from sample weight. Cooking losses were expressed as percentages of meat losses after cooking in an oven. The method comprised achievement of a core temperature of 76 °C in sample center for 25 min as described by Bastias et al. (2017). The hepatosomatic index and the yield were calculated according to Everaarts et al. (1993) and Bosworth et al. (2004), respectively.

Proximate analysis of rainbow trout and brown trout meat

Meat samples were prepared according to AOAC (2005; method 983.18). Water content was analyzed by drying of samples (AOAC 1995; method 950.46). Protein content was calculated using Kjeldahl assay by an automated system (Kjeltec 8400; FOSS, Sweden). Fat content was evaluated by Soxhlet extraction method using Soxtec 2050 automated system (FOSS, Sweden). Also, ash content was assessed by burning of the samples at 550 °C for 8 h in a muffle furnace (MLW, Germany).

Statistical analysis

Results were processed by STATISTICA 6.0 software (StatSoft Inc., 2002) and presented as mean and standard deviations.

Results and discussion

Data about morphological traits of both trout species are listed in Table 2. Higher values were significantly determined in brown trout for standard body length ($p<0.05$), body height ($p<0.001$), and body width ($p<0.01$); while differences in total body length were not relevant ($p>0.05$). Insignificant differences between the species were identified for intestinal length ($p>0.05$), unlike stomach length that was statistically significantly higher in brown trout ($p<0.001$). At the background of similar total body length, brown trout had considerably higher live body weight ($p<0.001$). Despite the weight differences, there were no statistically significant variations with respect to slaughter yield ($p>0.05$). Our results were comparable to those of Bermejo-Poza et al. (2015), reporting 83.6% yield and 1.64% hepatosomatic index in rainbow trout with average body weight of 353 g reared in cages located in the province of Guadalajara, Spain. Similarly, Marty-Mahé et al. (2004) found out 90% yield in brown trout weighing 3872 g on the average cultivated in cages at Camaret, France.

We found that technological properties of meat differed significantly between rainbow and brown trout. WHC of rainbow trout meat (9.49±3.86%) was considerably better ($p<0.001$) than that of brown trout meat (15.85±1.11%). Cooking loss in rainbow trout (31.78±6.17%) was lower ($p<0.001$) than that of brown trout meat (44.48±4.20%). In accordance with the present survey, Martelli et al. (2014) reported similar WHC values of meat of rainbow trout (9.74%) nourished in Trentino-Alto Adige, Italy. In rainbow trout meat originated from Lebanon, WHC, and cooking loss was 1.68 and 17.80%, respectively (El Rammouz et al., 2013). Unlike our data, Bermejo-Poza et al. (2015) demonstrated higher WHC (68.4%) in meat of

[DOI: 10.18502/jfqhc.6.1.457]

Table 1: Nutritional content in extruded feed "Aqua garant UNI"

Parameters	Manufacturer's specification
Crude protein (%)	42.00
Crude fat (%)	16.00
Crude fibre (%)	2.50
Water (%)	7.62
Lysine (%)	1.68
Methionine+cysteine (%)	2.84
Calcium (%)	1.42
Phosphorus (%)	1.40
Chlorides (%)	1.84
Metabolisable energy (MJ/kg)	18.20
Metabolisable energy (kcal/kg)	4352

-1 kg compound feed contains: vitamin A-10000 IE; vitamin D_3-1500 IE; vitamin-E-200 mg; vitamin K-3 mg; thiamine-10 mg; riboflavin-15 mg; pyridoxine-8 mg; vitamin B_{12}-0.02 mg; nicotinic acid-40 mg; folic acid-3 mg; biotin-0.3 mg
-1 kg compound feed contains: Fe-145 mg; Mn-67 mg; Cu - 16 mg; Zn-68 mg; J-1.5 mg; Co-0.5 mg; Se-0.6 mg

Table 2: Morphological traits of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) farmed in Bulgaria

Parameter	Rainbow trout (*Oncorhynchus mykiss*)	Brown trout (*Salmo truta fario*)	*P value*
Total body length (mm)	271.89±15.19	281.00±11.74	NS
Standard body length (mm)	231.11±13.18	245.50±11.65	*
Body height (mm)	28.44±3.71	38.20±4.96	***
Body width (mm)	62.11±5.95	72.50±7.89	**
Intestinal length (mm)	157.89±23.35	151.00±24.13	NS
Stomach length (mm)	30.44±5.00	61.50±10.01	***
Live body weight (g)	236.89±48.44	333.60±32.87	***
Intestinal weight (g)	9.72±3.38	21.42±3.83	***
Stomach weight (g)	8.20±3.68	11.42±6.17	NS
Liver (g)	3.35±0.56	6.09±0.61	***
Heart (g)	0.45±0.11	0.47±0.15	NS
Pancreas (g)	0.34±0.12	0.54±0.07	*
Carcass weight without viscera and gills (g)	195.33±39.62	278.70±25.40	***
Slaughter yield (%)	82.52±3.05	83.61±1.94	NS
Hepatosomatic index (%)	1.74±0.28	2.21±0.36	**

NS: non-significant; *: p<0.05; **: p<0.01; ***: p<0.001

Table 3: Proximate analysis of rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) meat farmed in Bulgaria

Parameter	Rainbow trout (*Oncorhynchus mykiss*)	Brown trout (*Salmo truta fario*)	*P value*
Water content (%)	73.80±0.08	71.25±0.13	***
Protein (%)	18.24±0.05	19.16±0.05	***
Fat (%)	6.56±0.07	8.19±0.08	***
Dry matter (%)	26.20±0.08	28.75±0.13	***
Ash (%)	1.40±0.03	1.41±0.02	NS

NS: non-significant; *: p<0.05; **: p<0.01; ***: p<0.001

rainbow trout grown in cages located in the Guadalajara province of Spain.

The water, protein, fat, dry matter, and ash contents of meat from rainbow and brown trout are presented in Table 3. Water content differed substantially with higher values in rainbow trout (p<0.001). Protein, fat, and dry matter contents were higher in brown trout (p<0.001). The water and protein levels seen in the current survey were in agreement with those reported by Souza et al. (2015); these researchers stated that water and protein contents of rainbow trout cultivated in Espírito Santo state, Brazil were 72.30 and 18.42%, respectively. Also, Marty-Mahé et al. (2004) affirmed that rainbow and brown trout meat originated from France contained 8%

[DOI: 10.18502/jfqhc.6.1.457]

fat. However, Nistor et al. (2014) reported lower dry matter content (24.79%) in rainbow trout meat in Romania than that we found. In the current survey, no statistically significant differences were found out with respect to ash content (p>0.05). In Brazil, Souza et al. (2015) observed higher ash content of rainbow trout meat (1.70%). In another research in Turkey, Yeşilayer and Genç (2013) analyzed the quality of meat in wild brown trout and established 74.80% water content, 18.1% proteins, 2.7% fats, and 1.6% mineral substances. Fish meat nutritional quality varies depending on the geographical origin, farming method, and season. Moreover, these variations may be due to different diet composition (Mairesse et al., 2006). On the other hand, genetic differences affect growth performance and feed utilization, and therefore also have influence on the fish meat quality (Martelli et al., 2014).

Conclusion

Meat of rainbow trout cultivated in Bulgarian farm exhibited better technological properties than that of cultivated brown trout; however, nutritional value of brown trout meat was superior.

Author contributions

G.Z. and D.S. contributed equally to study designing, experimental work, data analysis, and manuscript writing. Both authors read and approved the final manuscript.

Conflicts of interest

There was no conflict of interest.

Acknowledgements

The authors thank support of Bukovets fish farm, Tvarditsa, Bulgaria. This research was ethically carried out according to the local institutional review board.

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[DOI: 10.18502/jfqhc.6.1.457]