

Meat Chemical Composition and Content of Macrominerals in Common Carp (*Cyprinus Carpio L.*) and Rainbow Trout (*Oncorhynchus Mykiss W.*), Cultivated in Different Production Systems

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Abstract: The aim of the present study was to determine the chemical composition and content of macrominerals Ca, K, P, Na and Mg in the meat of common carp (*Cyprinus carpio L.*) and rainbow trout (*Oncorhynchus mykiss W.*) farmed in different production systems. The content of macrominerals was measured by atomic absorption spectrophotometry (AAS) in the Agricultural Research Laboratory of the Agricultural Faculty at the Trakia University. The differences in farming technologies did not affect the chemical composition of common carp muscles. In rainbow trout there were statistically significant differences in the chemical composition in relation to production systems. The chemical composition of rainbow trout meat differed in terms of crude protein and crude fat in both farming systems studied - in raceways and net cages. The protein content was significantly higher while crude fat content - considerably lower in the muscle of rainbow trouts grown in net cages. Carp muscle macrominerals in both cultivation techniques (in ponds and net cages) were arranged in the following order: $K > P > Ca > Na > Mg$. In rainbow trouts cultivation in raceways, macrominerals were arranged in the following descending order $P > K > Na > Mg > Ca$, while in the net cages: $K > P > Na > Mg > Ca$.

Keywords: *Cyprinus carpio*, *Oncorhynchus mykiss*, mineral content, AAS, production systems

1. Introduction

The most cultivated fish species in Bulgaria are common carp (*Cyprinus carpio L.*) and rainbow trout (*Oncorhynchus mykiss W.*), the number of cultured channel catfish and sturgeons is also increasing. Carp is grown mainly in earth ponds and rainbow trout in raceways. During the last years, the number of farms in Bulgaria practicing cultivation of these species in net cages tended to increase. The higher interest to carps and rainbow trouts is due to their rapid growth and the high nutritional value of the meat [1,2,3,4,5]. The high content of essential amino acids and protein in the meat [6] and the low fat content make it preferred for consumers. The biological value of fish meat protein is not different from that in the meat of other animals [7]. In the world, 15% of consumed animal protein originates from fish and fish products [8]. Daily protein needs of people can be satisfied with 400 g fish [7]. Fish muscles contain less connective tissue [9] compared to other farm animals (less collagen and insignificant amounts of elastin), therefore fish meat is quickly digested. The ash content of meat provides a measure of total mineral content in the tissues. Fish meat contains higher amounts of minerals, especially calcium, phosphorus, magnesium, potassium and significant amounts of vitamin D [2,10]. Studies of the minerals in living organisms are of biological importance, as many of them are involved in some metabolic processes and are essential to all living beings [11]. The muscles contain small amounts of these minerals, some of which are essential nutrients and components of many enzyme systems, contributing to the growth of the fish. The most important mineral elements are calcium, magnesium, potassium, phosphorus, iron and chlorine [12]. Their deficiency slows down blood clotting, causes a number of diseases, such as osteoporosis, anaemia, etc. [11,13,14]. The differences in the chemical composition

of the fish body are caused by factors such as age, season of catching, ambient conditions, farming technology and nutrition [15]. Fish meat has high water (60 to 80%) and low carbohydrate content under the form of glycogen [2]. Due to its high water content, this meat is more susceptible to spoilage compared to the meat of warm-blooded animals. The low fat content and the relatively low cholesterol content, as well as the significant content of minerals, vitamins and essential fatty acids make the fish one of the most valuable food products for humans [16,17,18]. The chemical composition of fish meat, apart from genetic factors, is also influenced by the quality of water, pH, temperature and feed [19,20,21,22,23]. The chemical composition of meat depends on the climate in the region of the farm and the season, although the main differences come from variations in the amount and quality of feed and activity of fish [24]. Cahu et al. [25] noted that the meat of fish from aquaculture had a higher fat content than the meat of fish from natural habitats. The fat content increased proportionally to the size and the feeding level of the fish [26,27]. Fish meat protein content is stable during the growth period [28], except for the case of deficient and unbalanced diet [29]. The protein content in fish meat varies from 12 to 24% or about 18% on average, which is similar to the protein content of mammalian meat [30].

The aim of the present study was to determine the chemical composition and content of macrominerals Ca, K, P, Na and Mg in the meat of common carp (*Cyprinus carpio L.*) and rainbow trout (*Oncorhynchus mykiss W.*) farmed in different production systems.

2. Material and methods

For performing the studies, 6 common carps (*Cyprinus carpio L.*) and 6 rainbow trouts (*Oncorhynchus mykiss W.*) were selected from each of the following farms:

- Tunja 73, Nikolaevo town – production system for carp species, grown in earthen ponds;
- Forest group, Jrebchevo Dam – net cage production system for common carp and rainbow trout farming;
- Reya Fish, Dospat Dam - net cage production system for rainbow trout farming;
- Bukovets – Tvarditsa, Tvarditsa town – production system for rainbow trout farming in raceways.

The fish were transported in a cooling bag with ice to the laboratory of the Biology and Aquaculture unit and separated according to the species. The total body length (L, cm) and live weight (Bw, g) were measured. Then the specimens were rinsed with deionized water, placed in polythene bags and stored at -20 °C until performance of tests.

The macromineral analysis (Ca, K, P, Na and Mg in mg/kg) and proximate analysis (water, dry matter, protein, fat and ash contents in %) were carried out in the Research Laboratory of the Agricultural Faculty at the Trakia University, Stara Zagora. Samples for assays were taken from the dorsal muscle of fish. Pretreatment of muscle samples of common carp (*Cyprinus carpio L.*) and rainbow trout (*Oncorhynchus mykiss W.*) was done by wet ashing in microwave oven (Perkin Elmer Multiwave 3000).

Meat samples were prepared according to AOAC (2006; method 983.18) and the following parameters were determined:

- Dry matter (%), according to BDS 11374-86;
- Moisture (%), according to BDS 11374-86;
- Content of proteins (%), according to BDS-ISO 5983;
- Content of lipids (%), according to BDS-ISO 6492;
- Mineral content (%), according to BDS 11374-86.

Macrominerals were assayed by atomic absorption spectrophotometry (AOAC, 2007) on Perkin Elmer atomic absorption spectrophotometer (AAS). The concentrations were calculated with the help of standard curves. For each element, a standard set of solutions were prepared to determine the content of each mineral in tested muscle samples. The content of Ca, K, P, Na and Mg were measured in mg/kg.

ANOVA was used for statistical analysis of data (MS Office 2010).

3. Results and Discussion

The live weight and body length of the studied species under the two production systems are given on Figure 1. Total body length (L) and body weight (BW) of common carp grown in earthen ponds and net cages and rainbow trout kept in raceways and cages were similar.

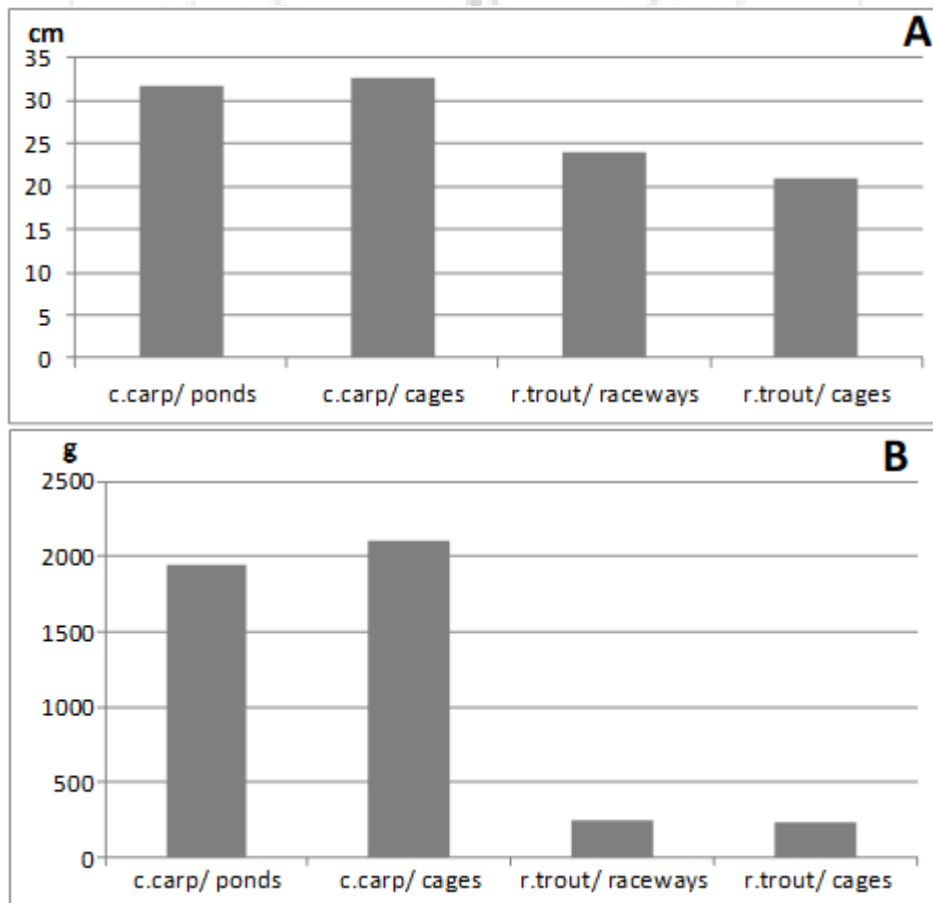


Figure 1: Measurements of the studied fish species: A) total body length (L) and B) body weight (BW)

The chemical composition of meat of studied fish species is presented in Table 1.

Table 1: Proximate analysis of fish muscle, (%)

Production systems	n	Moisture	Dry matter	Protein	Lipids	Ash
		$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$
Common carp						
ponds	6	76,16± 0,267	23,84± 0,267	17,66± 0,440	4,78± 0,188	1,39±0,014
net cages	6	76,11± 0,089	23,89± 0,089	17,15±0,133	4,74± 2,300	1,11±0,082
Rainbow trout						
raceways	6	76,69± 0,160	23,31± 0,161	16,98± 0,049 a	4,71± 0,038 b	1,36±0,016 c
net cages	6	77,14± 0,622	22,86±0,622	17,05± 0,029 a	3,94±0,094 b	1,12±0,019 c

The differences between the averages in a vertical row with the same letters are statistically significant: a-a- $p \leq 0.01$; b-b , c-c - $p \leq 0.001$.

There were no differences in the values of meat chemical indicators of carps grown in ponds and net cages. The data from carp meat proximate analysis showed that in both production technologies, the moisture, crude protein, crude fat and crude ash contents were similar. In rainbow trouts there were significant differences in meat crude protein, crude fat and crude ash contents of fish reared either in raceways or net cages. The obtained results are similar to

those found of [7] for rainbow trout meat. Rainbow trout is considered a medium oily fish with a meat lipid content of 2 to 7% [31]. Vranić et al.[7] found that the meat protein and mineral content was lower and the fat content was higher in cultivated rainbow trouts compared to Brown Trouts (*Salmo trutta fario*). Controlled conditions for fish farming imply the production of fish with the equal and constant meat chemical composition.

Meat macromineral content of the two studied fish species is presented in Table 2.

Table 2: Content of macroelements in the muscles of common carp (*Cyprinus carpio*) and rainbow trout(*Oncorhynchus mykiss*), mg/kg

Production technologies	n	Ca	K	P	Na	Mg
		$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$	$\bar{x} \pm SD$
Common carp						
Ponds	6	625,28±16,991	3446,49±19,391	2426,49±39,666	583,72±6,640	487,58±11,361
net cages	6	612,55±24,438	3629,90±13,182	2407,65±42,791	525,74±8,229	488,74±13,937
Rainbow trout						
Raceways	6	140,51±0, 187 c	2691,54±0, 543 b	2848,10±0, 388 a	662,55±0, 333 d	307,15±0,042 e
net cages	6	112,3±0,260 c	2610,01±0, 021 b	2311,38±0, 0231 a	671,07±0, 027 d	247,17±0,107 e

The differences between the averages in a vertical row with the same letters are statistically significant: a-a- $p \leq 0.05$; b-b - $p < 0.01$; c-c, d-d, e-e $p \leq 0.001$.

In carps reared in both production systems, the K content was the highest from all studied macrominerals and that of Mg - the lowest. Rainbow trout meat has the highest content of phosphorus (2848, 10 ± 0, 39 mg/kg) in raceways, but highest content of K in net cages (2610,01 ± 0, 02). In both technologies, calcium content in fish muscle was the lowest.

Authors having studied the mineral composition of fish muscle, also established various contents of mineral elements in different species of fish [12]. In our study, the content of the main elements in carp meat under both production technologies was in the following order: K> P> Ca> Na> Mg. In rainbow trouts there were differences in the content of mineral elements according to the technology of farming. In raceways, the macrominerals in descending order were P> K> Na> Mg> Ca, while in the net cages: K> P> Na> Mg> Ca.

4. Conclusions

- The chemical composition of common carp meat (*Cyprinus carpio* L.) did not differ depending on the farming technology – in earthen ponds or net cages.
- The chemical composition of rainbow trout meat (*Oncorhynchus mykiss* W.) differed in terms of crude protein and crude fat in both farming systems studied - in

raceways and net cages. The protein content was significantly higher while crude fat content - considerably lower in the muscle of rainbow trouts grown in net cages.

- In the meat of common carp cultivated in earthen ponds and in net cages, the highest content was that of potassium and the lowest - of magnesium.
- In the meat of rainbow trout in raceways, the highest content was that of phosphorus and in net cages: of potassium content. For both technologies, the lowest content in fish muscle was that of calcium.

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