Scientific Annals of Polish Society of Animal Production - Vol. 9 (2013), No 2, 57-62

The nutritional value and chemical composition of muscle tissue of carp (*Cyprinus carpio* L.) and rainbow trout *(Oncorhynchus mykiss* Walb.*)* obtained from fish farms in the Lublin region

Piotr Skałecki, Mariusz Florek, Anna Litwińczuk, Agnieszka Staszowska, Agnieszka Kaliniak

University of Life Sciences in Lublin,
Department of Commodity Science and Animal Raw Material Processing,
ul. Akademicka 13, 20-950 Lublin; skalka_p@op.pl

The aim of the work was to evaluate utility value of rainbow trout and carp as well as the nutritional value and chemical composition of their muscle tissue. The study involved 40 fishes (20 individuals of each species) caught on two farms in the Lublin Province. Rainbow trouts were characterized by a significantly higher proportion of the edible parts. Meat of rainbow trouts also contained significantly more protein and had higher calorific value as compared to the carp meat.

KEY WORDS: rainbow trout / carp / utility value / chemical composition

Polish aquaculture is based primarily on carp and rainbow trout. Production volume of both these fish species is comparable, while their average annual consumption per capita in 2011 was 0.47 kg for carp and 0.33 kg for rainbow trout [10]. Carp consumption is connected mainly with the Polish traditions of Christmas Eve and Christmas celebrations. In contrast, trout is considered as fish to be eaten year round; for this reason in recent years we have been observing increased interest in this species among consumers [5]. Economic utility of fish as food products depends on the species, quality attributes and quantitative characteristics, including nutritive value and chemical composition of their meat. The share of valuable edible parts is a significant parameter in this respect. In the case of carp merchantable specimens are those of 1 to 2 kg body weight. They are most commonly fish aged over 3 years (3+; the two- or three-year system is used), while in the case of rainbow trout they are specimens of 300 to 600 g body weight and aged over 1 year (1+). The level of fish consumption is influenced by the availability of information on their nutritive value and on consumer awareness. Greater consumption of less oily fish has been reported for consumers with university education and of younger age, willing to lose weight, consuming more fish in their childhood and in families with higher income levels [12].

The aim of this study was to assess the economic value of rainbow trout and carp as well as determine the nutritive value of their meat.

Material and methods

Analyses were conducted on 20 specimens of rainbow trout (aged 1+) and 20 specimens of carp (aged 3+) caught on two fish farms from the Lubelskie province, with 10 specimens of each species per farm. On the farms included in this study carp were kept in the low intensity production system (earthen ponds), while rainbow trout were produced in the intensive system (rearing in concrete tanks). Body weight of fish (g) was recorded, total length of fish, body length and lateral head length were measured using a measuring tape (cm), while the height of head, the greatest and smallest body height as well as body width were measured using a metric caliper.

Preliminary fish processing consisted in scaling (removal of scales from the skin), gutting, beheading (with a diagonal cut immediately behind the gills) and finning (removal of the caudal, dorsal, pectoral and ventral fins at approx. 0.5 cm from the base). After preliminary processing individual body parts (the head, gut, fins) were weighed. The filleted fish were divided into morphological elements, i.e. the fillet (skin and meat) and bones, and their percentage shares were recorded.

The basic chemical composition of meat was determined using conventional methods: water content by drying (103°C) according to the PN-ISO 1442:2000 standard; ash content by incineration in a muffle furnace (550°C) according to PN-ISO 936:2000; crude protein content according to Kjeldahl using a Büchi B-324 apparatus following PN-75/A-04018, and fat content according to Soxhlet (using n-hexane as a solvent) with a Büchi B-811 apparatus following PN-A-86734:1967. Physical and physiological energy values were calculated based on contents of crude protein and fat. Calculations applied physical energy equivalents (for protein 23.6 kJ, for fat 39.6 kJ) and physiological (Atwater) energy equivalents (for protein 16.7 kJ, for fat 37.6 kJ) [6]. Indexes of nutritional quality (INQ) were determined for individual nutrients according to the formula given by Hansen et al. [4], assuming reference values of energy consumption and nutrient intake according to the Regulation of the European Parliament and the Council (EE) no. 1169/2011 of 25.10.2011 (Official Journal L 304 of 22.11.2011, p. 18).

Statistical analysis was conducted by the one-way analysis of variance using the STATISTICA ver. 6.0 programme [11], while the significance of differences between means of a given parameter was determined by Tukey's test ($P \leq 0.05$ and $P \leq 0.01$).

Results and discussion

When assessing selected morphometric measurements of fish it was found that carp were characterised by significantly higher values of all body dimensions and weight in comparison to trout (Table 1).

The share of edible parts, i.e. meat and fillets, was significantly greater in rainbow trout in comparison to carp, by 13.17 and 16.64 percentage points (pp), respectively.

In turn, carp had a significantly greater share of the head (by 10.04 pp) and the skeleton (by 3.44 pp). The proportions of the skin and fins were comparable (Table 1).

Table 1
Morphometric measurements and the percentage of selected body parts of carp and rainbow trout

Specification	Rainbow trout		Carp	
	$\bar{x}$	S	$\bar{x}$	S
Total length (cm)	34.67^{A}	3.10	39.17^{B}	1.13
Body length (cm)	29.08^{a}	2.62	32.17^{b}	1.37
Side length of the head (cm)	6.47^{A}	0.40	9.80^{B}	0.81
Height of the head (cm)	4.13^{A}	0.46	6.18^{B}	1.43
The largest height of body (cm)	7.23^{A}	0.62	12.93^{B}	1.31
The smallest height of body (cm)	2.88^{A}	0.17	4.77^{B}	0.44
Width of the body (cm)	3.47^{A}	0.34	4.95^{B}	0.91
Body weight (g)	403.48^{A}	114.74	1101.97^{B}	228.56
Meat percentage	43.80^{B}	2.81	30.63^{A}	4.10
Fillet percentage	54.30^{B}	1.99	37.66^{A}	4.35
Head percentage	16.26^{A}	0.90	26.30^{B}	3.40
Gut percentage	10.88	2.82	11.26	2.48
Fins' percentage	3.54	0.68	4.34	0.74
Bones' percentage	10.93^{A}	1.26	14.37^{B}	0.68
Skin percentage	10.54	2.38	8.03	1.18

Means in rows marked with different letters differ significantly: a, b at P≤0.05; A, B at P≤0.01

When assessing percentage shares of individual body parts in the carp and the salmon Budi et al. [2] found similar dependencies. The shares of edible parts in salmon were greater by 14.20% for the filleted body and 20.50% for meat, while shares of inedible parts were greater in carp: for the head by 4.50% and the skeleton by 2.9%. Marcu et al. [9] reported a significant increase in dressing percentage of carp with their body weight, ranging from 50.68% for fish of 785 g to 60.28% for fish of 2010 g body weight.

Analyses of the chemical composition of meat of the investigated fish species showed significant differences in the shares of water and protein (Table 2). Meat of rainbow trout

Table 2
The chemical composition and nutritional value of meat of carp and rainbow trout

Specification	Rainbow trout		Carp	
	$\bar{x}$	S	$\bar{x}$	S
Water (%)	73.49^{A}	0.58	76.96^{B}	0.02
Ash (%)	1.09	0.20	1.39	0.10
Protein (%)	21.85^{B}	0.53	17.21^{A}	0.44
Fat (%)	3.57	0.65	4.44	0.64
Calorific value (kJ/100 g)				
Brutto Physical energy value	657.11^{B}	22.45	581.31^{A}	18.39
Netto Physiological energy value	483.89^{B}	21.52	441.71^{A}	19.11
INQ Index of nutritional quality				
Protein	5.59^{B}	0.14	4.97^{A}	0.13
Fat	0.65^{A}	0.12	0.91^{B}	0.13

Means in rows marked with different letters differ significantly: A, B at P≤0.01

contained on average 21.85% protein and 73.49% water, while in carp meat it was 17.20% and 76.96%, respectively. Energy value of meat was significantly lower in carp in comparison to trout: by 75.8 kJ/100 g in the case of physical energy value and by 42.18 kJ/100 g physiological energy value (Table 2).

The chemical composition of fish meat to a considerable extent depends on the species, type of food, age and fish body size [1, 3]. Unusan [13] in meat of rainbow trout recorded similar contents of protein and ash (20.28% and 1.53%), while giving lower values for water content (71.21%) and fat content (2.31%). Budi et al. [2] in carp meat showed protein content of 16.6%, 1.20% ash content, 73.22% water content and 8.97% fat content. Marcu et al. [9] for carp of 1150 g body weight reported protein content of 18.12% and fat content of 4.24%. Łuczyńska et al. [8], when assessing the nutritive value of the analysed fish species recorded a higher fat content (4.39%) in meat of rainbow trout of 480-610 g body weight in comparison to 2.81% in the meat of carp with body weight of 970-1205 g.

Energy value of an average fish serving (100 g) ranges from less than 400 to approx. 1225 kJ [7]. In the case of fish evaluated in this study the energy value of meat fell within the lower limit of the cited range (Table 2). However, the energy value of oily fish is lower than that of other animal origin products [6, 7]. Moreover, fish products are better

sources of protein than other animal origin products, since they provide greater amounts of this nutrient, it is of greater digestibility and at the same time lower energy value. This is indicated by the index of nutritional quality (INQ), which value for fish and processed fish products ranges from 7 to 8 [7]. The INQ value for fish meat exceeds even that for eggs and it is two-fold higher than for meat and dairy products. In this study the average value of this index for protein ranged from 4.97 for carp meat to 5.59 for trout. In the case of fat a higher value of this index (0.91) was recorded for carp meat in comparison to trout meat (0.74).

Summing up it may be stated that the compared fish species differ in terms of their shares of edible parts and the chemical composition of their meat. Percentage shares of edible parts were significantly higher in rainbow trout, which meat contained significantly more protein and had higher energy value.

REFERENCES

1. BUCHTOVA H., SVOBODOVA Z., KRIŽEK M., VACHA F., KOCOUR M., VELIŠEK J., 2007 – Fatty acid composition in intramuscular lipids of experimental scaly crossbreds in 3-year-old common carp (*Cyprinus carpio* L.). ***Acta Veterinaria Brno*** 76, 73-81.
2. BUDI I., LADOSI D., REKA ST., NEGREA O., 2008 – Study concerning chemical composition of fish meat depending on the considered fish species. ***Lucrări Stiinňifice Zootehnie si Biotehnologii***, vol. 41 (2), Timisoara.
3. FAUCONNEAU B., ALAMI-DURANTE H., LAROCHE M., MARCEL J., VALLOT D., 1995 – Growth and meat quality relations in carp. ***Aquaculture*** 129, 265-297.
4. HANSEN R.G., WYSE B.W., SORENSON A.W., 1979 – Nutrition quality index of food. Westport, CT: AVI Publishing Co.
5. HRYSZKO K., 2009 – Sektor rybny w Polsce – tendencje rozwojowe. ***Przemysł Spożywczy*** 9, 14-19.
6. JESZKA J., 2010 – Energia. W: Żywienie człowieka. Podstawy nauki o żywieniu (red. J. Gawęcki). T. 1. Wydawnictwo Naukowe PWN, Warszawa.
7. KOŁAKOWSKA A., KOŁAKOWSKI E., 2001 – Szczególne właściwości żywieniowe ryb. ***Przemysł Spożywczy*** 6 (55), 10-13.
8. ŁUCZYŃSKA J., TOŃSKA E., BOREJSZO Z., 2011 – Zawartość makro- i mikroelementów oraz kwasów tłuszczowych w mięśniach łososia (*Salmo salar* L.), pstrąga tęczowego (*Oncorhynchus mykiss* Walb.) i karpia (C*yprinus carpio* L.) ***Żywność. Nauka. Technologia. Jakość*** 3 (76), 162-172.
9. MARCU A., NICHITA I., NICULA M., MARCU B., KELCIOV A., 2010 – Studies regarding the meat quality of the specie C*yprinus carpio.* ***Lucări Stiinlifice Medicină Veterinară***, vol. XLIII (2), Timisoara.
10. PIEŃKOWSKA B., HRYSZKO K., 2012 – Spożycie ryb. ***Rynek Ryb – stan i perspektywy***, kwiecień 2012.
11. STATSOFT Inc., 2003 – STATISTICA. Data analysis software system, version 6, www.statsoft.com.

12. TRONDSEN T., BRAATEN T., LUND E., EGGEN A.E., 2004 – Consumption of seafood – the influence of over-weight and health beliefs. ***Food Quality Prefer.*** 15**,** 361-374.
13. UNUSAN N., 2007 – Change in proximate, amino acid and fatty acid contents in muscle tissue of rainbow trout (*Oncorhynchus mykiss*) after cooking. ***International Journal of Food Science & Technology*** 9 (42), 1087-1093.