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Quality in use and nutritional value of the muscle tissue of zander (*Sander lucioperca*) and pike (*Esox lucius*) reared in polyculture

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The research objective was to compare the quality in use and nutritional value of muscle tissue of zander (*Sander lucioperca*) and pike (*Esox lucius*) reared in a polyculture. The research material comprised 16 specimens (8 of each species) captured from one pond in a fish farm situated in the Lublin Voivodeship. The fish were of similar age. The pike, while having a higher body weight, had a higher percentage of guts, and the carcass percentage and a Fulton's condition coefficient were lower than in the zander. The chemical composition and calorific value of the muscle tissue were very similar for the two species (water 76.40% and 77.15%; protein 21.26% and 21.41%; lipids 0.41% and 0.58%; ash 1.43% and 1.42%; and energy 517 and 528 kJ/100 g for zander and pike, respectively). It is worth noting the high INQ value for the protein of both fish species (6.8 for pike and 6.9 for zander), which indicates that a 100 g portion of zander or pike fillet is a valuable source of protein in the human diet.

KEY WORDS: zander / pike / value in use / muscle tissue / chemical composition / nutritive value

In the last 10 years the consumption of domestic freshwater fish has become stabilized at a level of about 3 kg [9]. Consumption of freshwater fish in Poland could be raised mainly by increasing the consumption of the most important aquaculture species, i.e. trout and carp. Predatory species (pike, zander and catfish), reared in polyculture with cyprinids, also continue to attract consumers and eating establishments [12]. The use value of fish depends on their species and their qualitative and quantitative characteristics, including the nutritional value and chemical composition of the meat. A significant parameter is the proportion of valuable edible parts. Europeans have been shown to consider wild fish to be

a higher-quality product than farmed fish. However, irrespective of their source, consumption of fish is beneficial to human health [2, 14].

The aim of the study was to evaluate the use value and nutritional value of the muscle tissue of zander and pike reared in polyculture.

Material and methods

The study was carried out in the largest fish farm in the Lublin Voivodeship. The area of the farm is over 1,020 ha and the largest pond covers an area of 830 ha. The study was conducted on two species of predatory fish, zander (*Sander lucioperca*, n=8) and pike (*Esox lucius*, n=8), reared in the same earthen pond. The fish were caught in October 2015. All individuals were 2+ years of age. After the fish were caught they were stunned mechanically, killed (by cutting the spinal cord), and then weighed with a Radwag WPT/C/1 scales, accurate to 0.05 g. A straight edge was used to measure (cm) the total length, body length and head length of the fish, and a slide calliper was used to measure head height, maximum and minimum body height, and body width.

Preliminary processing of the fish included scaling (removal of the scales from the skin), gutting, deheading (by cutting around the gills), and removal of the fins (by cutting off the caudal, dorsal, thoracic and ventral fins about 0.5 cm from the base). Following preliminary processing body parts were weighed separately, i.e. the head, guts, and fins. The carcass was divided into the fillet (skin and meat) and bones and their percentage shares were determined.

Moisture content in the muscle tissue was determined by drying (103°C) according to PN-ISO 1442:2000; ash by combustion in a muffle furnace (550°C) according to PN-ISO 936:2000; crude protein by the Kjeldahl method with a Büchi B-324 unit according to PN-75/A-04018; and fat by the Soxhlet method (using n-hexane as a solvent) with a Büchi B-811 extraction system according to PN-A-86734:1967. All determinations of basic chemical components were made in duplicate. Calculation of the gross and net energy of 100 g of muscle tissue was based on the content of crude protein and fat, using the following energy equivalents: 23.6 kJ for protein and 39.6 kJ for fat [6]. In addition, the index of nutritional quality (INQ) was calculated for protein and fat according to Hansen et al. [3], using reference values for consumption of energy and nutrients according to Regulation (EU) No. 1169/2011 of the European Parliament and of the Council of 25 October 2011 (Dz.U. [Journal of Laws] L 304 of 22.11.2011).

Statistical analysis was performed using the STATISTICA statistical package ver. 6.0 [13]; means and standards deviations are shown in the tables. Differences between groups were verified by Student's t-test.

Results and discussion

Comparison of the results of the morphometric measurements showed that at a similar age (2+) body weight and all body dimensions were significantly greater ($P \leq 0.01$) in the

Table 1

Morphometric measurements and the percentage of selected body parts of zander and pike (mean ± standard deviation)

Specification	Zander		Pike	
Total length (cm)	43.35^{A}	±1.44	56.00^{B}	±1.32
Body length (cm)	35.58^{A}	±1.73	47.83^{B}	±2.02
Head length (cm)	10.18^{A}	±0.75	14.50^{B}	±0.50
Head height (cm)	4.68^{A}	±0.24	5.40^{B}	±0.10
Greatest body height (cm)	7.63	±0.25	7.66	±0.51
Smallest body height (cm)	3.03	±0.15	3.00	±0.14
Body width (cm)	4.77	±0.06	4.62	±0.23
Body weight (g)	684.44^{A}	±74.27	1139.37^{B}	±51.15
Carcass percentage	70.34	±3.61	67.85	±0.87
Head percentage	18.62	±3.72	19.95	±0.53
Guts percentage	5.27^{A}	±1.30	8.43^{B}	±0.65
Fulton coefficient	0.84^{B}	±0.04	0.65^{A}	±0.03

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

pike than in the zander (Tab. 1). The carcass percentage of the pike and zander did not differ significantly (67.85% and 70.34%, respectively), and the head percentage was similar as well (19.95% and 18.62%). A significantly greater percentage of guts was noted in the pike (by 3.16 percentage points), while a significantly higher Fulton coefficient was obtained for zander (0.84) than for pike (0.65).

Budi et al. [1], evaluating the percentage share of the inedible parts of pike, found a similar head percentage (19.75%) and a higher percentage of guts (11.80%) in comparison with the present study, whereas the carcass percentage in the study cited (65.80%) was lower. Jankowska et al. [4] compared the use value of zander reared in controlled conditions with fish acquired from a lake. They showed that the fish reared in extensive conditions, with a body length comparable to that noted in the present study, at 46.3 cm (±1.15 cm), attained a weight of 877.7 g (±50.77 g) and a Fulton coefficient of 0.88 (±0.04). They found a higher percentage of guts (11.49%) than in the present study, and a similar head percentage (17.98%).

Table 2
Chemical composition and nutritional value of muscle tissue of zander and pike (mean ± standard deviation)

Specification	Zander		Pike	
Water (%)	77.15	±0.72	76.40	±0.36
Ash (%)	1.43	±0.11	1.42	±0.02
Protein (%)	21.26	±1.63	21.41	±0.34
Fat (%)	0.41	±0.23	0.58	±0.12
Calorific value (kJ/100 g)	517.15	±41.68	528.45	±3.51
INQ*				
protein	6.90	±0.11	6.81	±0.07
fat	0.09	±0.05	0.13	±0.03

*INQ – index of nutritional quality

Zakęś et al. [15] compared the carcass value of wild and farmed zander. For wild fish aged 3-4 years, with a body length of 50.5 cm and a body weight of 1,185.1 g, they reported a Fulton coefficient of 0.91. For farmed fish aged 1.5 years with a body length of 47.2 cm and a body weight of 1,009.8 g, the Fulton coefficient was 0.96.

Comparison of the chemical composition of the muscle tissue of the fish species (Tab. 2) showed no significant differences in the proportions of individual components or in the calorific or nutritional value. Budi et al. [1] reported lower protein content (17.96%) and higher fat content (2.34%) for pike in comparison with the present study. An even higher percentage of fat (4.01%) in pike meat was noted by Kopicová and Vavreinová [8]. Jankowska et al. [5] report fat content in pike meat ranging from 0.19% for wild fish to 2.40% for fish reared in aquaculture. The effect of environment on fat content in the muscle tissue of zander was also confirmed by Zakęś et al. [15], who reported 1% fat in wild fish and 2.9% in farmed fish. Protein content was similar in the two groups, but did not exceed 20%. Similar protein content (19.50%) but very low fat content (0.13%) were obtained by Polak-Juszczyk and Adamczyk [10] in the muscle tissue of zander from the Vistula Lagoon.

The mean calorific value of a portion (100 g) of cyprinid fish reared in polyculture ranges from 516 to 792 kJ [12]. In the case of the predatory fish analysed in the present study, the calorific value of 100 g of muscle tissue ranged from 517.15 kJ in the zander to 528.45 kJ in the pike (Tab. 2). Lower energy value (ranging from 429 to 445 kJ/100 g) was noted in an earlier study on wild perch [11].

Fish products are an excellent source of highly digestible protein, which at the same time supplies little energy [7]. This is indicated by the high index of nutritional quality (INQ), whose value for fish and fish products exceeds even the index for eggs, and is twice as high as that of meat and dairy products. In the present study the average INQ in the case of protein was 6.81 for pike meat and 6.90 for zander. In the case of fat, the INQ values were 0.13 and 0.09, respectively. In an earlier study [12] conducted on cyprinid fish acquired from the same pond, lower INQ values were noted for the protein in the muscle tissue, i.e. 3.71 in bighead carp and 5.59 in grass carp, while a higher index was noted for fat—1.45 in bighead carp and 0.65 in grass carp.

To sum up the results obtained in the study, in the two species of predatory fish of similar age, the pike, despite its greater body weight, had a higher guts percentage and lower carcass percentage, as well as a lower Fulton coefficient. The chemical composition and calorific value of the muscle tissue of the two species were very similar. It is worth noting the high index of nutritional quality (INQ) for protein (6.9 for zander and 6.8 for pike), which indicates that a 100 g portion of fillets of these predatory fish is a good source of protein.

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