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# THE CHEMICAL COMPOSITION OF TWO COMMERCIAL FISH SPECIES – PIKEPERCH (*SANDER LUCIOPERCA*) AND RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) CULTIVATED IN ARTIFICIAL CONDITIONS

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**Abstract**

Fish is a nutrient rich food and possesses many components that have positive impact on human health. Nowadays, the fish come to the market from wild-capture fisheries and aquaculture. Latter becomes increasingly global for human consumption, thus total finfish aquaculture includes over 300 species farmed in ponds, floating net cages and recirculating aquaculture systems (RAS). It is reasonable to assume that the chemical composition of farmed fish will vary compared to wild-caught ones due to the different rearing conditions and artificial diets used for feeding the fish.

This study gives an overview of basic chemical composition of pikeperch (*Sander lucioperca*) and rainbow trout (*Oncorhynchus mykiss*). We analysed the muscle flesh composition of fresh and frozen pikeperch obtained from the local commercial tank-based recirculating aquaculture system together with rainbow trout obtained from river-based net cage farming system. We determined that fresh pikeperch contained 78.27±0.34% moisture, 18.95±2.45% protein, 1.34±0.18% fat and 1.62±0.21% ash, while frozen ones had 78.26±0.44, 20.91±0.62, 0.77±0.15 and 0.99±0.09% respectively. Statistically significant differences were found for fat and ash content ($p<0.05$). In both cases, artificially cultivated pikeperch has high nutritional value and fit for human consumption.

The chemical composition of trout was the following: 69.61±1.33% moisture, 17.78±0.48% protein, 11.41±2.24% fat and 0.88±0.01% ash. After reviewing the literature, we found that farmed trout has considerably higher fat content than wild trout. This primarily can be explained by use of lipid-rich diets and lower mobility in cages.

***Keywords***: aquaculture, fish species, body composition, pikeperch, rainbow trout.

## Introduction

Fish is a nutrient rich food and possesses many components that have positive impact on human health since it is a complete protein source that contains all essential amino acids as well as particular vitamins and minerals.

A sizeable share of fish comes to the market from aquaculture. More and more species are being raised in ponds, floating net cages and recirculating aquaculture systems (RAS). In recent years, pikeperch (*Sander lucioperca)* and rainbow trout (*Oncorhynchus mykiss*) are becoming increasingly popular for aquaculture production in Europe together with most commonly farmed species such as carp, tilapia and salmon.

In Russia, pikeperch is completely new farming species since it's widely available on the market are usually caught by fishermen from inland waters. According to FAO statistics, the Russian catch of pikeperch in 2013 was estimated in 6256 tons (more than 30% of the global catch) making the Russian Federation one of the main exporters of this species (FAO, 2015).

In case of rainbow trout, culture of this species in Russia takes place on small-scale local fish farms. However, production volume of trout is low and its mainly imported from Chile, Turkey and Denmark (Villegas, 2015).

At the same time, the potential of pikeperch cultivation might be grounded on its taste qualities, good growth rates and high price for fillets, whereas farming of trout along with the above advantages can reduce the pressure on wild caught stocks. These both species provide a supply of healthy food source and have low body lipid content of fish meat and highly digestible protein.

Based on the above, our interest was directed to the quality of domestic aquaculture products. It's generally known that consumption of farmed fish demands the certain requirements to the quality, food safety and nutritional value (Josupeit et al., 2001). Due to specific conditions, nutritional properties of fish are influenced by artificial diets, water quality, stocking density, rearing technology and many other factors (Crețu et al., 2014; Siemianowska et al., 2016). Thus, the aim of this study was to investigate the chemical composition of farmed pikeperch and rainbow trout. Our selection of these species based on their popularity on the market and similar amino acid profile (Jarmołowicz, Zakęś, 2014). The obtained results were compared with data from various literature sources.

## Materials and Methods

*Sampling*

Pikeperch samples were collected from the local commercial RAS consisted of tanks (volume 7000 L), biofilters (loaded by pelleted polyethylene), mechanical filters, UV lamps and air compressor. This commercial company supply fish to the market both in fresh and frozen state.

Pikeperch were stocked in tanks at density of 13.7 $kg \cdot m^{-3}$. The water temperature remained constant at 20.2±0.1 °C, oxygen level was maintained above 125% of saturation. Due to the lack of specific diets for pikeperch, fish were fed by commercial sturgeon diets consisted of feather meal, fish meal, poultry meal, rapeseed, rapeseed oil, soy, soy protein concentrate,

vitamins, minerals and premix. The nutrient composition according to producer was the following: 45% crude protein; 15% crude fat; 6.9% crude ash; 23.8% NFE; 3.3% fibre; 0.9% phosphorous and 21.2 MJ gross energy.

Two batches of pikeperch consisting of 6 individuals each were analysed. The first batch of product was fresh fish, while the second one was frozen: pikeperch were taken from the tank, killed and subsequently placed in a freezer at -20 °C for 3 days prior to realization.

In both cases, proactive and clinically healthy pikeperch were taken for analyses. All specimens have the age of 23 months and mean body mass of 727.7±12.7 g.

Rainbow trout fresh individuals (n=6) were collected from the local cage-based fish farm. The squared shape cages were 3.8 × 2.3 × 4 m with synthetic nets and with an average stocking density of 45 $kg \cdot m^{-3}$. During the rearing period the water temperature ranged from 1.2 to 26 °C. Fish were fed by commercial trout diets consisted of feather meal, fish meal, fish oil, krill meal, poultry meal, rapeseed oil, soy, soy protein concentrate, sunflower protein concentrate, wheat, wheat gluten, vitamins, minerals and premix. The nutrient composition of the diet is 43% crude protein; 29% crude fat; 7% ash; 14% NFE; 1% fibre; 0.9% phosphorous and 24.2 MJ gross energy. It should be noted that feeding regime was influenced by water temperature and concentration of dissolved oxygen. When the rearing conditions were unfavorable, the feeding was usually suspended for a few days. All trout specimens were taken from cages in December, when the water temperature was 4.3 °C. The mean body weight of fish was 1549.0±21.4 g.

The fish transportation to the laboratory was carried out in plastic containers with dry ice as a refrigerant.

*Proximate composition*

All laboratory tests were performed at the Department of Food Biotechnology of Kaliningrad State Technical University. All samples for proximate composition were analysed in accordance with the Russian state standard GOST 7636-85 "Fish, marine mammals, invertebrates and products of their processing. Methods for analysis". The frozen pikeperch specimens were thawed in the refrigerator overnight. The fish were gutted and filleted. The fillets were homogenized and used in subsequent analyses. Chemical tests of the homogenates were done in triplicate. Water content was determined after dryness in desiccator at 105 °C until constant weight was reached. Ash content was measured via ashing the samples in a muffle oven. Lipid content was measured with the Soxhlet method based on the fat extraction from a dry sample by an organic solvent (anhydrous sodium sulfate). Dietary crude protein levels were determined according to the methods of Kjeldahl via distillation and titration using a nitrogen to protein coefficient of 6.25.

*Statistical analysis*

All data were statistical analysed by one-way ANOVA test using R Software version 3.2.3. The variability of the mean values is represented by the standard error. Significant differences were defined at $P < 0.05$.

**Results and Discussion**

The obtained results of proximate composition of fresh and frozen pikeperch and fresh rainbow trout assumed in Table 1.

Table 1

**Proximate composition of fish (n = 6)**

| **Pikeperch (*Sander lucioperca*)** | | |
|---|---|---|
| **Component** | **Fresh** | **Frozen** |
| Moisture, % | 78.27±0.34 | 78.26±0.44 |
| CV, % | 0.76 | 0.96 |
| Protein (N total × 6.25), % | 18.95±2.45 | 20.91±0.62 |
| CV, % | 22.42 | 5.12 |
| Fat, % * | 1.34±0.18 | 0.77±0.15 |
| CV, % | 23.49 | 34.10 |
| Ash, % * | 1.62±0.21 | 0.99±0.09 |
| CV, % | 22.29 | 16.65 |
| **Rainbow trout (*Oncorhynchus mykiss*)** | | |
| **Component** | **Fresh** | |
| Moisture, % | 69.61±1.33 | |
| CV, % | 3.31 | |
| Protein (N total × 6.25), % | 17.78±0.48 | |
| CV, % | 4.73 | |
| Fat, % | 11.41±2.24 | |
| CV, % | 33.97 | |
| Ash, % | 0.88±0.01 | |
| CV, % | 1.21 | |

* Means in the row differ significantly ($p<0.05$);
CV – coefficient of variation

The fat content of frozen pikeperch (0.77%) was significantly lower than that of fresh one (1.34%) as well as ash content (0.99 and 1.62%, respectively) ($p<0.05$). Thus, the reduced fat content in frozen fish is may be due to the microbial load occurred after refrigerator thawing. Since at the initial stage of microbial spoilage, large amount of lipases enzyme can be produced, which breaks down lipids to form fatty acids (Latip et al., 2013) However, why is protein wasn't affected is a matter of consideration and further investigations are necessary.

Another reason is maybe be due to the differences in the fish individuals initially, since even under the same conditions of fish cultivation, there are still insignificant differences in the chemical composition can occur.

Protein is one of the most important nutrients from fish, therefore the farmed fish should not be compromised in this respect to wild-caught ones. According to several studies, the average protein content in fresh water pikeperch is ranged approximately from 16.9 to 23.7% (Molnár et al., 2006; Schulz et al., 2006; Skurihin, 2007; Özyurt et al., 2009). Thereby, on the basis of our findings, pikeperch farmed in the RAS have similar amount of protein (18.95%) and corresponds to the previous range.

Usually, the feeding diets with increasing lipid content resulted in significantly higher lipid, that is why farmed fish are frequently fatter than their wild counterparts (Schulz et al., 2006). Jankowska et al. (2003) established that intensive cultivation of pikeperch led to three-fold increase in fat content than that of wild specimens,

where amount of lipid typically does not exceed 1.2% (Skurihin, 2007). In our case, farmed pikeperch were characterized by low fat content (1.34%), which can be explained by many factors such as relatively low stocking density for this species, composition of the diet and feed ration. Moreover, closely related to pikeperch species the Eurasian perch had similar lipid content (from 1.23% to 1.35%) when fed with diets contained the fat range of 11.9–22.2% (Mathis et al., 2003).

It's opposite, however, to farmed rainbow trout. In according with data from Table 1 the content of fresh trout meat in lipids is 11.41%. This explains the relatively reduced moisture (69.61%), since it is well known that quantity of water is inversely proportional to the quantity of fat (Shafi, 2003). One of the factors responsible for the increase in fat is the rise of temperature (Martinez et al., 1992). As mentioned above, in the different periods of cultivation the water temperature in cages rose up to 26 °C exceeded the thermal optimum for this species. As a result it had an impact on higher lipid content, which is corresponds with the data obtained by Martinez et al. (1992), when cultivation under the temperature of 20.7 °C led to increase a lipid content in trout that ranged from 10.79 to 13.97%, while the water content fluctuated between 67.50–70.05%. Another reason is the high stocking density (45 $kg \cdot m^{-3}$) and consequently, the lower mobility in limited volume cages. Thus, Creţu et al. (2014) indicated that the cultivation of trout at higher stocking densities may lead to higher degree of fat retention. Just as the use of lipid-rich diets for feeding is also can be reflected on higher lipid content in the muscle flesh composition (Vranić et al., 2013).

The amount of the chemical composition of fish is also depends on age. Lieb at al. (1974) established that lipid content of rainbow trout doubled from 4.4 to 8.4% over the rearing period from the age of 14 to 32 weeks which corresponds with our results. In our case, farmed trout were approximately 96 weeks-old.

At the same time, the protein content (17.78%) are in accordance with the results obtained before by various scientists, where the values of this component varied from 15.60 to 19.40% (Martinez et al., 1992; Vranić et al., 2013; Creţu et al., 2014; Beličovska et al., 2015).

Based on the foregoing, we can say that both farmed species had high nutritional value and concede nothing to wild specimens or a previous cultivation experience.

## Conclusions

This study provides a brief overview of proximate composition of farmed pikeperch and rainbow trout. The results obtained show that both species are generally fit for human consumption which may indicate the feasibility of local cultivation. However, the further research are necessary to investigate a mineral content as well as the fatty acid and amino acid composition to gain a more accurate understanding of chemical changes during the different stages of individual growth.

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