Slaughter yield and chemical composition of Siberian sturgeon reared in a recirculating aquaculture system (RAS)

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Slaughter yield and chemical composition of Siberian sturgeon reared in a recirculating aquaculture system (RAS)

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Abstract. Sturgeon fish species are food fish of commercial significance in many countries. Sturgeon farming in Serbia is a relatively new branch of aquaculture, and sturgeon farming has been developing in the last several years. The objective of this study was to examine morpho-physiological and slaughter characteristics and proximate composition of one-year-old sturgeons produced in a recirculating aquaculture system (RAS). Sturgeons were cultured in a RAS system nearby Novi Sad and were fed with commercial feed. Moisture content in fillets ranged from 75.63 to 77.91%, protein content from 18.06 to 18.89% and lipid content from 2.37 to 4.38%. The slaughter performance results are in agreement with those reported by various authors for different strains of sturgeons. Sturgeon species have potential to become an attractive fish in our aquaculture in terms of overall proximate composition and slaughter performance.

1. Introduction

Sturgeon fish species are of increasing interest among consumers mainly due to their sensory properties. Also, sturgeon meat is considered to have beneficial nutritional composition. Furthermore, beneficial effects on health of consumers are also linked to sturgeons. Due to the above mentioned facts, sturgeon is a food fish of commercial significance in many countries. There is also increasing interest among fish farmers in sturgeon species due to the fact that sturgeons are relatively easy to breed, their acceptance of formulated feed is relatively high, their growing performances are satisfactory and their possibility to adapt to intensive rearing systems is relatively high [1]. The development of sturgeon aquaculture is important from the viewpoint that catching them wild is banned, so the production is possible only in aquaculture. In Serbia, rearing sturgeon is a relatively new branch of the aquaculture industry, and sturgeon farming has been developing in the last several years. Russian sturgeons are successfully reared in net cages, tanks and ponds, and they well accept artificial feed. It should be mentioned that the intensive breeding of sturgeon could lead to the spread of infectious diseases, so the proper preventive measures are important [2]. The proximate composition of cultured fish is influenced by several factors such as nutrition, genetics, water quality, health conditions, management practices on farms and environmental conditions [3]. Today, sturgeon culture systems are mainly based on new technologies and intensive systems such as recirculation systems (RAS) [4], and such culture conditions have enabled increased provision of sturgeon on the international market in the few last decades. The efficiency of production and quality of reared fish are of the greatest importance in commercial aquaculture production. Also, the commercial significance of sturgeon is increasing due to its high meat quality and relatively high market price, and demand for sturgeons is continuously increasing. There are not many literature data regarding quality parameters of sturgeons, especially their proximate composition and morphometric parameters including dressing percentage, but such data are needed to assess the production value of these fish. Having all the above mentioned facts in mind, the objectives of the present study were to determine proximate composition and morpho-physiological properties of sturgeons reared in RAS.

2. Materials and Methods

Cultured male Siberian sturgeon (*Acipenser baerii*) (average weight 301g) were obtained from a local sturgeon RAS farm. The fish were reared in circular RAS tanks and fed with commercial feed which contained 42% protein and 15% lipids. Five male individuals were randomly selected and morpho-physiological and chemical analyses were performed. Exterior measurements were made and slaughter analyses were performed according to methods described by Nikolova et al. [5]. Proximate composition of fish was examined applying standard SRPS ISO methods. Gravimetric methods were utilized to determine the moisture content [6] and total fat [7]; total protein content was determined by the combustion method [8]. Ash content was determined by combustion at 550 ± 25 ºC applying standard method [9]. Energy value was expressed per 100g of sturgeon fillet, and was calculated according to the equation below using conversion factors indicated in the Appendix 13 of the Rulebook on declaration, labelling and advertising of food [10]:
Energy value (kcal/ g) = 4 × carbohydrate content + 4 × protein content + 9 × fat content.

3. Results and Discussion

Proximate composition (Table 1) indicated a varied content of lipids and water in the examined fish. A negative correlation between lipid and water contents in the sturgeon meat was observed (Pearson coefficient of correlation r = 0.92), which is in agreement with the previously reported results [15]. In other studies, the proximate compositions of meat were highly variable in different sturgeon species and hybrids, i.e. Russian sturgeon (*Acipenser gueldenstaedtii*), Siberian sturgeon (*Acipenser baerii*) and hybrid (*Acipenser baerii Br* × *Acipenser medirostris* Ayres) [11, 12, 13]. Furthermore, the proximate composition parameters were highly variable within the one species [14].

Table 1. Proximate composition of Siberian sturgeon (*Acipenser baerii*) fillets produced in a recirculating aquaculture system

Parameter	X	SD	Range	CV
Crude protein (%)	18.54	0.38	18.06-18.89	2.07
Crude fat (%)	3.32	1.09	2.37-4.38	32.78
Moisture (%)	76.63	1.15	75.63-77.91	1.50
Ash (%)	1.45	0.17	1.22-1.58	11.54
Carbohydrates (%)	0.06	0.03	0.02-0.09	49.06
kJ/100 g	438.75	42.19	369-475	9.62
kcal/100 g	104.225	10.2	94-113	9.79

The proximate composition of sturgeon is known to be highly influenced by nutrition [12]. According to results reported by Şener et al. [11], whole body fat content in juvenile Russian sturgeon (*Acipenser gueldenstaedtii*) fed feeds including fish oil, soybean oil and sunflower oil were 4.65%, 4.73% and

5.19%, respectively. Wild sturgeon is classified as a medium-fat fish species, with lipid content between 5-15% [14]. Furthermore, the lipid contents in cultured sturgeons ranged from 5 to 15% and energy content ranged from 116 to 151 calories per 100 g of fresh uncooked fish [16]. Chapman et al. [17] noted the lipid content in Siberian sturgeon could be higher in comparison with other sturgeon species. According to results reported by Ljubojević et al. [15], the moisture content in wild sterlet was 75.38%, protein content was 17.54% and lipid content ranged from 4.8 to 6.1%. Lee et al. [18] reported that moisture content ranged from 77.2 to 77.5%, protein content from 13.1 to 13.8% and lipid content from 4.8 to 6.1% for cultured sterlet. According to results reported by Chapman et al. [17] the proximate composition of edible portions of Russian and Siberian sturgeon ranged from 70 to 76% for moisture, from 17 to 19.6% for protein, from 5 to 10% for lipid and from 1 to 2% for ash.

In this study, a significant correlation was measured between fish weight and protein content (Pearson coefficient of correlation, $r = 0.74$). Also, Ghomi et al. [19] observed a significant correlation between fish weight and protein content ($r = 0.504$), which is in accordance with our results. Furthermore, they also did not find any correlation between body fat and fish weight, which was the case in our study. On the other hand, we noted a lower fat content in smaller fish, which is in accordance with the observation by Palmeri et al. [20]. That could be due to the utilization of fat at a faster rate during early growth stages.

3.1 *Morpho-physiological properties and slaughter yield*

Results of morpho-physiological properties and slaughter yield of sturgeons are reported in Table 2. The obtained results were compared with the results of previous studies on the Siberian sturgeon but also on the other sturgeon species [13, 21]. The relative percentages of eviscerated weight (81.02%), gonads (1.79%), liver (0.73%), spleen (0.08%), heart (0.1%), swim bladder (0.49%), head without gills (14.07%), fillets with skin (32.47%) and carcass weight (77.81%) were lower in comparison with results obtained by Nikolova et al. [5] for sturgeons aged six and eight years. That confirmed that age increase leads to increase of the total weight, the total carcass weight, the meat content in the carcasses, and the weight of intestines, liver, heart, gills and head [5]. However, the relative proportion of the separate organs in the study conducted by Nikolova and Bonev [21] did not change with age, with the exception of the gills, which underwent a statistically significant proportionate increase with age. The same authors reported that the differences both in morphometric and morpho-physiological characteristics were insignificant. Furthermore, in the current study, fillet yield in relation to the total weight was 41.73%, while the skinless fillet yield in relation to the whole fish weight yield was 28.18% and fillet yield with skin was 32.47%. Slaughter performance was in agreement with those reported by other authors. According to results obtained by Chapman et al. [17], dressed fillets yields in sturgeon could be different by species. They reported that the skinless fillet yields for Russian sturgeon and Siberian sturgeon were 26% and 32%, respectively. Oliveira et al. [22] reported that fillets yields increased with fish weight. They observed that dressed fillet yields of Gulf of Mexico Sturgeon (*Acipenser oxyrinchus desotoi*) ranged from 19 to 23% of live weight.

Table 2. The slaughter parameters of Siberian sturgeon (*Acipenser baerii*) produced in the RAS

Parameters	X	SD	Range
Total weight, g	301.56	43.99	234.79-347.97
Total length, cm	43.94	2.64	40-47.8
Eviscerated weight, kg	244.33	38.16	184.8-286.56
Total intestines, g	6.66	1.06	4.63-7.64
Gonads, g	5.40	1.08	3.55-6.65
Liver, g	2.22	0.39	1.81-2.86
Spleen, g	0.26	0.06	0.2-0.36
Heart, g	0.30	0.10	0.22-0.49
Swim bladder, g	1.48	0.38	1.16-2.18

Fins and tail, g	12.28	2.63	8.27-14.78
Head without gills, g	42.42	5.60	36.66-45.8
Gills, g	5.57	0.83	4.56-6.32
Fillet with skin, g	97.94	17.98	68.75-109.8
Carcass weight (Total weight without intestines and whole head), g	234.66	36.94	177.74-275.43
Slaughter value 1 (Eviscerated weight/Total weight)*100, %	80.89	1.23	78.71-82.35
Slaughter value 2 (Carcass weight/Total weight)*100, %	77.67	1.12	75.70-79.15

The investigation of morpho-physiological parameters is very important for fish reared in relatively small amounts of water, such is the case with RAS. Both genetic and environmental factors determine body growth as well as slaughter and morpho-physiological characteristics of fish. These characteristics are very important if fish are grown for meat. Also, morpho-physiological and slaughter characteristics could be useful tools to evaluate physiological status, health status and well-being status of fish. Nikolova and Bonev [21] reported that liver size is connected to physiological condition of the fish, the heart weight is influenced by swimming activity and spleen weight is dependent on the nutrition factors.

4. Conclusion

In conclusion, sturgeon species have potential in Serbia to become an attractive fish in terms of overall proximate composition and dressing percentage. From a nutritional point of view, sturgeon fillet composition was characterized by a good content of crude protein and other nutrients. The slaughter performance was similar to those reported by other authors for different strains of sturgeon. Balanced nutrition is one of the most important factors for obtaining optimal proximate composition of sturgeon meat from the nutritional standpoint. The possibilities for utilising the currently relatively little used sturgeon species for high quality food and for introducing it as a new species in aquaculture production are big. Reliable analytical data regarding sturgeon quality is required. All reported results could be a useful tool in order to improve sturgeon production in different facilities in our country.

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