RESEARCHES ON MEAT QUALITY OF STURGEONS REARED IN RECIRCULATING AQUACULTURE SYSTEMS

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Abstract

This work brings some qualitative results of sturgeon meat reared under different conditions of growth, namely recirculating aquaculture system and natural environment. Biochemical composition of meat was determined by classical methods of quantification for the proteins - Kjeldahl method, for the fat - Soxhlet method and for the dry matter and ashes by dehydration, respectively by calcination. Analysis of the main macronutrients in the analyzed sturgeon carcass, proteins and fats, showed a superiority of their concentration in fish meat from the recycled system, the results being confirmed by repetition. Achieve of higher percentage of protein and fat in fish flesh is the main purpose of the intensive aquaculture in confined and controlled spaces which is why this work represents a further proof that recommends these technologies.

Key words: recirculating system, sturgeons, proteins, fats

INTRODUCTION

Sturgeon, because of their importance, both economic and ecological, are some of the most important fish species on the Terra and, the lower Danube is practically the only area in Europe where these fish live and reproduce, still naturally, in river .

The number of adult sturgeon that migrates upstream each year to reproduce has fallen drastically in recent years, which required the development of regulations to ban commercial catch [3]. In this context, to meet the market requirements, artificial reproduction of these species and their rearing in production systems intensive, appears as a necessity and an opportunity to develop the aquaculture sector.

The rearing in controlled environmental conditions of sturgeons by treating and recycling water is a thoroughly studied problem worldwide. The possibility of obtaining the aquaculture product continuously throughout the year is an important argument to address recirculated aquaculture systems. They allow a high degree of intensivity for biomass production through advanced monitoring of water chemistry in accordance with the quantity and biochemical composition of feed given and demands for optimal conditions for fish welfare [1].

As the conditions mentioned above are fulfilled, a superior quality and quantity of aquaculture product is obtained.

This research focused on the study of the carcass quality of beluga sturgeon with different background regarding environmental conditions where they grown: natural environment – Danube River and controlled environment – recirculating aquaculture system.

MATERIALS AND METHODS

The examined biological material was obtained from artificial reproduction in ISACCEA station, where larvae and then juveniles were kept until they were 100% adapted to supplementary feed. Of these, 100 exemplars were transferred in the recycled system located in the laboratory "Recirculating Aquaculture Systems Engineering" of the „Lower Danube" University, Galati.

In figure 1 is presented the recirculating system where the beluga fingerlings were reared.

Fig. 1. Recirculating system

From a constructive perspective the recirculating aquaculture system consists of:
a) a rearing units module represented by 4 rectangular tanks with a volume of approximately 300 liters per tank, the total system volume is 1.2 m^3;
b) water quality conditioning units, consisting of:
- Mechanical water filtration unit;
- Biological water filtration unit;
- Water sterilization unit;
- Water aeration-oxygenation unit;
- Hydroponic subsystem;
- Equipment for monitoring of physico-chemical parameters.
c) installation for water distribution in rearing tanks..

The water flow of the four tanks: 4 × 12 = 48 l / min

The main water parameters (temperature, dissolved oxygen, pH) were determined with oximeter - Oxi315i and pH-meter type pH 315i [6].

The food conversion ratio was calculated with formula:

$$FCR = F / (Wf-Wi)$$

where: F – the amount of given food;
Wf, Wi – final and initial biomass.

The specific growth rate was calculated with the following formula:

$$SGR = [(\ln Wf – \ln Wi)/ T]*100$$

where: Wf – final biomass;
Wi – initial biomass;
T – time interval.

Protein efficienty rato (PER) represents the ratio between the weight gain and total amount of intake protein.

$$PER=Wf-Wi/F*Pb$$

where : Wf – final biomass [kg];
Wi – initial biomass [kg];
F – total feed intake [kg];
Pb – gross protein in feed [%][4].

The daily feeding rate was 3% from fish biomass. The fodder used for experiments consist in Nutra 3.0 pellets which is a feed for trout with 55.0% crude protein, 16.0% crude fat, 10.0% ash, 0.6% crude fiber, 1.45% phosphorus and the amount of vitamins added per kg: Vit. A 14,000 U.I.-Vit. U.I.-Vit D3 2300. E 250mg - 8.5mg Copper - Vit. C 500mg.

Biological material from the wild has been caught in the Danube on 07/07/2009, from kmD 151, a place called by locals „Port", located on the right side of the Danube (opposite the town of Galati). This bottom of the area was plan without uneven, covered with gravel [7].

Analysis of the meat from two different origins was carried out as follows:

Determination of inorganic phosphorus (P_2O_5)

The method is based on the color reaction of inorganic phosphorus with ammonium molybdate, the phospho-molybdenum complex formed is then reduced in the presence of hydroquinone-sodium sulphite mixture.

For standard curve (Fig. 2) was used stock solution (0.1 ml P_2O_5/ml). There have been appropriate dilutions and solutions were treated in the same working conditions as sample. The readings were made at 660nm.

Determination of protein by the Kjeldahl method - Samples were mineralized with sulfuric acid and catalyst, after which proceeded to alkalizing with sodium hydroxide solution, ammonia distillation and distillate collection in a determined quantity of sulfuric acid solution followed by titration with sodium hydroxide solution. For determination have been used device PRO-NITRO I.

To express the result in protein substances, the amount of nitrogen calculated was multiplied by coefficient 6.25 (meat and meat products).

Determination of fat by Soxhlet method - Fats were extracted with ethyl ether which is an organic solvent. After removing the solvent, the residue obtained was weighed. Lipid extraction was performed using Soxhlet apparatus.

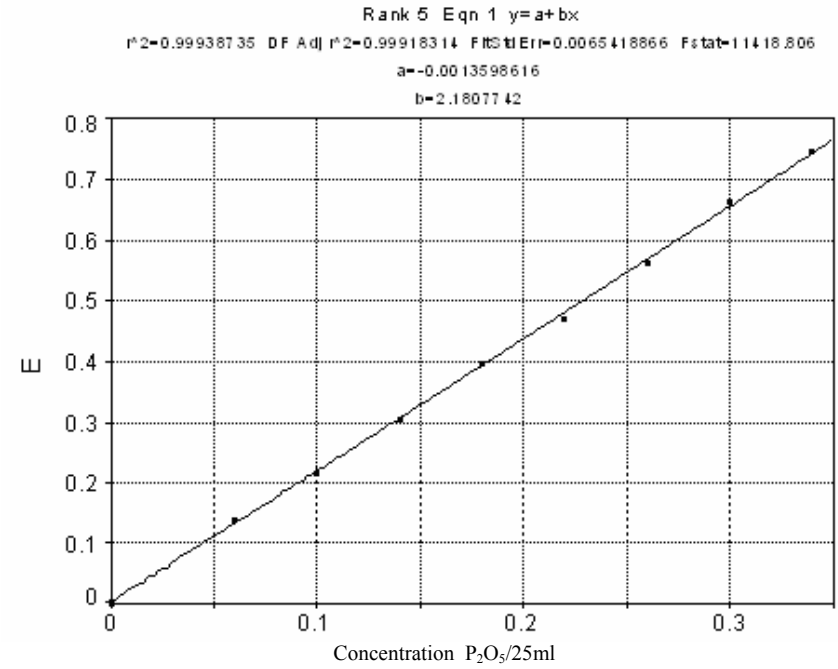

Fig.2. Standard curve for determination of inorganic phosphorus

Determination of dry weight - Determination of dry matter was achieved by thermobalancei "PRECISA" (infrared DARK Radiator). The sample is subjected to dehydration by heating with infra-red / IR or dark radiation.

Determination of ash - Ash was determined by rapid calcination of the sample with magnesium acetate at a temperature of 700-750^{0}C.

RESULTS AND DISCUSSIONS

Fish raised in the recirculating system displayed an active behavior consuming the entire amount of administrated feed, showing a preference for feed consumption from the bottom of the basin and less from the water body. In Table 1 are represented technological indicators calculated in the end o the experimental trial.

Table 1.
Growth performance of the biological material

	Variant 1/B_1	**Variant 2/B_2**
Initial biomass (g)	426	392
Average initial weight (g/ex)	8,87	8,34
Final biomass(g)	1084	924
Average final weight (g/ex)	23,06	21,48
Initial exemplars number	48	47
Final exemplars number	47	43
Survival rate (%)	97,9	91,4
Experimental period (days)	28	28
Total biomass gained (g)	658	532
Individual biomass gained (g/ex)	14,19	13,14
Specific growth rate - SGR (% BW/day)	3,33	3,06
Daily growth rate (g/kg/day)	0,5	0,46
Total feed/ aquarium (g)	476	396
Protein / aquarium	261,8	217,8
Protein efficiency ratio - PER (g)	2,51	2,44
FCR (K) (g feed/g biomass gained)	0.72	0.74

In the beginning of the experiment which lasted 28 days the total initial biomass was 426g in the first tank and 392g in the second tank with an average weight of 8.34 g/axemplar respectively 8.87 g/exemplar. At the end of the experiment resulted a biomass of 1086g in the first variant and 924g in the second variant with an average weight 21.48 g respectively 23.06 g.

The total quantity of given feed, 476g in the first tank and 396g in the second tank generated a biomass gain of 658g in first variant and 532g in the second experimental variant. Specific growth rate (SGR) in both variants surpassed 3% biomass per day. During the experimental period the individual biomass gain reached 13.14 g/ex respectively 14.19 g/ex. Feed conversion factor (FCR) is subunit in both experimental variants fact which confirm that the biochemical composition of the fodder meets the nutritional needs of sturgeons in this stage of development.

Recording of high values of the protein efficiency ratio (PER), as observed in the present experiment, shows an efficient utilization of protein from administered feed.

In the Table 2 are given the biometric measurements of the sturgeons caught in the Danube.

Tabelul 2..
Biometric measurements of the analyzed exemplars

Exemplars / *Biometry*	1	2
Total biomass (g)	84	60
Total length (cm)	26,5	25
Fork length (cm)	20	19
Height max. (cm)	3,8	3,2
Height min. (cm)	1	0,9

Fish is a rich source of food ingredients with particular functional properties, thus constituting an important source of protein with balanced amino acids and fats with valuable polyunsaturated fatty acids content. The chemical composition of fish meat may be influenced by biotic and abiotic factors.

For biochemical analysis were slaughtered two sturgeon exemplars from recirculating system (RAS) and two sturgeon exemplars caught in the natural environment (Tabel 3).

Table 3.
Physico-chemical characteristics of sturgeon meat

Nr.crt.	Sample	Nitrogen (%)	Protein (%)	Fat (%)	Dry weight (%)	P_2O_5 (mg/100g)	Ash (%)
1	Danube	2.40	15.00	1.12	18.18	240.03	0.94
2	Danube	2.38	14.91	1.25		223.94	1.00
3	RAS	2.73	17.07	1.31	28.12	281.39	1.02
4	RAS	2.77	17.34	1.44		270.15	1.10

From the data presented in Table 3 is observed that the amount of protein for farmed fish carcass is higher compared to the amount of protein from the Danube fish carcass. Thus, the amount of protein on dry weight basis for fish grown in controlled environmental conditions had a value of 23.74% dw compared with fish from the natural environment that had a value of 18.47% dw. Protein registered was 28% higher in farmed fish compared to that of the Danube.

After Sikorski [5] fish are classified into four categories based on the crude protein content: below 10%, 10-15%, 15-20% and over 20% proteins. Thus, it is noted that, from a protein content perspective, farmed sturgeon falls into a higher category than that of the natural environment.

Regarding fat content, the recorded values of fat content were comparable with that reported by others authors. According to Ionescu (2006) farmed beluga (1 year juvenile) has a fat content of 1.1 g%.

The amount of phosphorus quantified in sturgeon meat reared in recirculating system (280 mg %) was higher by 16%. comparing with the Danube sturgeon meat (240 mg%), Fish with high phosphorus content can provide an important part of the daily requirement for humans consumption.

CONCLUSIONS

1. All the results related with biotechnological indicators, growth rate and feed conversion rate emphasize the potential for feed valorification and technological performance of beluga reared under controlled environmental conditions.

2. The amount of protein is 28% higher in fish raised in recirculating system, compared to samples from natural environment.

3. The lipid content was comparable with values reported in the literature, about 1.3 g%.

4. The amount of phosphorus was higher in farmed fish in recirculating system compared to that found in wild fish, caught in Danube River.

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