

Assesment of Growth Performances of Juvenile Sterlet *Acipenser ruthenus* Raised in a Recirculating Aquaculture System (RAS)

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Abstract

The study was conducted within the recirculating aquaculture system for sturgeon rearing in Herneacova village, Timis County, on a population of juvenile sterlet (*Acipenser ruthenus*) aged between 346-431 days. Specimens were housed in five round tanks ($\varnothing=3$ m, $V=6$ m³, $h=100$ cm) and fed with commercial extruded pellets (3 mm granulation, 48% CP, and 10% EE). Fish from each tank were individually weighed and measured once every two weeks. Bioproductive indices such body weight gain (BW), specific growth rate (SGR), and feed conversion ratio (FCR) were calculated at the end of an 85 days experimental period.

Statistical analysis was performed using the SPSS IBM 22 and Minitab 16 software. Data were reported as Mean \pm Sx at a significant level of $p<0.05$. Testing differences between means was realized by ANOVA completed with post-hoc Tukey test.

The results obtained indicate that the growth performance of juvenile *Acipenser ruthenus* seems to be similar and even better than that of other sturgeons species reared in recirculating aquaculture system.

Keywords: *Acipenser ruthenus*, bioproductive indices, growth performances, sturgeon, recirculating aquaculture system (RAS)

1. Introduction

(RAS) are designed to minimize water consumption, control culture conditions and allow waste streams to be fully managed. They can also provide some degree of biosecurity through measures to isolate the stock from the external environment [1].

RAS offers the advantage that temperature and other variables such pH, salinity, metals, suspended solids, pathogens, oxygen, carbon dioxide and organic taint compounds can be

controlled, in order to maximize growth and maintain fish health.

RAS are currently being used to grow catfish, striped bass, tilapia, crawfish, blue crabs, oysters, mussels, aquarium pets [2, 3] and among sturgeons (White sturgeon, Siberian sturgeon, Russian sturgeon, Atlantic sturgeon, Beluga sturgeon, Sevruga, Sterlet) [4].

Sturgeon's rearing technologies were developed especially on sterlet, because this is a relatively small species, with breeding specimens having 2-4 kg body weight, and easier to manipulate. Also, this species reaches sexual maturity faster than other sturgeon (2-3 years in farm conditions and 4-6 years in natural waters) [5].

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Specific growth rate (SGR) and feed conversion ratio (FCR) are among the most significant technological indicators in juvenile sturgeon farming. Thus, specific growth rate (SGR) is the parameter that indicates most accurately the dynamic of individual growth and/or total biomass growth) and feed conversion ratio (FCR) is a measure of an animal's efficiency in converting feed mass into increased body mass.

This study was conducted to assess the growth performances of juvenile sterlet *Acipenser ruthenus* raised in a recirculating aquaculture system (RAS).

2. Materials and methods

Experimental fish

Our research was conducted between February 25 2014-21 May 2014 within the recirculating aquaculture system for sturgeon rising from Herneacova village, Timis County, on a population of juvenile sterlet (*Acipenser ruthenus*), aged between 346-431 days.

Biological material was hatched on 03/17/2013 and it was obtained from F2 generation of breeders. On arrival in the fish farm (27/07/2013) they have recorded an individual average weight of 55-60 g. At the beginning of the experiment, studied sterlet specimens were aged 346 days, average weight 390 g, and an average body length

of 45.5 cm. Five growth tanks and a total number of 150 individuals (30 individuals/thank) were targeted in the experiment.

Fish from each tank were individually weighed and measured once every two weeks. Gravimetric characters (weight) were done simultaneously with the metrics using an electronic scale after the fish were anesthetized with clove oil (10 ml/50 l water).

Experimental diet and feeding

Feed administration was done automatically, the bunker screw feeder having a working duration of 10 to 11 h/day at the beginning of the experimental period, and up to 10-13 hours/day to end. Given that sturgeon is "slow" fish, slowly consuming, the feeders were adjusted so that the feed was given 2 times/h (33 g/s). The daily feed ration was calculated based on sterlets biomass: at the beginning of the experimental period it was 1% from the stock biomass, and then it was reduced to 0.9% in March-April and to 0.75% in May.

Nutrition research in sturgeons has established that fingerlings and breeders specimens must have at least 40% protein and 8 to 10% fat in their diet [5].

So pellet had a grain size of 3 mm, a content of 48% CP, 10% EE, and the following composition (Table 1).

Table 1. Feed composition

Components	Unit	Value
Crude Protein	%	48
Crude fat	%	10
Crude fiber	%	0.8
Ash	%	8.6
Phosphorus	%	1.3
Calcium	%	1.6
Sodium	%	0.4
Vitamin A	(U.I)	13.750
Vitamin C	mg/kg	1.015
Vitamin E	mg/kg	276
Vitamin D (mg/kg)	mg/kg	1.782
Iron (ferrous sulphate monohydrate)	mg/kg	117
Iod (anhydrous calcium iodate)	mg/kg	7.8
Copper (copper sulfate pentahydrate)	mg/kg	7.8
Manganese (manganese oxide)	mg/kg	31
Zinc (Zinc sulfate monohydrate)	mg/kg	125

Experimental system

Water's physical-chemical parameters (temperature, dissolved oxygen, pH) were recorded using a system consisting of controller to which a probe was connected.

The other chemical parameters, nitrates, nitrites, hardness, chlorine, were calorimetrically determined with a photo flex colorimeter and using rapid testers.

Calculations and statistical analysis

Bio productive indices such body weight gain (increase) (BW), (specific growth rate-SGR), and feed conversion ratio-FCR were calculated at the end of a 85 days experimental period using the following standard formula:

- biomass (weight) gain (BW)=final biomass (W_t)-initial biomass (W_0)(kg);
- feed conversion ratio (FCR)=total amount of feed distributed (F)/biomass (weight) gained

(BW)(kg/kg)

- specific growth rate (SGR)= $100 \times (\ln W_t - \ln W_0)/t$ (% BW/day)

Statistical analysis was performed using the SPSS IBM 22 and Minitab 16 software. Data are reported as Mean \pm SD at a significant level of $p < 0.05$. Testing differences between means was realized by ANOVA completed with post-hoc Tukey test.

3. Results and discussion

Juvenile sterlet's body mass recorded at the beginning of the experimental period the lowest value in tank B I-367.33 $g \pm 15.50$ g, and the highest value in tank II-390.16 $g \pm 15.08$ g. Individuals from tanks III (385.16 $g \pm 13.89$) and IV (383.50 $g \pm 14.42$ g) showed average values very close to the latest one. However, the differences between averages for the considered parameter were not statistically significant when compared with each other.

Differences between tanks remain significant in tests carried out at the age of 361 days of the sterlet specimens. Individuals from tank I presented again the lowest average body mass 387.33 $g \pm 19.79$ g, while similar to the previous

situation, individuals from tanks II, III and IV have recorded close averages of the body weight: 427.66 $g \pm 21.52$ g, 425.33 $g \pm 18.36$ g and 424.33 $g \pm 17.05$ g. But the fish from tank V were able to recover and even to exceed the start lower value to the tanks II, III and IV, reaching 448.33 $g \pm 23.11$ g (Figure 1). In other works, fish can grow faster after a period of slower growth, offsetting the delayed increase and catching up the specimens with continuous growth. This can be explained in that the fish exhibit a phenomenon called "compensatory growth" as a part of their growth strategy [6].

At the age of 375 days, juvenile sterlets achieved an average body weight ranging between 458.00 $g \pm 18.93$ g (tank I) and 540.33 $g \pm 20.98$ g (tank II). Fish from tank II have succeeded to keep the average body weight difference relative to fish from tank II that becomes now significant at threshold 0.05. The same significant difference has installed when fish of tank II are compared with those of tank IV with an average body weight of 469.33 $g \pm 16.80$ g and tank V with an average body weight of 476.33 $g \pm 11.96$ g, which have a slower performance over the period 361 days-375 days.

Weighing performed at the age of 389 days revealed no significant differences regard the mean body weight between the five tanks compared.

Conversely, individuals from tank I, with an average body weight of 521.66 $g \pm 13.78$ g succeed to approach those of the tanks II, III and IV, which achieved average values of 542.00 $g \pm 18.98$ g, 545.66 $g \pm 15.84$ g and 529.66 $g \pm 15.31$ g respectively. Individuals from tank V with an average body weight of 511.00 $g \pm 15.00$ g followed a trajectory somewhat slower within the interval 375 days, 389-days.

After other two weeks (403 days), mean body weight showed in its evolution a similar trend to the previous covered period, without the differences identified between the tanks to become significant. The tanks II, III and IV with average values starting from 578.33 $g \pm 21.48$ g and continuing with 594.66 $g \pm 20.13$ g, and 595.66 $g \pm 20.03$ g respectively, were followed in order by tank V (555.33 $g \pm 13.55$ g) and tank I (533.66 $g \pm 19.04$ g).

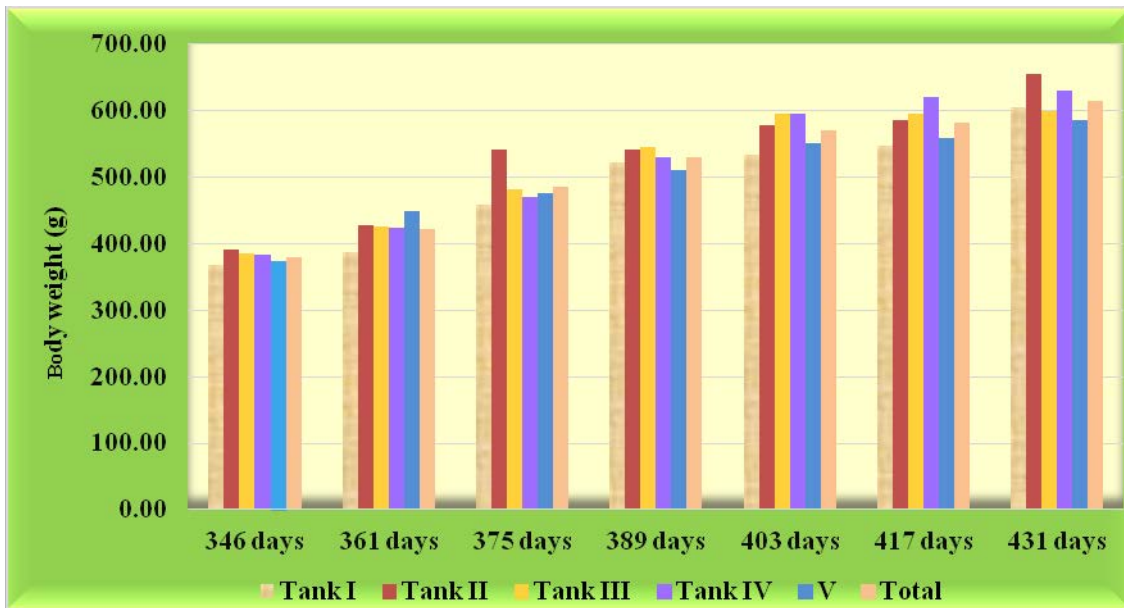


Figure 1. The dynamic of the body weight in the rearing tanks during 346 days-431 days

Individuals from tank V are clearly delimited from those of tank those of tank I at the age of 417 days, the average body weight of 72.67 g being statistically significant ($p < 0.05$). Mean values in the tank I ($585.66 \text{ g} \pm 17.86 \text{ g}$), tank II ($595.33 \text{ g} \pm 20.87 \text{ g}$), and tank V ($559.00 \text{ g} \pm 14.35 \text{ g}$) and compared to each other not proved to be significant. Last weighing done at the age of 431 days brings the averages body weight at very close values and the differences arise between tanks are not statistically significant. At the end of the

experiment, the average body weight of individuals in the tank II $654.00 \text{ g} \pm 26.36 \text{ g}$ go beyond the one belonging to individuals in tanks I, III and IV with 50.0 g, 54.67 g and 24.67 g, difference that increases at 69 g between tanks II and V.

From the analysis of the data plotted in Figure 2, it follows that the total biomass of the 150 individuals has increased from 56.97 kg at the age of 346 days, at 92.15 kg at the age of 431 days.

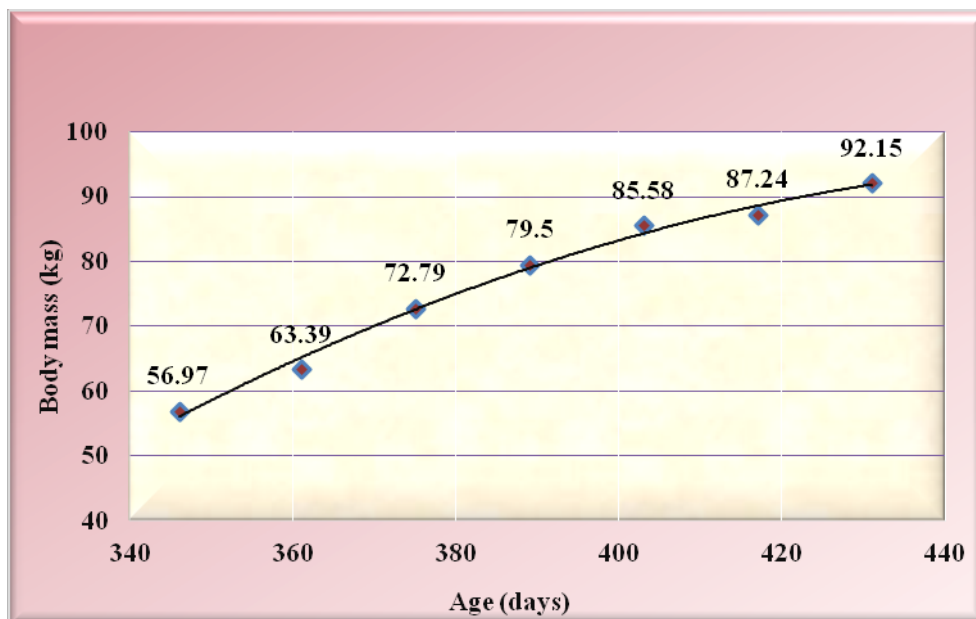


Figure 2. The evolution of the total biomass during 346 days-431 days

Specific growth rate and feed conversion ratio are the two most important factors indicating the effectiveness of feed management and economic performance in aquaculture. Along with water temperature and fish size, these two parameters are closely associated with daily feeding rate or ration size [7]. The determination of optimum ration size (daily feeding rate) giving the best growth and food conversion ratio is, therefore, an important element for the effective feed management [8] and successful commercialization of any fish species. To calculate some of them, the amount of feed that was to be administered has been established.

This ranged between 0.75 and 1% from fingerling size. Scientific literature recommend for juvenile sterlet with a body weight of 200-800 g, a feed rate ranging from 0.75% and reaching to 1.5% [9, 10].

Given the variations in temperature and the concern for maintaining the water quality, the decreasing of feed rate was imposed as table below shows. Knowing the volume of the rearing tanks (6 m³) we were able to determine the stocking density during the considered period (Table 2). Analyzing data from table 2 it can see that this increased from 9.47 kg/m³ to 15.34 kg/m³.

Table 2. The amount of feed administered in relation to the number of individuals and total body mass

n	Total biomass (kg)	Feed rate (%BW/day)	Calculated feed (kg)	Administered feed (kg)	Density (kg/m ³ water)
			346 days		
150	56.97	1	0.56	0.55	9.47
			361 days		
150	63.39	0.90	0.56	0.55	10.54
			375 days		
150	72.79	0.90	0.65	0.63	12.12
			389 days		
150	79.50	0.85	0.67	0.65	13.22
			403 days		
150	85.58	0.85	0.72	0.7	14.24
			417 days		
150	87.24	0.75	0.65	0.63	14.51
			431 days		
150	92.15	0.75	0.69	0.67	15.34

Based on the formula set out in section Material and methods, we determined the bio productive

indices of the juvenile sterlets at aged 361-431 days (Table 3).

Table 3. Bio productive indices of juvenile sterlets at 361 days-431 days (mean values)

Tanks	BW (kg)	SGR (%/day)	FCR (kg feed/kg weight gained)
			346 days-361 days
I-V	6.81	0.45	1.23
			361 days-375 days
I-V	9.90	0.75	0.72
			375 days-389 days
I-V	8.36	0.64	0.97
			389 days-403 days
I-V	7.22	0.55	1.17
			403 days-417 days
I-V	6.67	0.48	1.36
			417 days-431 days
I-V	6.91	0.51	1.18

BW (biomass (weight) gain = $W_t - W_0$

SGR (specific growth rate) = $(\ln W_t - \ln W_0) / t \times 100$, W_t : final weight; W_0 : initial weight; t: duration

FCR = feed conversion ratio (kg feed/kg weight gained)

Analyzing the data presented in table 3, it appears that a lower body weight gain is followed by a higher feed conversion ratio and vice versa.

Recorded values for the parameter FCR by studied starlet population, proving that sturgeon used efficiently the feed, FCR reported in literature being 1.0-1.4 in juvenile and maximum 1.6-2.0 in adults [5]. There are three reasons for that the fish are efficient eater: the biology of the fish (it's cold-blooded, so doesn't need energy to keep warm), the way the fish live (just float about without using much energy) and the high nutrient concentration of fish feed compared to land-based animals [11]. Additionally, it can observe that between efficiency of feed utilization factor, expressed by feed conversion ratio (FCR), and the specific growth rate (SGR) is an inverse relationship (Table 3).

Table 4 presents the evolution of the real weight gain in relation to water temperature and dissolved oxygen. Analyzing the values recorded for the microclimate parameters, we note that after the age of 375 days, as the water temperature increases, and the amount of dissolved oxygen decreases, real weight gain decreases. At the same time, the feed rate decreased with water temperatures increasing, in order to minimize the possible adverse effects of elevated levels of this parameter. As such, even if temperature exerts a predictable influence on the oxygen consumption, food processing and metabolic rate, the temperature increasing is not necessarily linked to a faster growth; Fish can become anorexic even under optimal growth conditions or absence of competitors [12].

Table 4. Real weight gain in relation to the water's temperature and dissolved oxygen during 346 days-431 days

Age	BW (kg)	Temperature (°C)	Dissolved oxygen (mg/l)
346 days-361 days	6.81	16.2	8.25
361 days-375 days	9.90	16.6	8.04
375 days-389 days	8.36	17.0	7.81
389 days-403 days	7.22	18.1	7.77
403 days-417 days	6.67	18.4	7.64
417 days-431 days	6.91	18.8	7.26

BW (biomass (weight) gain) = $W_t - W_0$

Table 5 shows the evolution of FCR in relation to water temperature and dissolved oxygen during the experimental period. The water temperature in the rearing tanks was within the recommended limits for the species and age of the studied individuals [13].

Regarding the level of oxygen, as the amount of dissolved oxygen is higher, growth rate is greatly improves and feed conversion is reduced [12]. In our study, the best feed conversion ratio was recorded at water's temperature of 16°C and an oxygen level of 8.04 mg/l.

Table 5. Feed conversion ratio in relation to the water's temperature and dissolved oxygen during 346 days-431 days

Age	FCR (kg feed/kg weight gained)	Temperature (°C)	Dissolved oxygen (mg/l)
346 days-361 days	1.21	16.2	8.25
361 days-375 days	0.72	16.6	8.04
375 days-389 days	0.97	17.0	7.81
389 days-403 days	1.17	18.1	7.77
403 days-417 days	1.36	18.4	7.64
417 days-431 days	1.18	18.8	7.26

FCR = feed conversion ratio (kg feed/kg weight gained)

4. Conclusions

The results of our experiment in terms of growth performance and feed conversion efficiency indicate that the *Acipenser ruthenus* could be regarded as a potential candidate for species diversification in the aquaculture sector.

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