Preliminary Results about Growth Performance and Food Conversion Ratio of *Acipenser stellatus* juvenils, Fed with Different Dietary Protein Levels

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Abstract

The main purpose of this study is to evaluate the effects of different dietary protein levels on *Acipenser stellatus* growth performance. Researches were conducted between 4 th November-3rd December 2011, in the recirculating system of Aquaculture, Environmental Science and Cadastre Department, University of Galati. A number of 60 fish with an average weight of 11.5±0.58 g were randomly stocked into four rearing units, with same stocking densities. Two experimental variants with different dietary protein levels, 64% (V1) respectively 41% (V2), were applied in duplicate. At the end of the experiment, the specific growth rate (SGR), calculated as mean value of both repetitions for each variant, was 4,64%/day at V1 and 4,63%/day at V2. Protein efficiency ratio PER (g/g) registered a better value at V2 (2.55 g/g), comparing to V_1 (1.62 g/g). Regarding feed conversion ratio, almost identical values were observed in case of both experimental variants: 0,96 at V_1 and 0.97 at V2. The final results of the experiment showed that while PER was significantly influenced by dietary protein levels, the rest of growing indicators had a very limited variation scale.

Keywords: Acipenser stellatus, FCR, PER, protein level

1. Introduction

Considering the growing rate of world population and so, the grow of humans need of various and healthy protein resources, aquaculture has come to play an important role in providing this proteins [1]. Intensive fish farming requires the availability of certain diets that provides maximum growth and survival rates under minimal costs conditions. [2]. All feed nutrients must be balanced, but proteins have an important role on fish reproduction, growth and even survival [3]. Although nowadays commercial diets are quite varied for common species (trout, carp), when it comes to sturgeons, their number is limited. Due to its sensitivity to nutritional requirements and feeding behavior, the growth of sevruga in its early stages, is very important, technologically speaking. Therefore, the fulfillment of both quantitative and qualitative physiological requirements is a strategic objective of the technological management at this development stage. In these circumstances, an appropriate nutritional program, in terms of dietary protein content, is an important issue for the early development stages. Given this arguments, the main objective of this work is to develop scientific knowledge regarding juvenile sturgeons nutritional requirements and to evaluate the influence of different dietary protein levels on their growth performances.

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2. Materials and methods

The biological material used in the present experiment is represented by 3 months old *Acipenser stellatus* juveniles (60 individuals), with a mean body mass of 11.5 g. The juveniles were provided from SC Kaviar House sturgeon station - Horia, Tulcea County, representing first generation obtained from aquaculture breeders. This event is a premiere in aquaculture domain from Romania where, until now, the breeders were represented by wild sturgeons. The experiment lasted 30 days (November 4 to December 3, 2011) and took place in the pilot station of Aquaculture, Environmental Science and Cadastre Department. Constructive description of the pilot aquaculture recirculating system is detailed in many other specialized studies [4, 5]. The monitoring of environmental factors was performed daily (temperature, dissolved oxygen) with a Hanna HI 9147 Multiparameter Portable and weekly (pH and nitrogen compounds - $N\text{-}NO^{3-}$, $NO^{2-}N\text{-}$, $N\text{-}NH^{4-}$). The pH was measured with WTW model 340 pH meter. Nitrogen compounds were determined with Spectroquant Nova 400 spectophotometric and Merck compatible kits. Statistical analysis performed to determine the homogeneity of the experimental group was made using Windows Excel software package. Statistical differences between the two experimental variants were determined by using T-test. Two variants were experienced: V1 (in B1 and B3) and V2 (in B2 and B4). In each experimental unit, a number of 14-16 sevruga juvenils were randomly placed, in this way creating homogeneous groups. Two types of commercial pellets were manually distributed, five times per day. Biochemical feed composition is shown in Tables 1 and 2.

Table 1. The chemical composition of a feed 1

Components	Quantity
Protein	64%
Lipids	12%
NFE	6%
Ash	11%
fiber	0.5%
Vitamin A	10 000IE/kg
Vitamin D3	800 IE
VitaminE	300 mg
Gross energy	84976/20 Kcal/MJ
Convertible energy	43901/16 Kcal/MJ

The protein content, commercial pellets most important parameter, percentage is: 64% for feed no.1-V1 and 41% for feed no. 2-V2. Feeding intensity was the same for both versions, namely 4.65% of the biomass.

Table 2. The chemical composition of a feed 2

Components	Quantity
Protein	41%
Lipids	12%
Cellulose	3%
Ash	6.5%
Phosphorus	0.9%
Vitamin A	10 000UI
Vitamin D3	1250 UI
Vitamin E	150 mg
Vitamin C	75 mg
Digestible energy	14.2 MJ/kg
Lysine	2.4%
Methionine	0.75%
Cystine	0.6%

At the end of the experiment, from biomass biometric measurements, the main growth performance parameters (daily growth rate, feed conversion factor, specific growth rate, protein efficiency) were calculated as following:

Increase of biomass growth (W) = final biomass (Wt)- initial biomass (W0) (g);

Feed conversion ratio (FCR) = total amount of feed distributed (F)/g biomass grow rate (W) (g/g);

Specific growth rate (SGR) = 100 x (lnWt - ln W0)/t (% BW/day);

Protein retention efficiency (PER) = increased growth biomass (W) / protein feed (P) (g);

Also in graph it was shown the correlation between length and weight determining the exponent "b" from the growth equation W = a* W-Lb where W = fish mass (g), L-total length (cm) and a – length coefficient.

3. Results and discussion

During the experiment, water quality parameters were monitored. Thus, the temperature values varied between 18.70 and 22.38±0.18°C ± 0.28°C, optimal for sturgeons growth [6, 7]. Dissolved oxygen values ranged between 5.85±0.44 - 8.15± 0.06 MGL/l and pH values between 7.93±0.04 - 8.14±0.04 pH unit. The good evolution of physical

water parameters, without significant variations, is shown in Figure 1.

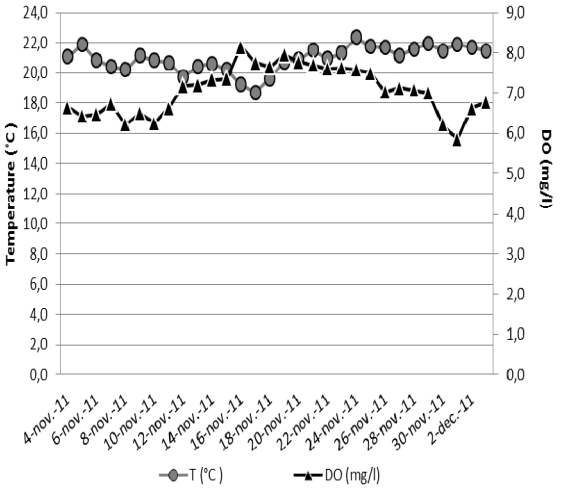

Figure 1. Variation of main water parameters

Concerning the dynamics of metabolism and nitrification products, they maintained within the optimal range, average values of nitrate, nitrite and ammonia being showed in Figure 2.

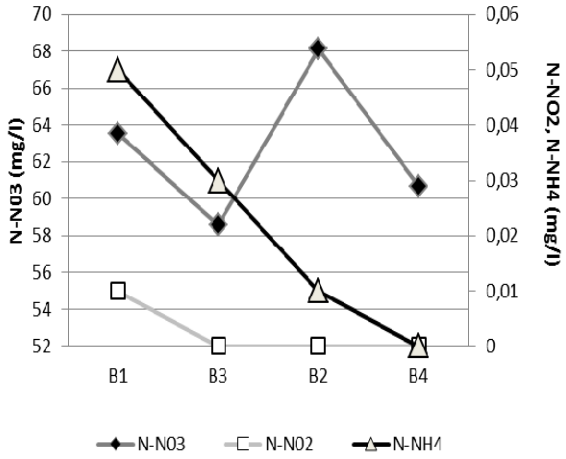

Figure 2. Changes in nitrogen compounds

The initial biomass biometric characteristics are presented in Table 3. Regarding mass variability, there were not significant differences between experimental groups, statistically speaking (T test, $p \geq 0.05$).

Table 3. Somatic characteristics at the start of the experiment

Indicators / *tank*		*W (g)*	*Lt (cm)*
V_1	B_1	11.83±6.31	15.33±3,34
	B_3	11.07±4.35	15.31±2.50
V_2	B_2	11.57±3.80	15.51±2.36
	B_4	10.94±6.43	15.03±3.42

The data related to growth and technological performances are presented in Table 4.

At the end of the experiment, the final biomass (calculated as the mean value of the two repetitions from the both variants) reached 2.29 kg/m^3 in variant V_1 and 2.25 kg/m^3 in variant V_2. Regarding the final individual mean weight (g/ex), it can be observed that fish from the second variant (V_2) showed a better growth compared with those from the first variant (V_1), so in variant V_2 the final average individual weight of the exemplars was higher (46.50 g/ex) than the one from V_1 (46.00 g/ex).

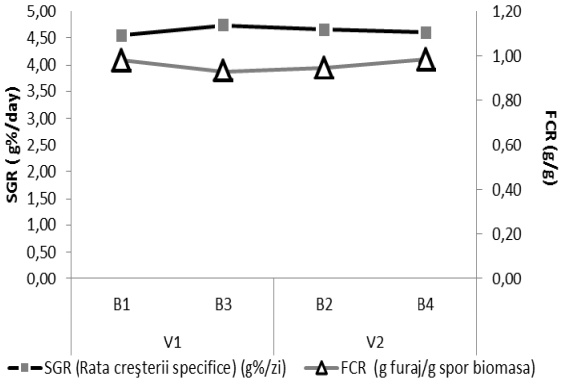

Figure 3. Evolution of FCR and SGR during the experiment

The values of protein retention efficiency (PER) in both variants (1.62 g/g in V_1, respectively 2.55 g/g in V_2) revealed that the individuals from V_2 have converted more efficiently the feed with 41% protein, fact also confirmed by Molla, 2010 [8], for Acipenser persicus (0.6 g), which reported good PER values for a dietary protein level of 40% (4-5g/g) and excellent PER values for a dietary protein level of 45% (5-6g/g). These values recommends using feed with 41% protein for growing sevruga juveniles, fact reported also by other authors, in case of other species of juvenile sturgeons ([9]-white sturgeon; [10]-siberian sturgeon; [11]-paddlefish).

Figure 4 presents the fish growth evolution in each of the four tanks. There are very close values between the two experimental variants, V_1 and V_2. The data related to juvenile sevruga growth from both experimental variants, V_1 and V_2, indicates that using two types of feed with different protein concentrations did not significantly influence the weight gain.

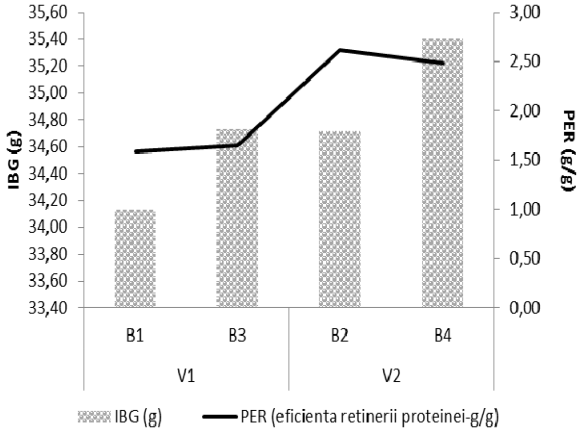

Figure 4. The variation of protein retention ratio (PER) and individual growth rate

Table 4. The synthetic table regarding the technological performance indicators for the *Acipenser stellatus* juvenile in a recirculating aquaculture system, under dietary different level

Experimental variant	V1			V2		
Indicator/tank	B1	B3	Mean	B2	B4	Mean
Initial biomass (g)	177	166	171.5	162	175	168.5
Initial biomass (kg/m^3)	0.59	0.55	0.57	0.54	0.58	0.56
Final biomass (g)	692	686	689	654	696	675
Final biomass (kg/m^3)	2.30	2.28	2.29	2.18	2.32	2.25
Biomass gain (g)	515	520	517.5	492	521	506.5
Biomass gain (kg/m^3)	1.71	1.73	1.72	1.64	1.73	1.69
Initial numbers of fish	15	15	15	14	16	15
Final numbers of fish	15	15	15	14	15	14
Survival (%)	100	100	100	100	94	97
Mean individual weight (g/ex)	12	11	11.5	12	11	11.5
Mean final weight (g/ex)	46	46	46.00	47	46	46.50
Individual biomass gain (g)	34	35	34.50	35	35	35.00
Specific growth rate SGR (%/day)	4.54	4.73	4.64	4.65	4.60	4.63
Feed conversion ratio FCR (g/g)	0.98	0.93	0.96	0.95	0.98	0.97
Crude protein (PB-%)	64	64	64	41	41	41
Protein efficiency ratio PER (g/g)	1.59	1.65	1.62	2.62	2.48	2.55

Thus, specific growth rate (SGR), which is the parameter that indicates most accurately the dynamic of individual growth and/or total biomass growth, has registered values between 4.64% in V1 case and 4.63% for V_2.

Also, in terms of FCR, almost similar values we registered (0.96 g feed / g biomass gain in V_1 and 0.97 g feed/g biomass gain in V_2). Also similar protein levels (54%, 40.75%), FCR having closed results to those of present study were reported by V. Cristea et al. [4], for two different dietary values in this case (1.19 for 54% and 1.3 for 40.75%).

From the regression power of individual weight regarding the allometric coefficient, respectively and length (initial and final), slight differences the conditions of the individuals, can be noticed (Figures 5, 6).

The relative robustness of a population of fish can be detected from a length-weight regression. Thus, in our case, the feed with a higher protein concentration does not influence the fish relative robustness. A negative allometric grow (b <3) can be seen on both initial and final stage of the experiment. The values of allometric coefficient, calculated at the end of the experiment, reflects an improvement of fish condition, in variant V2, comparing to the initial stage.

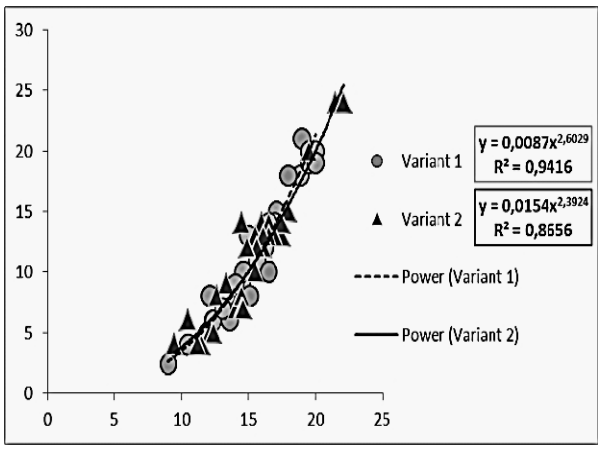

Figure 5. Length-weight regression at stocking

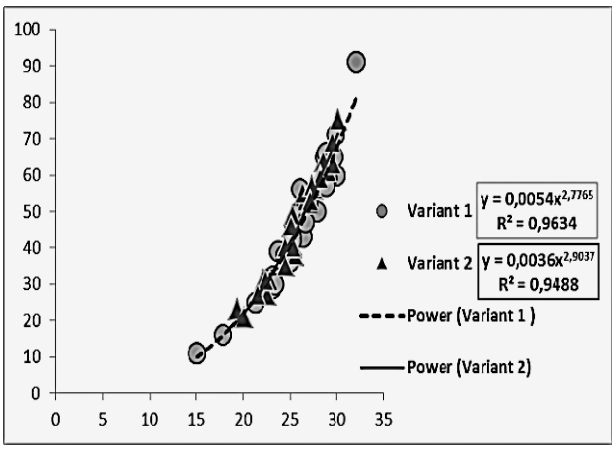

Figure 6. Length-weight regression at harvest

4. Conclusions

During the experimental period, the biological material showed an active feeding behavior and good growing conditions and adaptability. In present study, we can conclude that the group of fish fed with high protein diets (feed1-64% crude protein) showed an almost equal growth rate comparing with the other group fed with feed2 - 41% crude protein diet and therefore a lower protein utilization. Regarding the above statement, also Zhiqiang Guo [12] reported that food consumption decreases with increasing the dietary protein level. The most important economic factors, involved generally in feeding process of the commercial fish production, are feed efficiency and also growth indicators. As a result, the most suitable cost index is related to second group, the one where 41% crude protein diet was used. It is recommended that high protein diets used for juvenile sturgeons farms should be first evaluated from economical perspectives, so that situations as above, where increasing the dietary energy did not led to an improved growth performance, will not happen on an industrial level.

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References

1. Abedian, A. M., Mohammadi, M., Shariatmadari, F., Determination of optimal dietary protein level for juvenile beluga (Huso huso) Proceeding of the Fourth International Iran&Russia Conference, 2009, pp. 1370.
2. Piper, R.G., McElwain, I.B., Orme, L.E. McCraren, J.P., Fowler, L.G. and Leonard, J.R., Fish hatchery management, U.S. Fish and Wildlife Service. Washington, D.C., 1982.
3. Oprea, L., Georgescu, R., Nutriţia şi alimentaţia peştilor, Editura Tehnică, Bucureşti, 2000, p.11-12.
4. Cristea, V., Grecu, I., Ceapă, C., Cristea, V., Talpeş, M., Roşu, A., Research about *Acipenser stellatus* growth in super intensive system with aquarium units, International Symposium „Euro-food", 2003, p.815-834.
5. Vasilean, I., Cristea, V., Sfetcu, L., Influence of stocking density and water parameters on growth of juvenile beluga sturgeon (Huso huso, Linnaeus 1758), Bulletin of the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Bulletin, 2008, 65 (1-2).
6. Mims, S.D., Lazur, A., Shelton, W.L., Gomelsky, B. and Chapman, F., Species profile: Production of

Sturgeon. Southern Regional Aquaculture Center, Publication, 2002, 7200.
7. Van Eenenaam, J.P., Chapman, F. and Jarvis, P., Sturgeons and Paddlefish of North America. Aquaculture, In Le Breton et al., eds. KluwerAcademic PublishersDordrecht/Boston/London, 2004, pp. 277-311.
8. Molla, A.E. and Amirkolaie, A.K., Growth performance of Persian sturgeon fry, *Acipenser persicus*, fed diet containing different protein and energy levels, Journal of Applied Aquaculture, 2010, 27, 2011,766-770.
9. Moore, B.J., Hung, S.S.O. and Medrano, J. F., Protein requirement of hatchery produced juvenile white sturgeon (*Acipenser transmontanus*), Aquaculture, 1988, 71, 235–245.
10. Kaushik, S.J., Breque, J. and Blanc, D., Requiremqnts for protein and essential amino acids and their utilization by Siberian sturgeon (Acipenser baeri), In P. Williot editor. Acipenser. Actes du premier colloque international sur l' esturgeon. Cemagref, Bordeaux, France, 1991, pp. 25-39.
11. Steven, D. Mims, Andrew Lazur, William L. Shelton, Boris Gomelsky, Frank Chapman Production of Paddlefish, SRAC, 1999, Publication no. 437.
12. Zhiqiang, G., Xiaoming, Z., Jiashou, L., Dong, H., Yunxia Y., Zeqiao, L., Shouqi, X, Effects of dietary protein level on growth performance, nitrogen and energy budget of juvenile hybrid sturgeon, *Acipenser baerii* ♀ × A. gueldenstaedtii ♂, Aquaculture, 2012, 338-341(2012), 89-95