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The influence of pellets quality on the growth of sterlet, in recirculating aquaculture system

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Abstract. The paper presents some aspects regarding the influence of food quality on the breeding of sterlet, *Acipenser ruthenus* Linnaeus, 1758*,* in a recirculating aquaculture system (RAS). The experiment took place over 30 days, in four pilot breeding units type aquaria of 300 liters in volume. Two kind of variants were compared, with repetition, V1 with 46% crude protein and V2 with 30% crude protein, respectively. The stocking density was of 14 fish/unit. The same feeding level of 8 g/kg metabolic weight (1.5% from total biomass) was used in every unit. The technological indicators that showed up at the end of the experiment revealed the following: the mean biomass gain in V1 was of 0.74 kg/m^3 compared to 0.39 kg/m^3 in V2; this was nearly perfectly correlated with the food quality. The growth rate (GR) variated from 6.70 to 8.13 g/day in V1 and 3.63-4.17 g/day in V2; the specific growth rate (SGR), calculated as a mean value of the two repetitions of each variant, was of 1.11 g%/day in V1 and 0.63 g%/day in V2; the feed conversion ratio (FCR), calculated as the mean value of the two repetitions from the two variants, was of 1.49 in V1 and of 2.81 in V2. The parameters of fish breeding showed that changing the quality of fodder, the fish growing was positively influenced. This experiment showed also that sterlet is a sturgeon with a moderate growth rate and it is possible to obtain an increase of fish biomass using pellets with 30-46 % crude protein.
Key Words: sterlet, RAS, fodder quality.

Résumé. Le travail présente quelques aspects concernant l'influence de la qualité des granules sur la croissance de l'espèce *Acipenser ruthenus* Linnaeus, 1758*,* dans un système recircule d'aquaculture (RAS). L'expériment a été fait durant 30 jours dans des unités d'élévage (aquariums) avec un volume de 300 l. On a comparé deux variantes, avec répétition: V1 avec 46% proteine brute et V2 avec 30% proteine brute. Dans chaque aquarium ont été introduits 14 poissons, en utilisant la même ration alimentaire de 8g fourage/kg poid metabolique (1,5% de biomasse totale). À la fin de l'expériment, les indicateurs technologiques ont eu les valeurs suivantes: la biomasse gagnée en V1 a été 0,74 kg/m^3 tandis qu'en V2 elle a été 0,39 kg/m^3. La croissance journalière (GR) a augmenté de 6,70 g/jour à 8,13 g/jour en V1 et de 3,63 g/jour à 4,17 g/jour en V2. La valeur de la croissance spécifique (SGR), utilisée comme la moyenne entre les deux répétitions de chaque variante, a été de 1,11 g%/jour en V1 et 0,63 g%/jour en V2; en meme temps le coefficient de conversion de la nourriture (FCR), calculé aussi comme la moyenne entre les deux répétitions de chaque variante, a été de 1,49 g fourage/g biomasse gagnée en V1 et 2,81 g fourage/g biomasse gagnée en V2. Les indicateurs technologiques ont montré que la croissance des poisssons est positivement influencée par la qualité des granules. La recherche a fait la preuve aussi que l'espèce *A. ruthenus* est un esturgeon avec un rythme de croissance satisfaisant; en utilisant des granules avec les proteines de 30-46% on peut gagner une certaine quantité de poissons.
Mots-clés*: Acipenser ruthenus*, granules, systemes recircules d'aquaculture.

Rezumat. În lucrare sunt prezentate unele aspecte privind influenţa calităţii furajului asupra creşterii speciei *Acipenser ruthenus* Linnaeus, 1758, într-un sistem recirculant de acvacultură (RAS). Experimentul s-a derulat pe o perioadă de 30 de zile în unităţi de creştere tip acvariu cu un volum util de 300 litri. S-au comparat două variante experimentale, în duplicat: V1 cu proteină brută din furaj de 46% şi V2 cu proteină brută de 30%. Densitatea de populare a fost de 14 exemplare/acvariu. În fiecare unitate de creştere s-a folosit o raţie de 8 g/kg greutate metabolică (1,5% din biomasa totală). Indicatorii tehnologici obţinuti la sfârşitul experimentului au avut următoarele valori: sporul de biomasă obţinut în V1 a fost de 0,74 kg/m^3, iar în V2 de 0,39 kg/m^3. Rata creşterii zilnice (GR) a variat de la 6,70 g/zi la 8,13 g/zi în V1 şi de la 3,63 g/zi la 4,17 g/zi în V2; rata creşterii specifice (SGR), calculată ca o valoare medie între cele două repetiţii ale fiecărei variante, a fost de 1,11 g%/zi în V1 şi 0,63 g%/zi în V2; factorul de conversie a hranei (FCR), calculat ca valoare medie între cele două repetiţii a fost de 1,49 g furaj/g spor biomasă în V1 şi 2,81 g furaj/g spor biomasă în V2. Parametrii tehnologici au arătat că, schimbând calitatea furajului, rata creşterii este influenţată în mod pozitiv. Acest experiment ne-a

demonstrat că specia *A. ruthenus* este un sturion cu un ritm de creştere moderat şi că folosind furaje cu un conţinut de proteină brută între 30-46% se poate obţine un spor de creştere semnificativ.
Cuvinte cheie: cegă, sisteme recirculante, calitate furaje granulate.

Introduction. The decline of Danube Basin sturgeon populations, due to a combination of factors such as blockage of migration routes, overfishing, pollution and habitat loss, is real (Dettlaff et al 1993; Birstein 2002; Bloesch 2006; Hochleithner & Gessner 2001). Overfishing has caused increasing mortality of adult sturgeons, while the size of breeding sturgeon has been decreasing (Williot 1997).

Aquaculture of sterlet (*Acipenser ruthenus* Linnaeus, 1758) has only recently begun in Romania, prompted by their declining populations in natural habitats (Bura 2008; Muscalu et al 2009). Recirculating aquaculture systems provide opportunities to reduce water usage, to improve nutrient recycling and finally to obtain a fish biomass gain (Martins et al 2010; Bura & Szelei 2009).

In recirculating aquaculture systems, quality and quantity of food and its management represent main Technology Management requirements (Oprea & Georgescu 2000; Cristea 2002). In order to obtain a high survival rate of the species, the food must meet several conditions as follows: to be easily ingested, provide nutrients for the fish growth, constant water parameters, attract fish by color and smell (Hamlin et al 2006; Oprea & Oprea 2009a, 2009b).

The paper presents aspects regarding the influence of food quality on the breeding of siberian sturgeon, in a recirculating aquaculture system (RAS).

Material and Method. The experiments were conducted in the pilot laboratory of the Aquaculture Department of the Faculty of Food Science and Engineering, Galati. The recirculating aquaculture system was formed by four aquaria-type units with a volume of 300 liters and a size of 100x80x40 cm. The system is equipped with a mechanical and biological filtration unit, an UV sterilization unit (equipment Quiet Tetra UV-C 35000, power 36 W) and an aeration equipment (compressor RESUN Quiet LP-100 100W, 0.045 MPa pressure and flow air 150 L/min.) (see Figure 1).

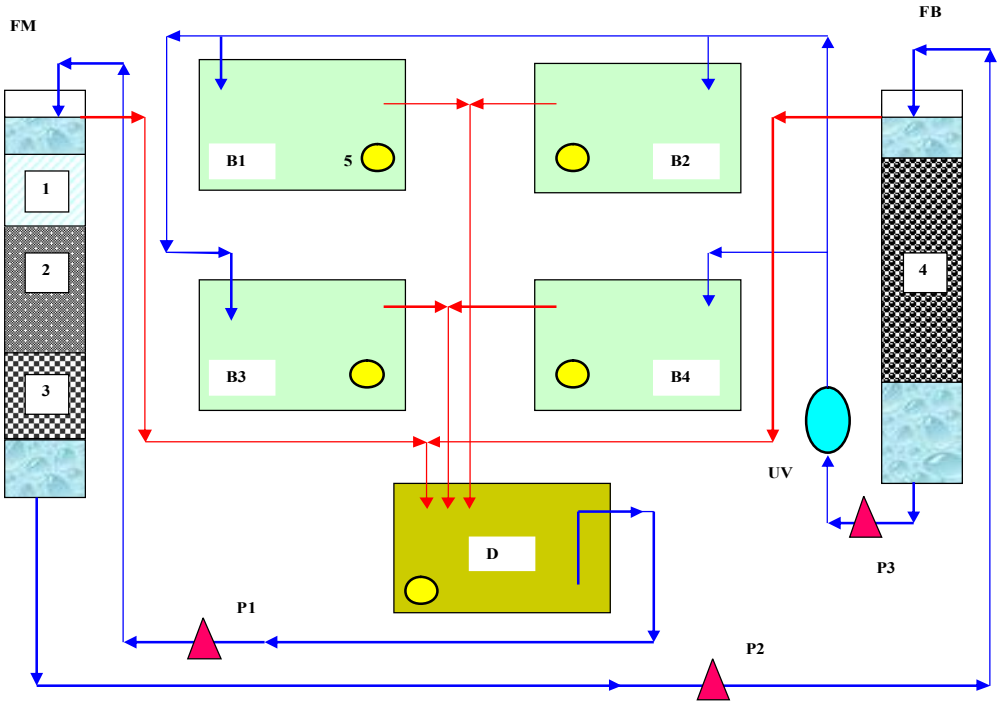

Figure 1. Recirculating system layout: (B1-B4)-aquaria, D-decanter, (P1-P3)-pumps, UV-sterilization lamp, FM-mechanical filter, FB-biological filter, 1-sponge, 2-sand, 3-gravel, 4-bactobolt, 5-aeration nozzle.

The temperature and the dissolved oxygen, which are the main physico-chemical water parameters, were measured daily with an equipment Hach-Lange Sc 1000.

As biological material, 6 months sterlet juveniles have been used, with an average body weight of 41 g/fish, provided by the Institute of Research and Development for Aquatic Ecology, Fisheries and Aquaculture from Galati. Two variants were experimented: V1 (aquaria B1, B2), and V2 (aquaria B3, B4), with the same stocking density, i.e. 14 fish/aquarium. During 30 days, between 20.11-19.12.2009, the same type of fodder of 2 mm granulation and different protein content (46% in V1 and 30% in V2) was distributed in all four tanks with the same feeding level of 8 g/kg metabolic weight (1.5% of total biomass) (see Table 1).

Table 1

Chemical composition of pellets

Nutrients	*V 1*	*V 2*
Crude protein	46 %	30 %
Fat	20 %	7%
Ash	6,8 %	7 %
NFE	20 %	43%
Crude fiber	2,8 %	5 %
Phosphorus	0,9 %	1,2 %
Vitamin A	9.500 U.I./kg	2500 U.I./kg
Vitamin D3	1500 U.I./kg	500 U.I./kg
Vitamin E	150 mg/kg	150 mg/kg
Copper	9 mg/ kg	150 mg/kg

Ingredients: products and sub-products from oilseeds, cereals and cereal sub-products, fish products, hemoglobin, oil, wheat gluten, BHT.
Granulation: 2 mm (1), 5 mm (2)

Results and Discussion. The main somatic measurements of fish at the start and at the end of experiment are given in the Table 2 and Table 3. The technological indicators of fish growth are presented with their values in Table 4 and graphically in Figure 2 and Figure 3. Figure 4 presents the variation of water temperature and dissolved oxygen.

Both experimental variants, V1 (aquaria B1, B2) and V2 (aquaria B3, B4) achieved significant growth gains in terms of survival by 100% in all tanks (see Table 4). In V2 the food ration had a lower protein content than V1 so that the growth rate was weaker, proportionally with feed quality. Analyzing the mean values for each variant, we can see an increase of fish biomass gain of 0.74 kg/m^3 in V1 and 0.39 kg/m^3 in V2. Daily growth rate (GR) ranged from 6.7–8.13 g/day (V1) and 3.63-4.17 g/day (V2). Figure 2 presents the evolution of the fish growth in all four growth units. Very similar values of the repetition of the two variants can be seen, meaning that the experiment went very well, having repeatable outcomes.

Among the most significant technological indicators there are the specific growth rate (SGR) and feed conversion ratio (FCR) (Oprea & Georgescu 2000). Both indicators were better in the V1 variant, when higher level protein was used (see Figure 3). Thus, the V1 has obtained a SGR value of 1.11 g%/day and an FCR of 1.49 g fodder/g gain growth, while in V2 has obtained a SGR value of 0.63 g%/day and a FCR of 2.81 g fodder/g gain growth. Figure 3 shows that there is an inverse correlation between SGR and FCR evolution; always a low FCR is achieved when SGR increases.

Regarding water quality, during the experiment the following parameters were daily monitored: water temperature and dissolved oxygen (see Figure 4). It is noted that during the experiment, temperature ranged within 19.1-24.6^oC, optimal for the growth of the species, while dissolved oxygen varied within the range 7.83–10.2 mg/L, values also optimal for the species studied.

Table 2

The somatic mesurements of fish at the start of experiment (stocking)

Nr. crt.	*V1*				*V2*			
	B1		*B2*		*B3*		*B4*	
	L (cm)	*W (g)*	*L (cm)*	*W (g)*	*L (cm)*	*W (g)*	*L (cm)*	*W (g)*
1	25	45	24.5	60	20	29	26	65
2	28	70	24.5	54	23.5	41	23	36
3	23.5	46	26.5	65	24.5	49	24	43
4	26	61	28	79	23.5	40	24	45
5	31.5	99	21.5	43	27.5	76	24.5	48
6	19.5	28	21	33	22	39	23	40
7	23.5	41	21	35	24.5	50	23	40
8	20	26	22	36	22	39	23	41
9	25	57	21	31	23.5	41	22,5	38
10	19	20	22.5	35	22.5	30	23	40
11	19.5	19	22.5	33	22	33	25	51
12	19	18	20	21	21.5	34	21	30
13	18	15	19	24	20.5	32	22	34
14	18.5	18	19	18	19.5	23	19	17
Total		563		567		556		568

Table 3

The somatic mesurements of fish at the end of experiment (harvesting)

Nr. crt.	*V1*				*V2*			
	B1		*B2*		*B3*		*B4*	
	L (cm)	*W (g)*	*L (cm)*	*W (g)*	*L (cm)*	*W (g)*	*L (cm)*	*W (g)*
1	25	49	22	38	22.5	29	26	54
2	37	172	24	41	27	57	21.5	38
3	26.5	59	21	25	25	50	24	44
4	22	32	21	27	21	32	26	56
5	21	29	27.5	86	24	41	25	51
6	27.5	55	25.5	75	21	27	24.5	46
7	20	26	27	58	25	50	26	52
8	23	28	24	53	24	45	25	49
9	30.5	94	27.,5	69	28	66	26	57
10	31	103	31	98	26	58	18.5	18
11	19	19	27.5	71	27	62	29	78
12	26.5	63	24.5	48	26	58	25.5	56
13	18	18	23	37	25	52	25.5	50
14	26.5	60	24.5	42	23	38	24	44
TOTAL		807		768		665		693

Table 4

Technological indicators of young sterlet growth

Experimental variant	*V1*			*V2*		
Indicator/acvarium	*B1*	*B2*	*Mean*	*B3*	*B4*	*Mean*
Initial biomass (g)	563	567	565	556	568	562
Initial biomass (kg/m^3)	1.87	1.89	1.88	1.85	1.89	1.87
Final biomass (g)	807	768	787.5	665	693	679
Final biomass (kg/m^3)	2.69	2.56	2.62	2.21	2.31	2.26
Biomass gain (g)	244	201	222.5	109	125	117
Biomass gain (kg/m^3)	0.81	0.67	0.74	0.36	0.42	0.39
Initial number of fish	14	14	14	14	14	14
Final number of fish	14	14	14	14	14	14
Survival (%)	100	100	100	100	100	100
Initial mean body weight (g/ex)	40	41	40.5	40	41	40.5
Final mean body weight (g/ex)	58	55	56.25	48	50	48.50
Number of days	30	30	30	30	30	30
Individual body weight gain (g)	18	14	15.75	8	9	8.50
GR (Growth rate)(g/day)	8.13	6.70	7.42	3.63	4.17	3.90
SGR (Specific growth rate) (g%/day)	1.20	1.01	1.11	0.60	0.66	0.63
Total feed distributed (g)	338	330	334	325	330	327.5
FCR (g fodder/g biomass gain)	1.35	1.64	1.49	2.98	2.64	2.81
Feeding level (g/kg met. weight)	8	8	8	8	8	8
Feeding level (% biomass)	1.5	1.5	1.5	1.5	1.5	1.5
Crude protein (%)	46	46	46	30	30	30

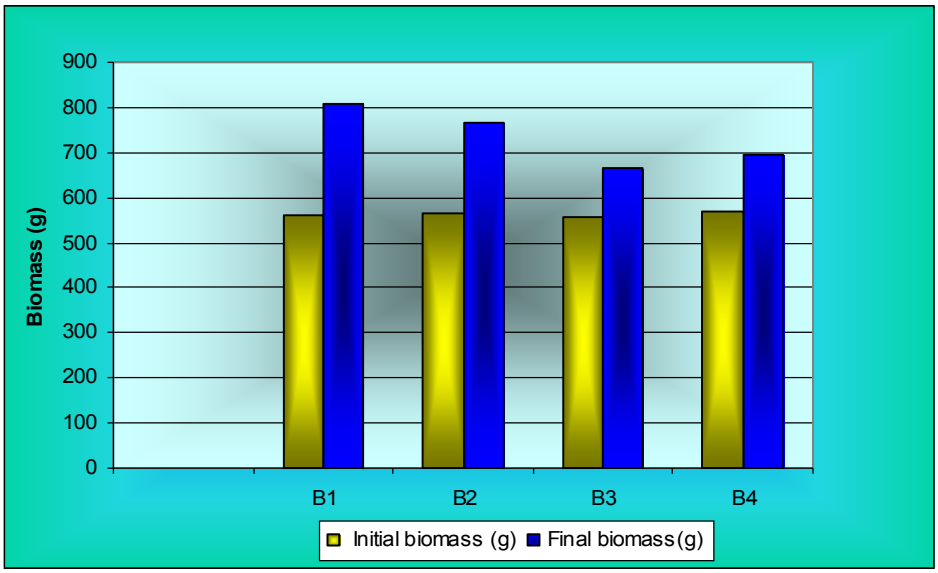

Figure 2. The evolution of fish growth.

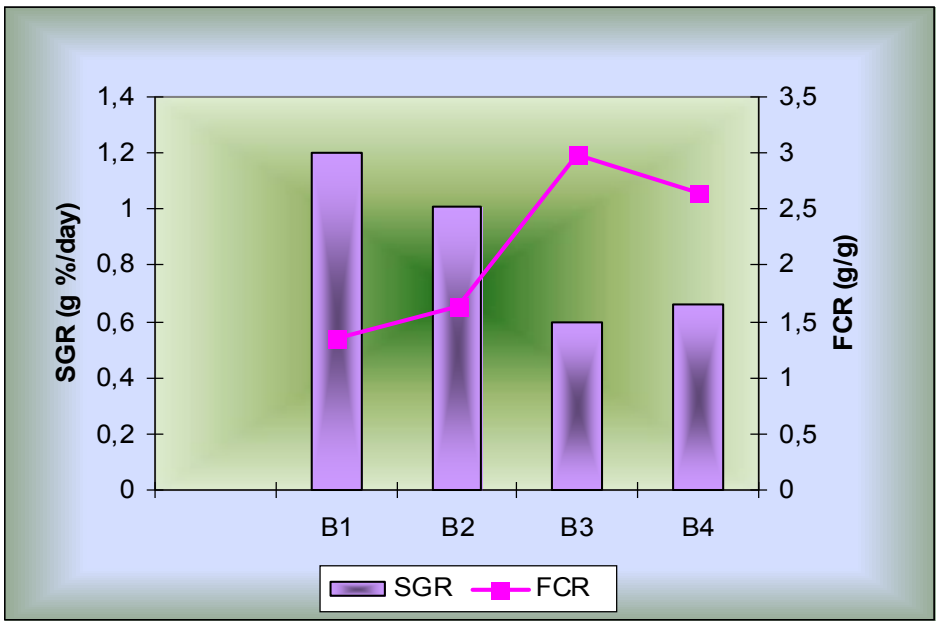

Figure 3. The variation of feed conversion ratio (FCR) and specific growth rate (SGR)

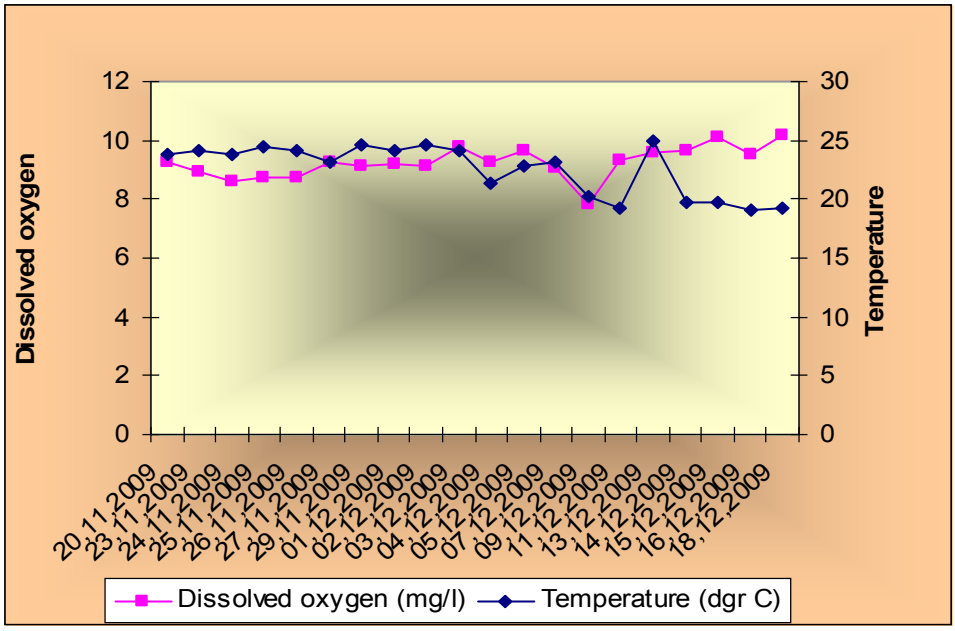

Figure 4. The variation of physico-chemical parameters of water

Conclusions. An effective way to reduce pressure on wild populations of sturgeon is growing this species in alternative systems, either traditional (ponds) or modern systems (recirculating systems). The research aimed to growing juveniles sterlet *A. ruthenus* in a pilot recirculating system represented by aquaria. The technological indicator that made the difference between the experimental variants was fodder quality.

The parameters of fish breeding showed that changing the quality of fodder, the fish growing was positively influenced. This experiment showed that *A. ruthenus* is a sturgeon with a moderate growth rate; it is possible to obtain an increase of fish biomass using pellets with 30-46% crude protein.

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