POLYCULTURE OF THE PIKEPERCH (*SANDER LUCIOPERCA*) FINGERLINGS INTO RECIRCULATING AQUACULTURE SYSTEM, WITH STERLET (*ACIPENSER RUTHENUS*) OR EUROPEAN CATFISH (*SILURUS GLANIS*) – A PRELIMINARY STUDY

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Abstract. *Pikeperch (Sander lucioperca) is one of the most appreciated fish species found in many European countries, in natural waters and in fish farms as well. This species started to be reared into recirculating aquaculture systems (RAS) in the last decade, but the farming technology has to be improved continuously in order to increase the fish production and to reduce the production costs. The aim of this paper was to reveal the preliminary data of a study regarding two polyculture variants of the pikeperch, with European catfish and with sterlet, in order to emphasize the best candidate species for polyculture in RAS. The pikeperch and sterlet fingerlings used in our study have been obtained in RAS, in the spring of the year 2017, from broodfish exclusively reared in RAS. When the study starts, the fish were 6 months and 5 months old, for pikeperch and sterlet, respectively. The European catfish fingerlings have been obtained through artificial method using broodfish from ponds, and reared in RAS until the age of 4 months, when our study starts. The RAS used for the fish rearing had four tanks, with 1 cubic meter of water each. Two variants of polyculture have been tested in 2 replicates: pikeperch with sterlet, and pikeperch with European catfish. The fish biomass of the additional species represented about 21% from the pikeperch biomass in each variant. The fish were fed with dry feed SUPREME-10, size 3mm (Coppens International, Nederland), the amount being calculated as 2.5% from pikeperch biomass in the first 2 weeks, and then reduced at 2% from pikeperch biomass. The main body traits (total length, standard length, maximum high and body weight) were measured at the beginning of the study, and afterwards at every 14 days covering the period of this preliminary study. Based on the data obtained after the measurements, the main bio-productive indices like Weight Gain (WG), Specific Growth Rate (SGR), Daily Growth Rate (DGR) and Feed Conversion Ratio (FCR), have been calculated. The results revealed that both species used in our study as secondary species in polyculture with pikeperch, have been suitable and led to a better valorization of the feed into RAS, but the polyculture of the pikeperch with European catfish seems to be more advantageous. Anyway, our study must go on for a better understanding of all aspects linked to these polyculture formulae used for pikeperch farming in RAS.*

Keywords*: pikeperch, sterlet, European catfish, polyculture, RAS*

INTRODUCTION

Pikeperch (*Sander lucioperca*) is one of the most appreciated fish species found in many European countries, in natural waters and in fish farms as well. The farming of this species in intensive or highly-intensive systems started in the last decade to be more and more accessible to the aquaculturists. It was proved few years ago that the pikeperch juveniles could accept formulated feed (LJUNGGREN et al., 2003; KESTERMONT et al., 2007) if they are accommodated with it at a proper time (STEENFELDT, 2015). Feeding of pikeperch in intensive systems has been investigated, the researchers bringing solutions for a better consumption of the dry feed. New feeding strategies for pikeperch juveniles and fingerlings has to be developed to increase the survivability and feeding efficiency in closed systems. The use of different size of the feed pellets (ZAKĘŚ et al., 2013), certain feeding frequencies (RONYAI & CSENGERI, 2008) or other feed characteristics, could influence the feed acceptance and the growth rate of pikeperch juveniles with high practical importance (GROZEA et al., 2010b).

Anyway, due to specific behavior of the pikeperch that eating only feed in the water column and especially from the proximity of the feeder (GROZEA et al., 2010a; 2015), there are many feed pellets falling to the bottom of the tank and they remain uneaten. Therefore, a supplementary bottom feeder fish species could be useful for a better use of the feed distributed into pikeperch tanks. The sturgeons, and especially sterlet (*Acipenser ruthenus*) could be a good candidate to be reared as additional species with pikeperch, into the same tank in RAS (KOZŁOWSKI et. al., 2014). Based on our previous observations regarding polyculture of the pikeperch into RAS, we assumed that European catfish (*Silurus glanis*) with certain sizes, could be also a species with valuable characteristics of bottom feeder when cohabitate with pikeperch.

The aim of this paper was to reveal the preliminary data of a study regarding two polyculture variants of the pikeperch, with sterlet and with European catfish, in order to emphasize the best candidate species to be reared together with pikeperch into the same tank, in RAS.

MATERIAL AND METHODS

The pikeperch and sterlet fingerlings used in our study were obtained in recirculating aquaculture system (RAS) at the Research Unit for Fish Farming in RAS (Banat's University of Agricultural Sciences and Veterinary Medicine „King Michael I of Romania" from Timisoara), in the spring of the year 2017 (pikeperch in April and sterlet in May). The pikeperch juveniles were obtained by means of controlled reproduction. The broodfish spawned on artificial nests disposed into a 1 m^3 tank of a RAS, after their hormonal stimulation with hCG (Chorulon, Intervet) using a single intra-peritoneal dose of 300 IU hCG kg^{-1} body weight in males and 600 IU hCG kg^{-1} body weight in females (KORBULY et al., 2010). From the 5th day post-hatching (DPH) pikeperch fry were fed with newly hatched brine shrimp nauplii (Coppens International, Holland). The pikeperch juveniles were habituated with dry feed Advance 200-300 μm (Coppens International, Holland) starting from the 15th DPH, that gradually (seven days) replaced live feed. Until the age of 6 month when the experiment starts, the pikeperch juveniles were reared in monoculture, being fed with different types and sizes of dry feed (Advance, Star Alevin and SUPREME-10), according with the fish size.

The sterlet juveniles were obtained by means of artificial propagation when the temperature in the RAS where the broodfish were kept reached 15°C. They were stimulated with an analog of LHRH: des-Gly10 [D-Ala6]-LHRH ethylamide acetate salt (LHRH-A) (L4513, SIGMA-ALDRICH), using a single dose according with the method described by RONYAI (2008). The juveniles were raised in RAS, into elongated rectangular tanks in the first month of life, and then into square tanks with rounded corners with one cubic meter of water in each tank. The fish were maintained in these tanks until the age of 5 month, in monoculture, being fed with dry feed, the same used for pikeperch.

The European catfish fingerlings were obtained at SC Nimb SA in June 2017, through artificial method, using broodfish from ponds. The eggs were incubated indoor into Zuger jars connected to a RAS, and the fry were exclusively reared into RAS until they reached 2 cm. Afterwards they were transferred into Research Unit for Fish Farming in RAS (BUASVMT) and reared until the age of 4 months, when they were used for experiments.

The RAS used for the fish rearing had 4 tanks, with 1 cubic meter of water each. Two variants of polyculture, were tested in 2 replicates:

- Variant 1 (V1) pikeperch with European catfish (21% from pikeperch biomass), in 2 tanks;

- Variant 2 (V2) pikeperch with sterlet (21% from pikeperch biomass), in 2 tanks.

During experimental period (one month), the fish were fed with dry food SUPREME-10, size 3mm (Coppens International, Nederland), the amount being calculated as 2.5% from pikeperch biomass in the first 2 weeks, and then reduced at 2% from pikeperch biomass. The feeding was made using 24 hours belt feeders (FIAP, Germany).

The main physical-chemical parameters were measured using SC1000 controller and Spectrophotometer DR3900 (Hach Lange, Germany): water temperature 21.5-23.5°C, turbidity < 4 NTU, pH 7-8, dissolved oxygen > 5 mg L^{-1}, nitrates < 120 mg L^{-1}, ammonium < 0.2 and nitrites < 1.5 mg L^{-1}. Water exchange rate was adjusted at 1 h^{-1}, in each tank. One m^3 of water from the RAS was replaced daily with fresh water.

Total length (TL), standard length (SL), maximum body depth (MBD), and body weight (BW) were measured according with the methods described by BURA & GROZEA (1997) and GROZEA (2007). The measurements were carried out at the beginning of the study and afterwards at every 14 days covering the period of this preliminary study, each time being made on 120 pikeperch (30 per tank) and 60 catfish fingerlings (30 per tank), randomly sampled from each tank. Only 36 sterlet fingerlings (18 per tank) from V2 were measured, these representing entire population from the experimental variant. The fish were anesthetized during the biometrical study, with clove oil. For each trait, there were calculated the mean, standard deviation, standard error and coefficient of variation.

Based on the data obtained after the measurements, the main bio-productive indices like Weight Gain (WG), Specific Growth Rate (SGR), Daily Growth Rate (DGR) and Feed Conversion Rate (FCR), were calculated, using the following formulae:

Weight gain (%); WG = 100 (final BW - initial BW) / initial BW

Specific growth rate (% day^{-1}); SGR_{BW} = [(ln final BW - ln initial BW) / ΔT] x 100

SGR_{TL} = [(ln final TL - ln initial TL) / ΔT] x 100

Daily growth rate (g d^{-1}); DGR = (final BW – initial BW) / ΔT

Feed conversion rate; FCR = Feed distributed / (final Biomass – initial Biomass)

where: ΔT is the duration of the experiment, the other being described above

The experimental data were analyzed using STATISTICA10 software. The data statistically processed are written into the paper as Mean ± SD.

RESULTS AND DISCUSSIONS

Table 1

The growth dynamic of the total length (TL) in pikeperch fingerlings, during the experimental period in the two experimental variants (n = 60 specimens for each variant)

Specification	M0		M1		M2	
	V1	V2	V1	V2	V1	V2
Mean (cm)	26.85^{a}	26.97^{a}	28.06^{b}	28.13^{b}	29.75^{c}	29.65^{c}
SD	1.51	1.50	1.39	1.50	4.17	1.37
SE	0.19	0.19	0.18	0.19	0.54	0.18
CV	5.61	5.57	4.94	5.35	14.00	4.63

M0 – the measurements at the beginning of the experiments; M1 – the measurements at 14 days; M2 – the measurements at 28 days
SD – standard deviation; SE – standard error; CV – coefficient of variation
V1 and V2 – experimental variants
Values of the mean in the same row with the same letters indicate non-significant differences (p> 0.05)

The TL, SL and BW of the pikeperch from the 2 experimental variants reveals significantly growing ($p \leq 0.001$) for all measurements at every 2 weeks. Anyway, the differences between the pikeperch fingerlings in the two variants remained not significant ($p > 0.05$) after 4 weeks of polyculture. That's mean that a supplementary species didn't have a worse or better influence on pikeperch growing than the other. Nevertheless, a very high difference was observed when the supplementary species have been evaluated.

Table 2

The growth dynamic of the standard length (SL) in pikeperch fingerlings, during the experimental period in the two experimental variants (n = 60 specimens for each variant)

Specification	M0		M1		M2	
	V1	V2	V1	V2	V1	V2
Mean (cm)	23.51^{a}	23.75^{a}	25.04^{b}	25.12^{b}	26.55^{c}	26.46^{c}
SD	1.35	1.38	1.35	1.49	1.61	1.33
SE	0.17	0.18	0.17	0.19	0.21	0.17
CV	5.76	5.82	5.39	5.95	6.07	5.01

Table 3

The growth dynamic of the maximum body depth (MBD) in pikeperch fingerlings, during the experimental period in the two experimental variants (n = 60 specimens for each variant)

Specification	M0		M1		M2	
	V1	V2	V1	V2	V1	V2
Mean (cm)	4.96^{a}	4.99^{ab}	5.12^{ab}	5.14^{b}	5.42^{c}	5.37^{c}
SD	0.51	0.41	0.36	0.37	0.53	0.44
SE	0.07	0.05	0.05	0.05	0.07	0.06
CV	10.34	8.25	7.11	7.24	9.85	8.18

Table 4

The growth dynamic of the body weight (BW) in pikeperch fingerlings, during the experimental period in the two experimental variants (n = 60 specimens for each variant)

Specification	M0		M1		M2	
	V1	V2	V1	V2	V1	V2
Mean (g)	146.57^{a}	152.43^{a}	182.12^{b}	184.10^{b}	207.30^{c}	204.58^{c}
SD	28.71	25.88	30.00	34.42	42.24	38.87
SE	3.71	3.34	3.87	4.44	5.45	5.02
CV	19.59	16.98	16.47	18.70	20.37	19.00

Based on the data obtained after the biometrical study, some bio-productive indices of the pikeperch fingerlings were calculated (table 5). The Weight Gain (WG), Specific Growth Rate (SGR) and Daily Growth Rate (DGR) reveal superior values in V1 comparing with V2. So far, the differences were not very high, but the trend of the values indicate increasing gaps between the two variants. The study will continue one month more after this preliminary data will be published, and we assume that the data in larger period will better clarify if the differences become statistically significant.

Table 5

Growth parameters of the pikeperch during the experimental period in the two experimental variants

Specification	V1		V2	
	In the first 2 weeks	In 4 weeks	In the first 2 weeks	In 4 weeks
Weight gain (%)	24.28	41.43	20.78	34.21
SGR_{BW} (% day^{-1})	1.67	1.33	1.45	1.13
SGR_{TL} (% day^{-1})	0.34	0.39	0.32	0.36
DGR (g)	2.74	2.34	2.44	2.01

The catfish juveniles used as supplementary species with pikeperch in V1, significantly increased ($p \leq 0.001$) their individual BW from 51.27±8.43 g to 101.53±22.35 g, during 28 days. These data indicate that the BW of the European catfish increased with about 98%, becoming almost double in 4 weeks.

The sterlet fingerlings used as supplementary species with pikeperch in V2, increased their individual BW from 128.81±26.23 g to 181.56±46.56 g, during 28 days, the differences being significant ($p \leq 0.001$) too. That's meaning an increasing of the initial BW with about 41% in 4 weeks.

Table 6

Feed conversion rate (FCR) during the experimental period in the two experimental variants, reported to the pikeperch biomass and to the total fish biomass per tank

Specification	V1		V2	
	In the first 2 weeks	In 4 weeks	In the first 2 weeks	In 4 weeks
FCR (pikeperch)	1.28	1.54	1.49	1.80
FCR (pikeperch + additional fish species)	0.99	1.03	1.21	1.44

Comparing the total biomasses of the two supplementary species, the European catfish biomass in V1 increased faster than the sterlet biomass in V2. Therefore, the European catfish biomass increased in average with 2.17 kg per tank in the experimental period, comparing with sterlet biomass which reached only 0.95 kg per tank in four weeks. The biomasses of both supplementary species have been gain based on the feed pellets uneaten by pikeperch fingerlings, the feeding regime of the pikeperch being ad libitum. Therefore, the European catfish juveniles seems to be a better supplementary species in the same tank with pikeperch, this fact being sustained by the feed conversion rate (table 6) lower in V1 than in V2. Anyway, our experiment will continue (this being only preliminary study) and more data will deeply clarify if the European catfish is a better supplementary species than sterlet for indoor polyculture, in RAS.

CONCLUSIONS

1. The differences between the pikeperch fingerlings' sizes and body weight in the two polyculture variants remained not significant ($p>0.05$) during experimental period.

2. Weight Gain (WG), Specific Growth Rate (SGR) and Daily Growth Rate (DGR) reveal superior values in pikeperch fingerlings from V1 (in polyculture with European catfish) comparing with V2 (in polyculture with sterlet).

3. The catfish juveniles in V1 significantly increased ($p \leq 0.001$) their individual BW becoming almost double in 4 weeks, better than sterlet fingerlings in V2, with a BW growing of about 41% in the same period.

4. A better growing of the European catfish in polyculture with pikeperch has been reflected by the fish biomass too, this being higher in V1 than in V2.

5. Polyculture of the pikeperch with European catfish seems to be more advantageous that the polyculture of the pikeperch with sterlet, but for a better substantiation, our experiment will continue.

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