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COULD STERLET (*ACIPENSER RUTHENUS*) AS POLYCULTURE SPECIES TO POSITIVELY INFLUENCE THE PIKEPERCH (*SANDER LUCIOPERCA*) FARMING IN RECIRCULATING AQUACULTURE SYSTEMS?

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Abstract

The pikeperch farming in recirculating aquaculture systems (RAS) has a relatively short history, and many ideas for production improvement in this species recently emerged. The polyculture is one of these. The aim of this study is to evaluate if sterlet as polyculture species reared in RAS with pikeperch could have a beneficial impact on tank's bioproductivity and growth dynamic of the juvenile pikeperch. One control (monoculture) (C) and two polyculture variants have been established in duplicate: 1335 pikeperch, 45 days old /m^3 with 10% (V_1), and 20% (V_2) sterlet. The experiment has been carried out during 35 days into a RAS with 6 tanks (1 m^3/tank). The fish were fed in all tanks with dry food, 10% of pikeperch biomass in each tank daily, assuring ad libitum feeding. A significant plus of fish biomass resulted by valorisation of the pellets unconsumed by the pikeperch, in both experimental variants (V_1, V_2). The pikeperch reared for 35 days in polyculture with 20% sterlet (V_2) had significantly higher body weight than the pikeperch reared with 10% sterlet (V_1) or in monoculture (C).

Key words: *pikeperch, polyculture, RAS, sterlet.*

INTRODUCTION

The potential of polyculture of two or more fish species and the polyculture of fish with other animals or plants for obtaining of multiple products with economical value has been already highlighted by many researchers (Dey et al., 2005; Elia et al., 2014; Nicolae et al., 2015; Stickney, 2015; Filep et al., 2016; Hisano et al., 2019). The polyculture in ponds is generally used for a better utilization of different trophic and spatial niches (Rahman et al., 1992), but the monoculture is the most popular stoking method in recirculating aquaculture systems (RAS). RAS is based on the water recycling using mechanical and biological filters which allows highly-intensive productions of various fish species (Grozea, 2002, 2007). Anyway, the polyculture in RAS, proven significant advantages in pikeperch farming (Kozłowski et al., 2014; Mihailov et al., 2017) due to the very selective feeding behaviour of this species, that eat pellets exclusively in the water column. The pellets reaching the bottom of the tank remain uneaten by pikeperch which have a very specific behaviour (Grozea, 2015; Grozea et al., 2016; Mihailov et al., 2017). Into a recent study carried out by our team we considered sterlet (*Acipenser ruthenus*) as a good candidate to be reared as additional species with pikeperch in RAS, eating pellets from the bottom of the tank (Mihailov et al., 2017). The preliminary results obtained by us corroborated with other information from specialty literature have been encouraging (Kozłowski et al., 2014). The aim of this study is to evaluate if sterlet (*Acipenser ruthenus*) as polyculture species (10 – 20%) with pikeperch (*Sander lucioperca*) reared in recirculating aquaculture system could have a beneficial impact on tank's bioproductivity and growth dynamic of the pikeperch.

MATERIALS AND METHODS

Forty-five days old pikeperch mixed with forty days old sterlet have been used in our polyculture variants.

Juvenile pikeperch was obtained by means of controlled reproduction in the recirculating aquaculture system (SAR) of the Banat's

University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, in April 2019. Juvenile sterlet was obtained from Nimb Fish farm - Giarmata. Both species have been previously farmed in RAS, in monoculture, being accommodated with the same dry feed.

Two polyculture variants have been tested in duplicate: pikeperch with 10% sterlet (V_1) (135 sterlet/tank), and pikeperch with 20% sterlet (V_2) (270 sterlet/tank). The control variant (C), meaning pikeperch in monoculture, was established with the same number of the pikeperch like in V_1 and V_2 (1335 individuals/m^3).

The average body weight of the pikeperch at the beginning of the experiments was 0.77±0.07, 0.82±0.08 and 0.85±0.09 g/individual for V_1, V_2 and C, respectively. The initial body weight of the sterlet used for polyculture varied between 2.57 and 3.48 g/individual.

The experiment has been carried out during 35 days into a RAS with 6 rectangular fiberglass tanks (1 m^3/tank) and a treatment unit which assured the water quality in the normal limits during all experimental period. The main physical-chemical parameters have been monitored two times per day and maintained in normal limits for pikeperch farming: temperature 22±1°C, dissolved oxygen 6-7.5 mg/l, nitrates <150 mg/l, ammonium <0.3 mg/l, nitrites <0.6 mg/l. In order to maintain the good water quality, 2 m^3 of water from RAS was daily replaced with fresh water.

The fish were fed during the study with 1.2- 1.5 mm ADVANCE and 2 mm STAR ALEVIN pellets (Alltech-Coppens, The Netherlands), according with the fish size, 10% of pikeperch biomass in each tank. This amount assured *ad libitum* feeding for pikeperch batch and was weekly adjusted according with the weight dynamic of the pikeperch. Feeding was done using 24-hours belt feeders (FIAP, Germany).

The unconsumed feed was siphoned once per day from the bottom of the tanks.

In order to evaluate growth dynamic of the fish, total length (TL) and the body weight (BW) were weekly measured for 15 pikeperches and 15 sterlets from each tank, meaning 30 fishes from each variant. The morphometry has been carried out after the fish were anesthetized with clove oil (Fares SA, Romania). The mean, standard deviation (SD), standard error (SE) and coefficient of variation (CV) have been calculated for each morphometric trait of both fish species.

Specific Growth Rate (SGR) for BW (SGR_{BW}) and TL (SGR_{TL}), Daily Growth Rate (DGR) and Feed Conversion Rate (FCR) were calculated using the following formula:

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 data were analysed using STATISTICA10 software. Duncan post hoc test was used to assess the significance of differences. The data statistically processed are presented into the paper as Mean ± SD.

RESULTS AND DISCUSSIONS

As a result of the weekly measurements made for body weight and total length, of the juvenile pikeperch, during the experimental period, it was observed a constant and significant growth ($p \leq 0.05$) in both morphometric traits and polyculture variants. The Figures 1, 2 and Tables 1, 2 are suggestive in this regard.

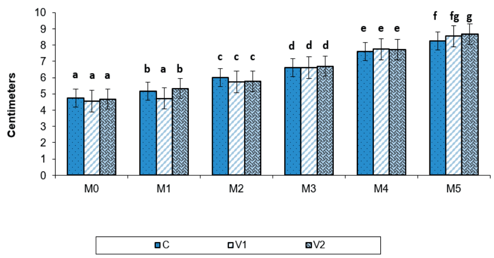

Figure 1. The weekly dynamic of the total length and the significance of the differences in pikeperch. M0 - M5 – weekly measurements. Same letter indicates not significant differences (p>0.05)

The growth of the TL and BW in pikeperch shown a quite similar dynamic which reflected a significantly better growth of the fish from V2 where the pikeperch were reared in polyculture with sterlet 20%. The pikeperch from this trial were longer ($p \leq 0.05$) than the fish from control batch and also heavier ($p \leq 0.001$) than the fish from C and V1 variants. Therefore, BW of the pikeperch in V2 reached at the end of experimental period 5.86±1.67 g, significantly higher ($p \leq 0.001$) than the fish in C and V1 (4.81±1.36 g and 5.13±1.15 g, respectively). It was an interesting founding which could be due to the faster removal of the pellets from the bottom of the tank by the sterlet which lead to a local better water quality even at a higher fish biomass per tank.

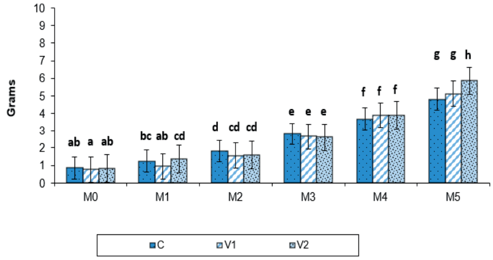

Figure 2. The weekly dynamic of the body weight and the significance of the differences in pikeperch. M0 - M5 – weekly measurements. Same letter indicates not significant differences (p>0.05)

Table 1. Growth dynamics of the total length - TL (cm) of the juvenile pikeperch during the 35 days (n = 30)

Specification	M0			M1			M2			M3			M4			M5		
	C	V1	V2	C	V1	V2	C	V1	V2	C	V1	V2	C	V1	V2	C	V1	V2
Mean (cm)	4.74	4.55	4.68	5.17	4.72	5.33	6.01	5.74	5.77	6.62	6.62	6.70	7.59	7.74	7.72	8.25	8.54	8.68
SD	0.57	0.11	0.42	0.48	0.46	0.42	0.59	0.72	0.47	0.60	0.57	0.7	0.86	0.62	0.85	0.70	0.66	0.79
SE	0.10	0.02	0.08	0.09	0.08	0.08	0.11	0.13	0.09	0.11	0.10	0.13	0.16	0.11	0.16	0.13	0.12	0.14
CV	12.10	2.35	8.96	9.22	9.68	7.96	9.75	12.58	8.17	9.00	8.58	10.68	11.28	7.99	11.06	8.54	7.73	9.07

M0 - M5 – the weekly measurements; SD – standard deviation; SE – standard error; CV – coefficient of variation; C – control; V1 and V2 – trials

Table 2. Growth dynamics of the body weight - BW (g) of the juvenile pikeperch during the 35 days (n = 30)

Specification	M0			M1			M2			M3			M4			M5		
	C	V1	V2	C	V1	V2	C	V1	V2	C	V1	V2	C	V1	V2	C	V1	V2
Mean (g)	0.85	0.77	0.82	1.25	0.94	1.37	1.81	1.56	1.59	2.81	2.66	2.62	3.68	3.90	3.90	4.81	5.13	5.86
SD	0.09	0.07	0.08	0.38	0.26	0.34	0.47	0.55	0.41	0.60	0.73	0.78	0.88	0.89	1.24	1.36	1.15	1.67
SE	0.02	0.01	0.02	0.07	0.05	0.06	0.09	0.10	0.07	0.11	0.13	0.14	0.16	0.16	0.23	0.25	0.21	0.31
CV	10.1	8.84	10.32	30.39	28.09	24.70	25.92	35.04	25.65	21.47	27.54	29.79	23.95	22.93	31.72	28.19	22.45	28.56

M0 - M5 – the weekly measurements; SD – standard deviation; SE – standard error; CV – coefficient of variation; C – control; V1 and V2 – trials

The growth of the TL and BW in sterlet shows the same trend like in pikeperch, with a better growth of the sterlet from V2 (Tables 3, 4 and Figures 3, 4). This dynamic is very well corelated with the observations of the pikeperch growth dynamic, and could be due to the same reason, upper specified. Therefore, the polyculture of the pikeperch with 20% sterlet could lead to the improving the growth of both species.

Table 3. Growth dynamics of the total length - TL (cm) of the juvenile sterlet during the 35 days (n = 30)

Specification	M0		M1		M2		M3		M4		M5	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
Mean (cm)	7.46	8.59	9.81	10.38	12.01	12.01	13.69	13.89	15.07	15.89	16.23	16.61
SD	0.65	0.86	1.03	0.86	0.95	1.08	1.36	1.15	1.5	1.13	1.24	1.48
SE	0.12	0.16	0.19	0.16	0.17	0.20	0.25	0.21	0.27	0.21	0.23	0.27
CV	8.75	9.97	10.47	8.30	7.94	9.01	9.95	8.28	9.95	7.10	7.64	8.93

M0 - M5 – the weekly measurements; SD – standard deviation; SE – standard error; CV – coefficient of variation; C – control; V1 and V2 – trials

Table 4. Growth dynamics of the body weight - BW (g) of the juvenile sterlet during the 35 days (n = 30)

Specification	M0		M1		M2		M3		M4		M5	
	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2	V1	V2
Mean (g)	2.57	3.48	4.89	5.65	7.82	8.06	11.44	11.96	12.81	15.48	15.39	18.67
SD	0.27	0.30	1.52	1.17	1.64	1.89	3.42	2.34	3.31	3.13	3.76	4.77
SE	0.05	0.05	0.28	0.21	0.30	0.35	0.62	0.43	0.61	0.57	0.69	0.87
CV	10.38	8.57	30.47	20.68	20.96	23.44	29.91	19.54	25.88	20.23	24.46	25.56

M0 - M5 – the weekly measurements; SD – standard deviation; SE – standard error; CV – coefficient of variation; C – control; V1 and V2 – trials

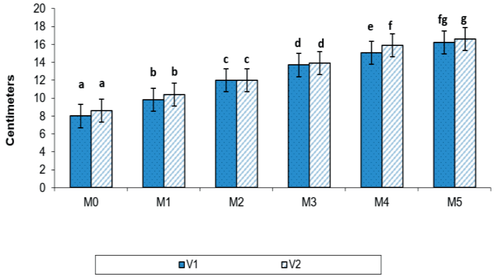

Figure 3. The weekly dynamic of the total length and the significance of the differences in sterlet. M0 - M5 – weekly measurements. Same letter indicates not significant differences (p>0.05)

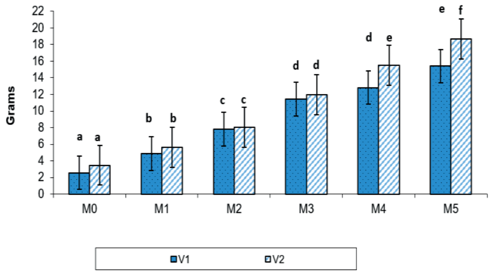

Figure 4. The weekly dynamic of the body weight and the significance of the differences in sterlet. M0 - M5 – weekly measurements. Same letter indicates not significant differences (p>0.05)

Comparing the total biomass per m^3 of the three trials the best yield was registered in the experimental variant V2 (Figure 5 and 6), where at the end of the experiment 12.095 kg of fish (7.054 kg pikeperch and 5.041 kg sterlet) were obtained. In the experimental variant V1, 8.261 kg of fish (6.184 kg pikeperch and 2.077 kg sterlet) were harvested.

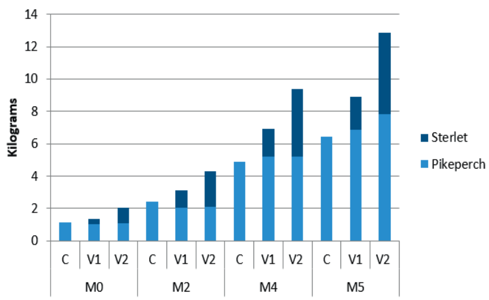

Figure 5. Graphical representation of fish biomass growth (kg/m^3) during experimental period

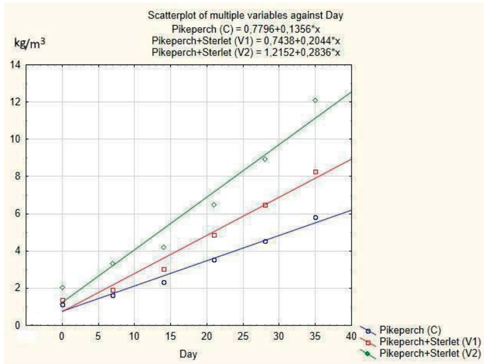

Figure 6. Fish biomass dynamic during 35 days, mathematically adjusted, in control and experimental variants

In both polyculture variants (V1 and V2) the fish biomass per m^3 was higher than in monoculture (variant C), but not only total fish biomass but pikeperch biomass as well (5.803 kg of pikeperch being obtained in variant C).
Bio-productive parameters are generally better for polyculture variants, the results being shown in Table 5.

Table 5. Bio-productive parameters of the pikeperch at the end of experimental period (35 days) in the experimental variants

Specification	Control	V1	V2
SGR_{BW} (% day^{-1})	4.952	5.418	5.618
SGR_{TL} (% day^{-1})	1.583	1.798	1.764
DGR (g)	0.113	0.124	0.144
FCR (Pikeperch)	2.039	1.843	1.597
FCR (pikeperch + sterlet)	-	1.381	0.946

(FCR) for the juvenile pikeperch may be noticed in variant V2 (1.597), compared to the variants V1 (1.843) and C (2.039) at the end of the experimental period. FCR for total biomass (pikeperch + sterlet) was also better in V2 (0.946) than in V1 (1.381).

CONCLUSIONS

The pikeperch reared for 35 days in polyculture with 20% sterlet (V2) had significantly higher body weight than the pikeperch reared with 10% sterlet (V1) or in monoculture (C).
A significant plus of fish biomass resulted by valorisation of the pellets unconsumed by the pikeperch, was obtained in both polyculture variants (V1, V2).

Bio-productive parameters were better for the polyculture variants.

Polyculture could be a good way to positively influence the pikeperch farming in RAS, having a beneficial impact on tank's bioproductivity and on the growth dynamic of the pikeperch.

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