Scientific Papers. Series D. Animal Science. Vol. LXV, No. 1, 2022
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

EXPERIMENTAL RESULTS REGARDING THE GROWTH OF PIKEPERCH (*SANDER LUCIOPERCA* - LINNE, 1758) IN THE FIRST YEAR IN PONDS

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Abstract

The pikeperch (Sander lucioperca, L.-1758) is a valuable fish species, with a high demand among human consumers, due to its superior nutritional and organoleptic characteristics such as: white flesh, soft texture, lack of intramuscular bones and pleasant taste. One of the main challenges of the pikeperch rearing technology is encountered during the first summer of the production cycle. The main desideratum during this period is to obtain large quantities of fingerlings per unit area, with the highest possible survival rate and low production costs, under the conditions specific to the rearing units. Therefore, the aim of the present study was to apply 2 different feeding regimes for the rearing of one summer old pikeperch in earthen ponds, as it follows: V1- with pelleted fish feed and V2- with live fish food. Thus, the experiments were performed at S.C.D.P. Nucet during three different rearing seasons (2018, 2019 and 2020), in triplicate. The best results were obtained in variant V2 (live food administration) and the followed indicators were survival rate, individual growth rate and production per unit area.

Key words: *earthen ponds, fish feed, live food, productivity, Sander lucioperca.*

INTRODUCTION

The development of aquaculture depends on the introduction of new species in the rearing technologies, as well as on the success of obtaining fingerlings for further stocking in ponds. The pikeperch (*Sander lucioperca*, Linnaeus, 1758) is a very active and energetic predatory fish in its natural environment, but extremely sensitive in aquaculture farms (Dobrotă et al., 2021). It is a new species in aquaculture and it is produced in Europe in extensive systems, in large earthen ponds. This method was applied in order to maintain a balanced fish population, since no fish feeds are administered and fish nutritional requirements were achieved by the natural productivity of ponds (Falahatkar & Javid Rahmdel, 2021). Nowadays, the pikeperch is used forthe biological control against fish with no economic value and other undesirable aquatic species in cyprinid polyculture ponds, to increase production (Falahatkar et al., 2018). The aforementioned specie can live in freshwater, brackish water and saltwater, but generally prefers freshwater systems such as rivers and lakes (Zakes, 2009).

Pikeperch rearing in monoculture technologies have been carried out in recirculating aquaculture systems (RAS) since the beginning of the 21st century in Western Europe (Teletchea & Fontaine, 2014). Therefore, it is considered a relatively new approach in the aquaculture industry. According to FAO, the Czech Republic, Hungary, Romania, Poland, Ukraine, Denmark, the Netherlands and Tunisia are the largest industrial producers of pikeperch (FAO, 2020).
To support the development of rearing technologies for this valuable fish species, the European Commission set up a comprehensive program in 2005 in partnership with 11 other EU Member States to improve breeding, hatching, larval, fry and fingerling rearing (Kucharczyk et al., 2007).
However, despite recent development sachieved in the fish feed production sector, specifically intended for the rearing of various one-summer old fish species, live food remains the main food used for the initial stages of fish nutrition (Chiorean et al., 2009). The main challenges in rearing pikeperch are the high mortality rates and failure to adapt to artificial feeds. A significant share of the pikeperch mortalities can

result from the lack of adequate food, when the shift from live food to artificial feed is made. The 45-day-old larvae are unable to recognize or ingest artificial food particles, as the behaviour of live food in the water column includes active movement, which is a crucial factor in attracting the larvae's attention (Xu et al., 2003).

The aim of the study is to grow the pikeperch (*Sander lucioperca*) in the first summer, in monoculture, by administering live food or fodder. The performance indices followed are: the quantity of biological material obtained per unit of area, the survival rate, the average weight and the feed conversion coefficient, under the specific conditions of the aquaculture units in Romania. The ability of the species to adapt to feeding on granulated feed when growing in the first summer has been considered.

MATERIALS AND METHODS

The researches within the present study were carried out in the period 2018-2019-2020 at the Fish Culture Research and Development Station Nucet, Romania. The experimental ponds are located in the river bed of the Ilfov creek, downstream of the Ilfoveni accumulation dam. For the rearing of one summer old pikeperch, the material base was represented by six earthen ponds, with an area of 1000 square meters each. The inlet and outletare done individually for each pond, through monk-type installations. The depth of the rearing ponds is between 0.8-2.0 m. The water inlet was made from a common inlet channel and at the monks' grills metal sieve with the eye of 4 mm was installed, in order to prevent other species of fish from entering the pond. Since the supply channel was common, the physico-chemical water parameters were similar inall experimental ponds. Before stocking, the ponds were drained and disinfected with calcium hypochlorite, more intensely in the wet areas.

The fish stocking was made with 50-day-old pikeperch (Figure 1 a-e.), with average weights between 1.823-2.850 g in two variants, in triplicate, as follows:

1. Variant V1, using a stocking density of 750 specimens/pond, where pelleted fish feed was administered, in ponds B1, B2 and B3;
2. Variant V2, using a stocking density of 750 specimens/pond, where live food was administered, in ponds B4, B5 and B6.

In 2018, the stocking was made on June 5th and the feeding period was undertaken until October 7th, resulting in a number of 124 days of feeding (on Sunday no feed was administered). Also, the fish harvesting was carried out on October 24th.

In 2019 the stocking was made on June 9th and the feeding period was undertaken until October 6th, resulting in a number of 119 days of feeding (on Sunday no feed was administered). Fish harvesting was carried out at October 16th.

In 2020, the stocking was made on June 11th and the feeding period was undertaken until October 9th, resulting in a number of 120 days of feeding (on Sunday no feed was administered). Fish harvesting was carried out at October 14th.

Figure 1 (a-e). Fish biometrics and pond stocking

In variant V1, in all the study years, for the feeding of the biological material, pelleted fish feed "Aqua Start 0.7" was administered, with a variable granulation of 0.6-0.8 mm, especially for fingerlings of 1-5 g. The aforementioned fish feed was obtained by applying a microencapsulation technology, in order to protect nutrients and to maintain water quality, and at the same time, possess a high nutritional value, with high stability in water. The crude protein was 55% and the feed was administered in the first 30 days after stocking. After 30 days, the biological material was fed with "Aqua Start 1", which has the same characteristics as "Aqua Start 0.7", except for the feed size (0.9-1.1 mm) and the crude protein (57%).

In variant V2, before the pond flooding, barley was sown to form a vegetable bed in order to facilitate the reproduction of the crucian carp. During the summer, 10% of the pond surfaces of B4, B5 and B6, was used for aquatic vegetation development. After flooding, the pond was stocked with 50 kg of crucian carp, with an average weight between 15-80 g/ex. For the feeding of the crucian carp, approximately 1000 kg of feed was administered in each pond. The feed had the following ingredients: 35% corn, 15% wheat, 17% soybean meal, 25% sunflower meal, 5% fish meal, 3% vitaminized calcium. The feed ingredients were ground and mixed to result a crude protein of 25.5%. This variant was foreseen so that the crucian carp offspring will serve as live food for the pikeperch.

Calculations. During the experiments, measurements (TL ± 1 mm) and weighing of the total and individual fish biomass were performed. For individual biometric measurements, 200 specimens of pikeperch were taken from each growth unit (W ± 1 g) and the following parameters were calculated:

a) The production per unit of area (kg/ha) =

$$= \frac{\text{quantity of biomass obtained (kg)}}{\text{unit of area (ha)}};$$

b) Fulton coefficient K = $(W*100)/l^3$ (Pojoga, 1977), where:

W- individual weight (g);

l - standard length (cm).

c) Feed Conversion Coefficient (FCR)

$$= \frac{\text{quantity of managed feed (kg)}}{\text{obtained fish biomass (kg)} - \text{stocked fish biomass (kg)}}$$

In the V2 version, where the live food was administered, at the FCR 's calculation, in order to obtain an increase of 1 kg of pike-perch, 2 kg of crucian carp (*Carassius gibelio*) are required, and to obtain a growth increase of 1 kg of crucian carp were administered 3 kg of feed. In order to make individual biometric measurements, the pike-perchs were anesthetized with 2-phenoxyethanol in order to reduce the stress at handling.

Statistical data processing. The results, of groth and developement parameters, of the experimental groups were statistically analyzed using descriptive statistics and ANOVA One Way test. The programs used were Microsoft Excell (Office 2010) and SPSS Statistics 20.0 for Windows. The results were presented as mean±standard deviation.

RESULTS AND DISCUSSIONS

During the experimental period, the water physico-chemical parameters were monitored. The obtained results were compared to the optimal values according to the “Norm on the classification of surface water quality”, correlated with the data from the specialized literature for waters destinated for fish use (OMMGA no. 161/2006) (Table 1).

During the rearing cycle of one summer old fish, the supply of the necessary food, both in terms of quantity and quality, is a decisive factor in achieving superior growth rates (Kozloski et al., 2018)..

The nutrition of the fingerlings is of particular importance in the fish feeding process, especially during the first summer.

Thus, during this period, the natural or artificial food which the fingerlings will consume, must ensure a balance in terms of the necessary elements (proteins, lipids, carbohydrates, vitamins, macro- and micro-elements), otherwise, serious damage in the further development of the fish body will be registered, manifested through the significant decrease of growth, survival rate and welfare (Zakes et al., 2003).

As well, besides the relationship between food needs and larval weight, other abiotic factors such as water temperature and dissolved oxygen concentration must be taken into account when calculating the daily feeding ratio and when establishing the administration protocol (Cadar, 1984).

In both experimental variants (V1 and V2), the feeding began the day after fish stocking. Feed was administered daily, in four rounds, in each pond. The quantities administered during the rearing cycle were according to Table 2.

Table 1. Water physico-chemical parameters during the experimental period

No.	*Analysed parameter*		*Measurement unit*	*Registered valued*		
				Inlet	*Ponds*	*Optimum values*
				Mean values for the studied years		
1	pH		pH units	7.1	7.6	7-7.8
2	Alkalinity		mg/l	168	174	200-400
3	Calcium (Ca^{2+})		mg/l	34.1	41.4	90-120
4	Magnesium (Mg^{2+})		mg/l	19.8	22.6	10-40
5	Ca^{2+}/ Mg^{2+}		mg/l	1.7	1.8	5
6	Organic matter		mg $KMnO_4$/l	19	22.3	20-60
7	Oxygen		mg/l	8.2	7.1	5-12
8	Ammonia (NH^{+}_{3})		mg/l	-	-	-
9	Nitrates (NO^{-}_{3})		mg/l	-	0.17	2.5-4
10	Nitrites (NO^{-}_{2})		mg/l	0.003	0.003	0.03
11	Phosphates (PO^{3-}_{4})		mg/l	-	0.06	0.05-1.5
12	Chloride	Cl^{-}	mg/l	9.32	9.39	30
		NaCl	mg/l	12.14	14.56	20
13	Ammonium (NH^{+}_{4})		mg/l	-	0.015	0.5-1
14	Total hardness		(^{0}D)	13.5	14.6	12

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Table 2. Fish feed administration, detailed on months

Experimental variant	**Month**	**June**	**July**	**August**	**September**	**TOTAL**
V1, V2	Quantity (%)	10	25	35	30	100

In variant V1, the amount of feed administered was different from one day to the next and from one pond to another, depending on the appetite of the fish material. In terms of the frequency, the meals were administered twice a day, in the morning at 9 and in the afternoon at 14:30. Due to its floatability, the consumed amount could be observed and thus allowing the *ad-libitum* administration.

In variant V2, the administration of the feed was carried out in a single step, during the morning at 9 o'clock. The amount of feed administered in this variant was the same for all the ponds during the whole experimental period, 1000 kg/basin respectively.

Once every 15 days, control fishing was carried out, in order to determine the growth rate and health status.

The ruler and centimetre were used for measurements and electronic scales were used for weight determination (Figure 2 a-b and Figure 3 a-b).

The main biotechnological indicators calculated within the present study, in the intensive rearing system, for the pikeperch were as it follows:

- Quantity per unit area;
- Individual weight (W g/ex);
- Sv survival rate (%).

Figure 2 (a-b). Harvest fishing

Figure 3 (a-b). Harvest fishing

The values of the biotechnological indicators for the rearing of pikeperch one summer old fingerlings are presented in Tables 3 and 4.

Table 3. Biotechnological indicators for the rearing of one summer old pikeperch, during the experimental period

Year	Variant	Pond	STOCKING No. of specimen	Mean weight (g/ex)	Quantity (kg)	Sv (%)	PRODUCTION Nr. Ex.	Mean weight (g/ex)	Quantity (kg)	Kg/ha	Fish feed (kg)	Conversion coefficient	Fulton coefficient
2018	V1	B1	750	1.929	1.447	67	503	156	78	784	112	1.46	1.08
		B2	750	1.823	1.367	71	533	127	68	676	84	1.27	0.91
		B3	750	1.967	1.475	74	555	121	67	672	90	1.37	0.92
	V2	B4	750	2.562	1.922	91	683	269	184	1836	1000	1.52	1.13
		B5	750	2.85	2.138	92	690	265	183	1829	1000	1.5	1.17
		B6	750	2.624	1.968	84	630	335	211	2111	1000	1.37	1.01
2019	V1	B1	750	1.983	1.487	69	517	135	70	699	88	1.29	0.88
		B2	750	2.141	1.606	63	473	141	67	666	76	1.17	0.98
		B3	750	1.945	1.459	59	442	152	67	673	93	1.41	1.06
	V2	B4	750	2.234	1.676	89	668	312	208	2083	1000	1.4	1.26
		B5	750	2.456	1.842	92	690	296	204	2042	1000	1.38	1.13
		B6	750	2.235	1.676	93	698	285	199	1988	1000	1.42	1.14
2020	V1	B1	750	1.894	1.421	68	510	138	70	704	93	1.35	1.03
		B2	750	2.236	1.677	67	503	167	84	839	104	1.26	0.91
		B3	750	2.045	1.534	62	465	145	67	674	86	1.31	1.01
	V2	B4	750	2.486	1.865	89	668	296	198	1976	1000	1.4	1.21
		B5	750	2.563	1.922	88	660	321	212	2119	1000	1.37	1.29
		B6	750	2.554	1.916	95	713	284	202	2024	1000	1.41	1.2

Table 4. The results (average) obtained for the biological indicators in experimental variants

Year	Variant	Sv (%)	W mean (g)	Quantity (kg)	kg/ha	Conversion coefficient	Fulton coefficient
2018	V1	70.7	135	71	711	1.36	0.97
	V2	89.0	290	192	1925	1.46	1.10
2019	V1	63.7	143	68	679	1.29	0.97
	V2	91.3	298	204	2038	1.40	1.18
2020	V1	65.7	150	74	739	1.31	0.98
	V2	90.7	300	204	2039	1.39	1.23

1. Quantity per unit area

The best production obtained was in 2020 in variant V2, pond B5, 212 kg/pond (2119 kg/ha) respectively, and the lowest in 2019 in variant V1, pond B2, 67 kg/pond (666 kg/ha) respectively.

In all the study years, the highest quantity obtained was in variant V2 (Figure 4), being from 2.7 to 3 times higher than variant V1, as it follows:

- in 2018 the average quantity obtained in variant V2 was 192 kg (1920 kg/ha) and in variant V1 71 Kg (710 kg/ ha), which is 2.7 times higher compared to variant V1;
- in 2019 the average quantity obtained in variant V2 was 204 kg (2040 kg/ha) and in variant V1 68 Kg (680 kg/ha), which is 3.0 times higher compared to variant V1;
- in 2020 the average quantity obtained in variant V2 was 204 kg (2040 kg/ha) and in variant V1 74 Kg (740 kg/ha), which is 3.0 times higher compared to variant V1.

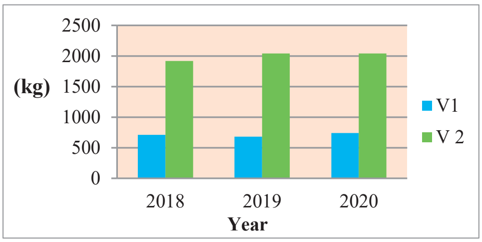

Figure 4. Quantity variation reported to the surface area

2. Average weight

The highest average weight was registered in 2018 in variant V2, pond B6 (335 g/specimen) and the lowest in 2018 in variant V1, pond B3, 9221 g/specimen).

During the whole experimental period, the highest average weight was obtained in variant V2 (Figure 5), being from 2.0 to 2.2 times higher compared to variant V1, as it follows:

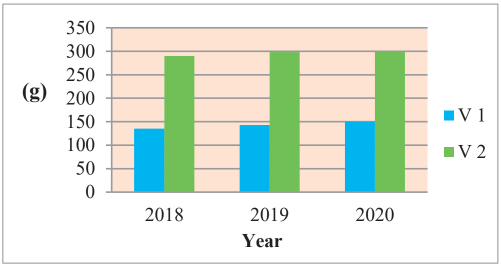

Figure 5. Variation of fish average weight

- in 2018 the average weight obtained in variant V2 was 290 g/specimen and in variant V1 was 135 g/specimen, which is 2.2 times higher compared to variant V1;
- in 2019 the average weight obtained in variant V2 was 298 g/specimen and in variant V1 of 143 g/specimen, which is 2.1 times higher compared to variant V1;
- in 2020 the average weight obtained in variant V2 was 300 g/specimen and in variant V1 was 150 g/specimen, which is 2.0 times higher compared to variant V1.

3. Survival rate

The highest survival rate was registered in 2020 in variant V2, pond B6, 95% respectively and the lowest was registered in 2019 in variant V1, pond B3, 59% respectively.

In all the study years, the highest survival rate was obtained in variant V2 (Figure 6), ranging from 1.3 to 1.4 times higher than in variant V1, as it follows:

- in 2018 the average survival percentage obtained in variant V2 was 89.0% and in variant V1 was 70.7%, which is 1.3 times higher compared to variant V1;
- in 2019 the average survival percentage obtained in variant V2 was 91.3% and in variant V1 was 63.7%, which is 1.4 times higher compared to variant V1;
- in 2020 the average survival rate obtained in variant V2 was 90.7% and in variant V1 was 65.7%, which is 1.4 times higher compared to variant V1.

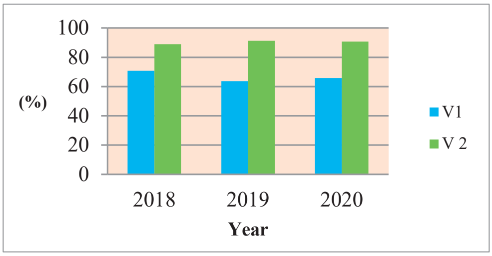

Figure 6. The variation of the survival rate

The conversion coefficient had similar values in both experimental variants, falling in variant V1 within the range 1.29-1.36 and in variant V2 within the range 1.39-1.46. When calculating this coefficient in variant V2, the transformation of the administered feed into live food and live food in the amount of pikeperch obtained was taken into account.

The Fulton coefficient also had similar values in both experimental variants, falling in variant V1 within the range 0.97 - 0.98 and in variant V2 within the range 1.10 - 1.23.

It was observed that the highest values were registered in variant V2 in terms of production per unit area, average weight and survival rate. In terms of conversion rate and Fulton coefficient, the values were also similar. This is due to the fact that the pikeperch mainly prefers live food and consumes it with pleasure, being a complete, attractive food, intended for this predatory species. It can be stated that pelleted fish feed is available at any time, which gives it an advantage from this point of view.

CONCLUSIONS

The observed indices such as: the quantity obtained per unit area, the survival rate, the average weight and the conversion coefficient were higher in variant V2 (administration of live food) compared to variant V1, where the biological material was fed with granulated fodder. Good results were also obtained in the V1 version, and it can be stated that the pikeperch has adapted and consumed the granulated fodder, which that the fish farmers can easily procure and store.

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