COMPARISON OF TWO WEANING METHODS OF JUVENILE PIKEPERCH (*SANDER LUCIOPERCA*) FROM NATURAL DIET TO COMMERCIAL FEED

SROVNÁNÍ DVOU METOD PŘEVODU JUVENILNÍHO CANDÁTA OBECNÉHO (*SANDER LUCIOPERCA*) Z PŘIROZENÉ POTRAVY NA KOMERČNÍ KRMIVO

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ABSTRACT

The aim of our experiment was comparison of two weaning methods of juvenile pikeperch: direct (variant A, dry feed without natural food) and combined (variant B, co-feeding of dry feed and frozen chironomids). Six thousand individuals of juvenile pikeperch with mean initial total length (TL) 38.61 ± 2.40 mm, weight (W) 0.45 ± 0.08 g and condition factor (K) 1,34 ± 0,13 (n = 100, average ± SD) from pond were randomly distributed into six plastic tanks in the recirculation system. After 21-day rearing period, the weaning success was evaluated. In the variant B there was achieved significantly higher ($p<0,007$) survival (58.37%) in comparison with the variant A (27.87%). However, some fish in the variant B preferred only chironomids and did not intake any dry feed. TL of these fish was only 48.23 mm, W 0.76 g and K 1.08. By comparison of successfully converted fish there was not found any significant difference between variants (A - 27.87 % and B - 25.13 %). In values of specific growth rate (SGR), weight (W) and condition coefficient (K) there was not found any significant difference too (A - 7.70%.d^{-1}, 2.28 g and 1.40 respectively, B - 8.06%.d^{-1}, 2.47 g and 1.40 respectively). On the basis of achieved results it is possible to recommend method of direct conversion for use in fishery practice.

Key words: pikeperch, weaning, growth, survival, chironomid larvae, intensive conditions

ABSTRAKT

Cílem našeho experimentu bylo srovnání dvou metod převodu juvenilního candáta obecného: přímé (varianta A, suchá dieta bez přirozené potravy) a kombinované (varianta B, kombinace suché diety s mraženými larvami pakomárů). Šest tisíc kusů juvenilního candáta o počáteční průměrné celkové délce (TL) 38,61 ± 2,40 mm, hmotnosti (W) 0,45 ± 0,08 g a koeficientu kondice (K) 1,34 ± 0,13 (n = 100, průměr ± směrodatná odchylka) z rybníka bylo náhodně nasazeno do šesti plastových žlabů (objem 250 l) v recirkulačním systému. Po 21 dnech odchovu byla vyhodnocena úspěšnost převodu. Ve variantě B bylo sice dosaženo průkazně vyššího ($p<0,007$) přežití (58,37 %) oproti variantě A (27,87 %), ale část ryb byla navyklá pouze na larvy pakomárů a nepřijímala suchou dietu. TL těchto ryb byla pouze 48,23 mm, W 0,76 g a K 1,08. Při srovnání úspěšně převedených ryb nebyl shledán rozdíl mezi variantami (27,87 % a 25,13 %). V hodnotách specifické rychlosti růstu (SGR), hmotnosti (W) a koeficientu kondice (K) také nebyl shledán průkazný rozdíl (7,70%.d^{-1}, 2,28 g a 1,40 ve variantě A, 8,06%.d^{-1}, 2,47 g a 1,40 ve variantě B). Na základě dosažených výsledků lze pro užití v rybářském provozu doporučit metodu přímého převodu.

Klíčová slova: candát obecný, převod, růst, přežití, larvy pakomárů, intenzivní podmínky

INTRODUCTION

Pikeperch, *Sander lucioperca* (Linnaeus, 1758) is a commercially important species of ichthyofauna of the Czech Republic. Its present occurrence in open waters is affected to a large extent with stockfish restocking. Approximately 40 t of marketable pikeperch are annually produced in polyculture ponds in the Czech Republic. It is a favourite and sought out object of angling and annual catches from fishing grounds range between 125 and 165 t (Brožová, 2005). The given volume of catches must be assured by stocking sufficient numbers of stocking material obtained from aquaculture. Pikeperch belongs to the most valuable and most expensive fish species on the market. In association with the development of European aquaculture, pikeperch and perch belong to very promising fish species with anticipated enhancement of marketable production from intensive aquaculture of both species being in great demand of the European market.

Use of advanced fry of pikeperch reared in ponds proves to be useful for possible production of stockfish under controlled conditions of intensive aquaculture. This advanced fry is adapted and converted to artificial diet under controlled conditions. Survival rate during the period of conversion is decisively important for the total success of stockfish rearing and it ranges within 24-80%, most frequently about the 50% limit (Zakęś, 1997a,b; 1999; Szkūdlarek and Zakęś, 2002; Ljunggren *et al.*, 2003; Baránek *et al.*, 2007; Molnár *et al.*, 2004b).

Various methods of conversion may be employed: direct conversion to dry diet (Zakęś, 1997a, b; 1999; Szkūdlarek and Zakęś, 2002; Baránek *et al.*, 2007), application of natural food (zooplankton, tubifex worms and chironomid larvae) followed by co-feeding with dry diet (Zienert and Wedekind, 2001; Molnár *et al.*, 2004b; Zienert and Steinl, 2004), appropriately an application of minced fish flesh (Molnár *et al.*, 2004a). Application of a

semi-moist feeding mixture is another possibility. A semi-moist feeding mixture was effective when converting the advanced fry of *Perca flavescens* to dry diet (Brown *et al.*, 1996). In pikeperch and perch, fish fed with a semi-moist feeding mixture showed worse specific growth rate (SGR) and lesser filled stomach if compared to those fed with agglomerated marine larvae feed (Ljunggren *et al.*, 2003). Bódis *et al.* (2007) evaluated the efficiency of four weaning methods of juvenile pikeperch (chironomid larvae (Group C), tubifex (Group T), daphnia (Group D) and direct conversion without live food (Group P)) in 12-day experiment. The highest specific growth rates and condition factors were detected for Group C (4.2%, 1.46 ± 0.5) and Group T (4.2%, 1.48 ± 0.6), respectively. The survival of the groups was as follows: 86.7 ± 9% (Group C), 78 ± 4% (Group T), 52 ± 1.4% (Group D) and 41 ± 9% (Group P). The rate of cannibalism ranged between 6.3 and 13.7% during the transition period.

The aim of our experiment was comparison of two weaning methods of juvenile pikeperch: direct (variant A, dry feed without natural food) and combined (variant B, co-feeding of dry feed and frozen chironomid larvae).

MATERIAL AND METHODS

Source of experimental fish

Advanced fry of pikeperch was obtained from pond nursing (Pohořelice Fish Farming Co.). Brood fish were spawned in a storage pond using the method of semi-artificial spawning and the nest with fertilized eggs was transferred to a small pond (0.27 ha) where the advanced fry was nursed till the age of 30 days. Fish after the harvest were transported in PE bags under oxygen atmosphere to the experimental recirculation facility of the Department of Fishery and Hydrobiology. Mean (n = 100, average ± SD) initial total length (TL) of fish was 38.61 ± 2.40 mm and mean individual weight (W) was 0.45 ± 0.08 g. Mean condition coefficient [K = weight in g x 100 x (standard length in cm)$^{-3}$] was 1.34 ± 0.13.

Culture facilities

Experimental rearing to verify the effectiveness of weaning lasted for 21 days. Fish were stocked into the experiment after 1-day starvation (harvest, transport, stocking) without previous condition period (enhancement of fish condition with application of natural food). Fish which died due to handling when stocked were replaced on the first day of experiment in the morning. Total number of 6 000 specimens of advanced pikeperch fry were stocked into 6 white plastic tanks of 250 l volume with 42.5 cm height of water column, coupled to a recirculation system. The recirculation system with simple bio-filter and oxygenation was of 5 m^3 total volume and daily exchange of water was up to 10%. Fish were randomly divided into two experimental groups. The goal of the experiment was to compare two methods of conversion whilst one of them utilized frozen chironomid larvae as a natural food source. Every experimental group was stocked in three replicates. Initial stocking density was 4 specimens per litre. Light intensity in the rearing room was low (40 - 60 lux) in light regime 16 hours of artificial illumination and 8 hours without illumination (total darkness).

Water quality

Water temperature was registered daily with mean value 20.0 ± 0.57 °C. Oxygen saturation and pH level (WTW pH/Oxi 340i) were also measured daily and mean values were 98.8 ± 1.55% and 7.20 ± 0.10, respectively. The $N\text{-}NH_4^+$ content in the experiment was lower than 0.2 $mg.l^{-1}$ and $N\text{-}NO_2^-$ content was lower than 0.05 $mg.l^{-1}$ (WTW PhotoLab Spektral). Water inflow through jets was set equilibrated to all tanks and it provided water circulation with exchange of the total volume in the tank once per hour.

Feeding

Fish starved one day prior to the experiment. In both variants dry commercial diet DAN-EX 1352 (DANAFEED, Denmark) with 0.6 mm particle size was used from the beginning to the end of experiment. Feed was administered 16 h daily in excess (DFR 4% of biomass weight (BW) in the variant A and 2% in the variant B) by means of a belt feeder. In the variant B we used modified weaning method described by Zienert and Wedekind (2001). Chironomid larvae in this variant were fed twice a day (8 a.m. and 4 p.m.) in amount of 10% of BW at the beginning of the experiment and the amount was lowered till D_{18}. From the D_{19} only the commercial diet was fed. Feed remnants were removed regularly twice a day from the experimental tanks.

Data collection and statistical analysis

Tanks were checked twice a day to register mortality, cannibalism and to remove appropriate cannibals from tanks. Dead fish were removed twice a day and in case of expressive damage of tail fin, they were involved into losses caused by cannibalism. In case of removal of a cannibal with prey from the tank, both fish were involved into losses caused by cannibalism. At the end of experiment, 30 fish were sampled from each tank (90 fish from each experimental variant), fish were anaesthetized with clove oil (0.03 $ml.l^{-1}$) and individually measured [TL (total length), SL (standard length) with 1 mm precision and W (weight) with 0.01 g precision]. Growth was quantified by means of specific growth rate (SGR = [ln (final weight) – ln (mean initial weight)] x $days^{-1}$ x 100). Condition coefficient was computed (K = weight in g x 100 x $(\text{standard length in cm})^{-3}$). Food conversion ratio (FCR) was not assessed, as feeding was administered in excess during the experiment and the diets used did differ in dry matter. Statistical assessment of the parameters studied (TL, W, SGR, K, survival rate, cannibalism) employed the analysis of variance test (ANOVA) and Scheffe´s multiple comparison method in Unistat programme. Duration of the experiment in days was assigned as D_1-D_{21}.

RESULTS

Most fish in the variant B began to intake chironomid larvae already during the first two days of experiment, fry in the variant A began to intake the dry feed during the first week of experiment. In all tanks, food was taken from water surface or from the water column, chironomids in the variant B was exceptionally taken also from bottom of the tank.

Growth rate was very similar in experimental variants A and B (Table I). The highest mean total length, standard length and weight was gained by fry in the variant B, but only in the parameter of total length there was found significantly difference. No difference was found for the condition coefficient (K) and SGR between variants A and B (K 1.40 and SGR 7.70 $\%.d^{-1}$ vs. K 1.40 and SGR 8.07 $\%.d^{-1}$, respectively) but these variants significantly differed at fish from the variant B, which preferred only chironomid larvae and did not intake any dry feed (in Table I called „chironomid fish", K 1.08 and SGR 2.50 $\%.d^{-1}$). Between successfully converted fish from both variants and "chironomid fish" there was found significantly difference in all of evaluated parameters (see Table I).

Any significant difference among the experimental groups was registered neither for the level of cannibalism, nor for amount of successfully converted fish from both variants. Losses due to cannibalism ranged within 36.47–57.00 %. In the variant B there was achieved significantly higher ($p<0,007$) survival (58.37%) in comparison with the variant A (27.87%). However, some fish in the variant B preferred only chironomids and did not intake any dry feed. TL of these fish was only 48.23 mm, W 0.76 g and K 1.08. Very similar results were gained in both the variants A and B, the variant B showed better results in final body weight and SGR but without a significant difference.

Table I: Growth parameters, survival and cannibalism of juvenile pikeperch (mean ± SD)

Specification	Experimental groups		
	A	B	„Chironomid fish" from B
Final TL (mm)	62.85 ± 0.51^{a}	65.03 ± 2.93^{b}	48.23 ± 3.03^{c}
Final SL (mm)	54.19 ± 0.23^{a}	55.37 ± 2.42^{a}	41.13 ± 2.75^{b}
Final W (g)	2.28 ± 0.09^{a}	2.47 ± 0.27^{a}	0.76 ± 0.17^{b}
Condition factor (K)	1.40 ± 0.05^{a}	1.40 ± 0.02^{a}	1.08 ± 0.11^{b}
SGR ($\%.d^{-1}$)	7.70 ± 0.19^{a}	8.07 ± 0.54^{a}	2.50 ± 0.11^{b}
Survival (%)	27.87 ± 2.00^{a}	58.37 ± 27.86^{b}	not evaluate
Converted fish (%)	27.87 ± 2.00	25.13 ± 5.13	not evaluate
Cannibalism (%)	57.00 ± 5.89	36.47 ± 12.99	not evaluate
Natural mortality (%)	15.13 ± 4.91^{a}	5.16 ± 3.58^{b}	not evaluate

Means with different superscript indicate significant difference at $P < 0.05$ level.

DISCUSSION

Results of the experiment confirmed that the advanced fry of pikeperch nursed under pond culture conditions could be, after gaining mean TL 38 mm and W 0.45 g, successfully converted directly to inert diets under the conditions of controlled aquaculture. In contrary to other authors (Zakęś, 1999; Baer *et al.*, 2001; Molnár *et al.*, 2004a, b), we did not feed in the variant A the fry with frozen natural food or minced animal tissues during the initial habit-forming phase.

Zakęś (1999) considers the initial size of pikeperch fry to be the key factor determining the effect of intensive rearing of juvenile pikeperch under controlled conditions, as it decides about the level of adaptation during conversion to dry diets. The period of forming the habit to intake and utilize dry diet lasts for 14–28 days depending on the initial size of pikeperch fry. According to Hilge (1990), the fry of pikeperch can be exclusively fed with dry feed since the TL 40–50 mm. According to Baer *et al.* (2001), the pikeperch fry can be directly converted to dry feed only after gaining 0.65 g weight. Zienert (2003) considers the 0.50 g weight to be suitable for conversion.

Survival rate gained in fry of variants A (27.9%) and B (58.4%) fed from the beginning of adaptation with dry feed or co-feeding dry diet and chironomid larvae is comparable to data stated by Zakęś (1997b), Szkūdlarek and Zakęś (2002) and Molnár *et al.* (2004b). Also the losses caused by cannibalism (37–57%) during the first 21 days of rearing refer to data of Szkūdlarek and Zakęś (2002) and Molnár *et al.* (2004b). Bódis *et al*. (2007) found the weaning method with chironomid larvae better than other methods (tubifex, daphnia or direct conversion) in aspect of growth and survival. In the present study, the survival rate in the variant B (chironomid larvae) was higher than in variant A (direct conversion), in contrary to results of Baránek *et al.* (2007), where higher survival rate had been gained in variant fed only with dry diet. However, some fish in the variant B preferred only chironomids and did not intake any dry feed. TL of these fish was only 48.23 mm, W 0.76 g and K 1.08. Number of successfully converted fish (25.1%) in the variant B was even lower than in the variant A (27.9%). In summary, use of frozen chironomid larvae for weaning of juvenile pikeperch (TL 38.6 mm, W 0.45 g and K 1.34) from natural diet to commercial feed has no positive effect on final weaning success. On the basis of achieved results it is possible to recommend method of direct conversion for use in Czech fishery practice.

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