

PRODUCTION EFFECT OF VARIOUS FEEDS ON TWO SIZE CLASSES OF JUVENILE TENCH (*TINCA TINCA*) UNDER THE CONDITIONS OF INTENSIVE REARING

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Abstract

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The experimental rearing of tench (*Tinca tinca*) juveniles of two size classes with initial individual weight of 0.8 and 1.2 g was performed into flow-through aquaria connected to recirculation system during a period of 63 days. Three feeds (KARPICO Supreme 7 Ex, ASTA 2, L05/CH) with nutrient content of 37/8, 42/7 and 35/7 (% proteins/ fat) were used in the experiment. Achieved values of production indicators – feed conversion ratio (FCR) and specific growth rate (SGR) ranged from 1.84 to 4.15 and from 0.70 to 1.49 %·d⁻¹, respectively in relationship to the size class and feed used. More favourable values were achieved with the bigger size class regardless to the diet used (FCR 1.84–3.53 and SGR 0.83–1.49 %·d⁻¹) and the best results were achieved when using ASTA 2 feed (2.05 and 1.84 or more precisely 1.36 and 1.49%·d⁻¹).

juvenile tench, growth, feed conversion, specific growth rate, condition

The increased requirements of European market cannot be satisfied by tench production in ponds and thus, possibilities for non-traditional breeding approaches to rearing of early and juvenile stages under controlled conditions of intensive aquaculture are searched for. Using a proper feeding strategy, the rearing of tench larval stages can be carried out successfully in recirculation facilities (WOLNICKI and KORWIN-KOSSAKOWSKI, 1993; WOLNICKI and GORNY, 1995; WOLNICKI *et al.*, 2003). MAREŠ *et al.* (2005) gained 97% survival rate when nursing the tench larvae till the age of 21 days upon commercial starter feeds under controlled conditions, which was found to be comparable to results gained with the live food.

Results of the studies performed up-to-date showed a possibility to perform the intensive rearing of post-larval and juvenile stages of tench based on commercial feeding mixtures (QUIRÓS and ALVARIÑO,

1998; WOLNICKI and MYSZKOWSKI, 1998; RENNERT *et al.*, 2003; WOLNICKI *et al.*, 2003). When compared to juvenile stages of other cyprinids, the growth of tench fed with commercial feeds is extremely slow, even in case of addition of natural food (QUIRÓS and ALVARIÑO, 1998; MYSZKOWSKI *et al.*, 2001; WOLNICKI *et al.*, 2003, MAREŠ *et al.*, 2006; WOLNICKI *et al.*, 2006). Another problem accompanying the intensive culture of juvenile tench utilizing commercial feeds is a frequent occurrence of morphological malformations, which might be associated with the quality of the diet used (KORWIN-KOSSAKOWSKI *et al.*, 2004; WOLNICKI *et al.*, 2006), with high feeding intensity (KAMLER *et al.*, 2006) or with different growth performance (RENNERT *et al.*, 2003). The absence of an appropriate feed is a factor limiting the nursing of larval and juvenile stages of tench under controlled conditions (QUIRÓS *et al.*, 2003). The development and production of tench feed

prerequisites gaining knowledge on nutritional requirements of this species (JIRÁSEK and MAREŠ, 2005).
 The goal of the experiment performed was to test the production effect of various feeds in juvenile tench of different size classes.

MATERIAL AND METHODS

The feeding test with tench juveniles of two size classes (0.83 g and 1.19 g) was performed from January 31 to April 4, 2005. The experiment was carried out in the experimental facility of the Department of Fishery and Hydrobiology of the Mendel University of Agriculture and Forestry in Brno, Czech Republic. Tench juveniles originated from artificial propagation (June 15, 2004) at Pohořelice Pond Aquaculture Co. and they were reared in the experimental facility under controlled conditions till the beginning of the test.
 The experimental goal was to test the production efficiency of the following three feeds used for the size classes of tench under study: commercial

extruded feed KARPICO Supreme 7 Ex (fa. Cop-pens, The Netherlands), produced commercially for common carp fry, feed ASTA 2 (Poland), a pilot-pro-duced feed tested on various species and age classes of fish, and an experimental diet L05/CH of our own production with 0.5% Chlorella addition, based upon plant proteins and tested on other fish species as well. Results of chemical analyses of the diets used are gi-ven in Tab. I.
 The experiment was carried out in 6 flow-through aquaria (30 l volume with 15 cm height of water column) integrated into a recirculation system. Water temperature, pH and oxygen saturation of water (%) were measured daily. Mean water temperature during the experiment was 22.7 ± 1.3 °C, pH was 8.53 ± 0.05 and oxygen saturation was 104.7 ± 6.15 %. Content of $N-NH_4^+$ was lower than 0.1 mg.l⁻¹ during the whole period and the content of $N-NO_2^-$ was less than 0.05 mg.l⁻¹.

I: Nutrient and energy content in the diets used (own analyses)

Diet	Dry matter (%)	Protein (%)	Fat (%)	Ash (%)	NFE (%)	BE (kJ.kg ⁻¹)	DE (kJ.kg ⁻¹)
KARPICO	96.20	36.03	7.03	8.15	45.00	19329	15023
ASTA 2	87.53	42.39	6.71	7.29	31.14	18282	13948
L05/CH	95.17	35.13	7.00	8.24	44.80	19067	14832

NFE = nitrogen-free extract
 BE = brutto energy
 DE = digestible energy

Fish were graded into two size classes (lighter – L and heavier – H) and each of them was stocked into 3 aquaria (1 replicate for each feed and weight class),

100 specimens each. The input data of the fish are reported in Tab. II.

II: The input length-weight data of the juvenile tench (mean ± SD, n = 15 specimens)

Class	TL (mm)	SL (mm)	W (g)	K _F
L	43.52 ± 2.25	35.70 ± 1.43	0.83 ± 0.02	1.03 ± 0.15
H	48.54 ± 3.70	39.90 ± 3.11	1.19 ± 0.02	1.08 ± 0.23

The fish were weighed in 7-days interval. Weights registered were used to compute the FCR ($FCR = F.(W_t - W_o)^{-1}$) and to determine the feeding ratio for the next period. The coefficient of weight condition according to Fulton was computed as followed: $K_F = W.10^5.TL^{-3}$. The index of specific growth rate ($SGR = [(ln W_t - ln W_o).t^{-1}].100$) was computed upon the mean individual weight from the total fish stock

biomass. Feeding ratio of 3% of the fish biomass was used during the test and the daily feed ration was divided into three aliquots for hand feeding at 7.00, 12.00 and 17.00. Front side ot the aquaria was partly covered by green paper in order to reduce the amount of reflected light and to adjust light conditions in the aquaria (20–30 lux illumination intensity at water surface). Twenty specimens of each variant were mea-

sured individually at the end of the experiment (TL, SL, W with precision to 0.01 mm or 0.01 g), the values registered were evaluated using the analysis of variance test (ANOVA) and Scheffe's multiple comparison method in Unistat programme. Ten specimens from each variant were also used to check the weight of gutted fish and pooled samples of entire fish and of

pooled viscera from individual feeding variants were used for chemical analysis.

RESULTS

Values of the production parameters under study, registered after termination of the feeding experiment are given in Tab. III.

III: Values of selected productive parameters after 63 days of testing

Variant	W_0 (g)	W_t (g)	SGR (% $\cdot d^{-1}$)	FCR	PER	Survival (%)
KARPICO L	0.85	1.71	1.11	2.45	1.13	94
KARPICO H	1.21	2.65	1.25	2.30	1.21	92
ASTA 2 L	0.84	1.98	1.36	2.05	1.15	97
ASTA 2 H	1.17	2.99	1.49	1.84	1.28	99
L05/CH L	0.81	1.49	0.70	4.15	0.69	99
L05/CH H	1.20	2.02	0.83	3.53	0.81	96

Higher growth intensity of fry of higher initial weight was registered in all experimental variants. The highest individual weight was gained by fry of the variant H, fed with ASTA 2 starter feed (2.99 g). The highest specific growth rate was found for fry of both size classes (L and H) fed with ASTA 2 feed (SGR 1.49 and 1.36% $\cdot d^{-1}$, respectively) while the lowest ones were found for fry of the L05/CH variant (0.83 and 0.70% $\cdot d^{-1}$, respectively). The most effective conversion of feed to weight gain was found for fry of both size classes with the ASTA 2 variant (FCR 1.84

and 2.05, respectively) and the lowest one in fish fed with the L05/CH variant (FCR 4.15 and 3.53, respectively). In all experimental feeding variants, the bigger fry (H group) showed better feed conversion than the lighter fry (L group). The protein intake was most effectively converted to weight gain in fry fed with the ASTA 2 starter feed (PER 1.28 and 1.15, respectively). Survival of fish in ASTA 2 and L05/CH variants was nearly the same about 98%, while for fish fed with the KARPICO variant the mean survival rate was 93%.

IV: The length-weight data of the tench at the end of the experiment

Variant	TL (mm)	SL (mm)	W (g)	K_F	K_C
KARPICO L	51.54 $\pm$ 3.48 ^a	42.06 $\pm$ 2.98 ^a	1.65 $\pm$ 0.34 ^a	1.19 $\pm$ 0.09 ^a	0.98 $\pm$ 0.07 ^a
ASTA 2 L	53.23 $\pm$ 4.66 ^a	43.02 $\pm$ 4.05 ^a	1.73 $\pm$ 0.50 ^a	1.12 $\pm$ 0.07 ^a	0.97 $\pm$ 0.05 ^a
L05/CH L	47.69 $\pm$ 2.75 ^b	38.89 $\pm$ 2.29 ^b	1.26 $\pm$ 0.30 ^b	1.15 $\pm$ 0.16 ^a	0.93 $\pm$ 0.08 ^a
KARPICO H	56.68 $\pm$ 3.13 ^{a,b}	46.94 $\pm$ 2.93 ^{a,b}	2.47 $\pm$ 0.57 ^a	1.34 $\pm$ 0.15 ^a	1.12 $\pm$ 0.12 ^a
ASTA 2 H	59.44 $\pm$ 4.56 ^a	48.55 $\pm$ 3.87 ^a	2.45 $\pm$ 0.58 ^a	1.15 $\pm$ 0.08 ^b	0.98 $\pm$ 0.05 ^b
L05/CH H	55.26 $\pm$ 5.42 ^b	45.26 $\pm$ 4.42 ^b	2.02 $\pm$ 0.76 ^a	1.15 $\pm$ 0.09 ^b	0.99 $\pm$ 0.08 ^b

Note: Values with the same alphabetic markers within a column do not differ significantly ($P > 0.05$).

It is evident from the data in Tab. IV that significantly highest values of total length were gained by bigger fry (H group) of the ASTA 2 variant. No difference was found for body weight among the H groups of all variants. Significantly the highest value of Fulton's coefficient of condition was found for fry of the H group in KARPICO variant (K_F 1.34). Among

the L groups of all variants, there were significant differences in total length, body length and weight for the commercial feeds (KARPICO and ASTA 2) vs. the experimental mixture (L05/CH) but this difference was not confirmed by values of the coefficient of condition.

Values found by the analysis of chemical composition of body of experimental fish are given in Tab. V. Higher content of protein in the ASTA 2 was also reflected by higher retention of body protein (15.50%). With the same fat content in feeds tested, the highest fat deposition (6.71%) was found in fry

of the KARPICO variant. In fish of the other variants, the body fat content was about 5%. Similarly, the visceral fat content in fry of the KARPICO variant (42.62%) was significantly higher than those in L05/CH (30.33%) and ASTA 2 variants (29.31%).

Tab. V: Chemical composition of fish body at the end of the experiment

Variant		Dry matter (%)	Protein (%)	Fat (%)
KARPICO L	Whole fish	24.04	15.02	6.74
	Viscera	29.74		43.53
ASTA 2 L	Whole fish	24.17	15.61	5.30
	Viscera	35.69		28.01
L05/CH L	Whole fish	21.84	14.26	4.63
	Viscera	35.37		32.00
KARPICO H	Whole fish	21.49	12.06	6.68
	Viscera	40.15		41.71
ASTA 2 H	Whole fish	23.54	15.37	4.48
	Viscera	33.81		30.61
L05/CH H	Whole fish	22.39	14.39	5.39
	Viscera	34.42		28.67

DISCUSSION

This experiment demonstrated that tench fry of smaller initial weight gained worse production result in all experimental feeding variants under study. Only the survival rate gained was found to be comparable, as it ranged within 92–99% in both size classes of fry. Thus, a higher mortality of juvenile tench found with application of commercial feeds for other fish species (QUIRÓS and ALVARIÑO, 1998; QUIRÓS *et al.*, 2003) was not proven. The weight growth intensity was higher for heavier fry of all experimental variants, as demonstrated by the SGR values which were superior by 14% as a mean, compared to those of the lighter fry. The SGR values for fry fed with the ASTA 2 variant ($1.43\% \cdot d^{-1}$) were higher than those gained by WOLNICKI *et al.* (2006) with the same feed. Growth intensity of fry of the KARPICO and L05/CH variants (0.77 – $1.18\% \cdot d^{-1}$) was higher than that reported for tench fry fed with commercial feeds by DE PEDRO *et al.* (2001), QUIRÓS *et al.* (2003) and MAREŠ *et al.* (2006). Values of the coefficient of condition according to Fulton (K_p) nearly did not differ for fry of both size classes and they ranged within 1.12–1.19. The highest value of K_p (1.34) was found

for fry fed with KARPICO feed, what was comparable to data by QUIRÓS *et al.* (2003), MAREŠ *et al.* (2006) and WOLNICKI *et al.* (2006).

More effective conversion of the tested feeds was found for the bigger fry as the FCR values were 7% lower in a mean than those of the smaller fry. The lowest FCR (1.84) values was found for the bigger fry fed with the ASTA 2 variant. Also, values of FCR registered for fry fed with KARPICO (2.37) and L05/CH (3.83) feeds were more favourable than levels of feed conversion reported for tench fry by MAREŠ *et al.* (2006). Utilization of the protein taken for weight gain was found to be the most effective in fry of the ASTA 2 variant (PER 1.22) and the worst in the L05/CH variant (0.75). Bigger fry of all feeding variants showed 12% higher PER values as a mean, compared to the smaller one. Content of protein found in body of the fry fed with the ASTA 2 starter feed (15.74%) referred to data stated by WOLNICKI *et al.* (2006) with the same diet but the body fat deposition was found to be lower in fry under study.

Of the feeds used in the experiment under study, the Polish starter feed ASTA 2 for nursing juvenile cyprinids in intensive aquaculture had the best performance. It was proved by values of the productive indi-

ces studied, as well as by absence of morphological malformations. It confirmed the conclusions drawn by KORWIN-KOSSAKOWSKI *et al.* (2004) and WOLNICKI *et al.* (2006) who have used the same feed. It is probable that the nutritional requirements of juvenile tench will be fulfilled with the feed containing 42–45% protein, 7–10% fat and up to 30% carbohydrates, with energetic value of 18,500 kJ BE.kg⁻¹, i.e. 14,000 kJ DE.kg⁻¹. The worse production results gained with KARPICO and L05/CH feeds might be affected by high content of carbohydrate (about 45%) difficult to be digested and assimilated by juvenile tench (ARLINGHAUS *et al.*, 2001). DE PEDRO *et*

al. (2001) also found worse growth of juvenile tench when using feed with sacharide content above 35%. The feed for juvenile salmonids with high fat content cannot be recommended for juvenile tench either (QUIRÓS *et al.*, 2003).

Results of the performed study demonstrated that if the fry of tench have grown more slowly since the larval period, than their growth and feed conversion were not improved during the juvenile period either, even if the food competition with bigger fish was excluded. Smaller fry should not be used for further rearing.

SOUHRN

Produkční účinek různých krmiv u dvou velikostních skupin juvenilního lina obecného (*Tinca tinca*) v podmínkách intenzivního chovu

V průtočných nádržích napojených na recirkulační systém byl proveden experimentální odchov dvou hmotnostních skupin plůdku lina obecného o počáteční kusové hmotnosti 0,8 a 1,2 g v délce 63 dnů. V testu byly použity tři krmné směsi (KARPICO Supreme 7 Ex, ASTA 2; L05CH) s obsahem živin (% NL/tuk) 37/8; 42/7 a 35/7. Dosažené hodnoty produkčních ukazatelů – krmný koeficient (FCR) a specifická rychlost růstu (SGR) se pohybovaly v rozmezí 1,84–4,15 a 0,70–1,49 %·d⁻¹ v závislosti na velikostní skupině a použitém krmivu. Přiznivější hodnoty byly dosaženy u skupiny větších ryb bez ohledu na použitou dietu (1,84–3,53 a 0,83–1,49 %·d⁻¹) a nejlepších výsledků bylo dosaženo při použití krmiva ASTA 2 (2,05 a 1,84, resp. 1,36 a 1,49 %·d⁻¹).

juvenilní lín, růst, konverze krmiva, specifická rychlost růstu, kondice

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