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A performance test with five different strains of tench (*Tinca tinca* L.) under controlled warm water conditions

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Summary

Growth performance tests were carried out with a total of five different strains of tench (*Tinca tinca* L.) originating from the Czech Republic (4) and Germany (1). Tench larvae and juveniles were reared in closed recirculating systems for 446 to 452 days, respectively. At the end of each test, the tench strains showed differences in performance, e.g. specific growth rates (SGR) from 2.13 to 2.52, feed conversion ratios (FCR) from 1.75 to 3.65 kg feed per kg weight gain, and survival rates from 64.4 to 81.0%. Thus, appropriate strain selection appears to have the potential to remarkably increase productivity of the species. The highest SGR was observed in the Vodnany 96 strain in the first trial and the best FCR in the Tabor strain in the second trial. However, the rearing conditions in the recirculating systems were not optimal for tench; many fish with deformed bones (head, fins, spine) were observed in all strains, particularly in the faster-growing strains.

Introduction

The tench (*Tinca tinca* L.) is an Euro-Siberian fish which has been raised in European pond culture as a secondary or by-product fish since the Middle Ages. However, the tench has never matched the common carp in aquaculture importance. Therefore, Steffens (1995) designated the tench as a neglected pond fish species. In recent years, there has been an increased interest in tench for research and commercial fish farming in several European countries.

Research results from Füllner (1996), and Füllner and Pfeifer (1994a,b, 1998) demonstrate the possibility of higher yields per hectare by improved technologies in pond culture. Higher yields can also be achieved based on genetic aspects such as selection, cross-breeding, induced gynogenesis and triploidy (Flajšhans et al., 1998). Differences in various performance traits such as growth, feed conversion, vitality, disease resistance and body composition have been reported among populations, lines or strains of many fish species. It is possible that tench strains of different geographical origins may exhibit differences in performance trials. Therefore, performance tests with five tench strains, four from the Czech Republic (Marianske Lazne, Tabor and two Vodnany strains) and one from Germany (Königswartha) were carried out over a period of about 450 days.

Materials and methods

The performance tests were run in two trials with three strains each, dictated by limited rearing capacities: Königswartha, Vodnany hybrid strain and Vodnany pure strain, year class 1996; and Marianske Lazne, Tabor and Vodnany pure strains, year class 1998.

All tench larvae were obtained by artificial reproduction. Eggs were incubated in Zuger glasses or gauze frames. After hatching, the tench larvae of the first trial were initially stocked into six 30-L glass aquaria (two groups per strain) in a small recirculating system, consisting of ten 30-L glass aquaria and two biological filters (Eheim E 2260) for all aquaria. In the second trial, nine 30-L aquaria (three groups per strain) were stocked in the same recirculating system. Fish at the beginning of the two trials numbered 200 per group (aquaria). Water temperature in the rearing units was 22 ± 1°C.

After 100 days, when body weight exceeded 1 g, fish of the first trial were stocked into six 500-L circular tanks, each with a water volume of 285-L, in a recirculating system. In the second trial, six 500-L tanks were stocked after 256 days, when body weight exceeded 1 g. Delayed stocking in the second trial was due to the slower growth of fish. Each circular tank was initially stocked with 150 fish. In both trials, the water temperature in the circular tanks was 23 ± 1°C. The recirculating system had a total rearing volume of about 10 m^3. Water purification was centrally realized by a mechanical filter (lamella filter) and a biological filter (trickling filter). The daily water demand was about 10% on average. During the entire test period the ammonia and nitrite content amounted to 0.1–0.2 and 0.3–0.4 mg L^{-1}, respectively. The content of dissolved oxygen ranged between 6.0 and 8.0 mg L^{-1}. In some isolated cases, only 5.1 mg L^{-1} were reached. The measured pH-value was about 7. In two cases, the pH decreased below 6.0. After 1 day the value could be increased up to 6.5 by adding a little bit more water.

During the first 100 days after hatching, all strains in the first and second trial were fed *ad libitum* with *Artemia* nauplii, zooplankton, macrozoobenthon and a trout starter feed. The protein and fat contents of the starter feed were 50 and 12%, respectively. Thereafter, the juvenile tench were fed solely with a commercial trout feed (Trouvit). The protein and fat content in this feed amounted to 45 and 20%, respectively. The daily feeding rations decreased from 5% the first 100 days to 2 and 1.5% of the total fish biomass at the end of the first and second trials, respectively. Fish were fed by hand. The first trial lasted for 446 days, the second trial lasted for 452 days.

To determine the fish biomass, all fish were weighed every 4 weeks. Until an individual body weight of about 1 g was reached, the fish were weighed in groups; fish were thereafter weighed individually. The daily feeding rations were calculated on the basis of the biomass of each group for the next 4 weeks. Fish mortalities were also determined every 4 weeks by counting the total stock in each group. Specific growth rates

(SGR) and feed conversion ratios (FCR) were calculated as follows:

$$SGR = 100(e^g - 1) \text{ and } g = (\ln BW_2 - \ln BW_1)/t_2 - t_1$$

with: BW_1: initial body weight at day t_1; BW_2: final body weight at day t_2; t_2–t_1: number of feeding days.

$$FCR = \text{feed (kg)/weight gain (kg)}$$

The principal influence of different strains on SGR and body weight was tested by one-way analysis of variance (ANOVA). Differences of mean values were evaluated for significance by the range tests of Tukey HSD (P = 0.05) for homogeneous variances (Levene test) and by the range tests of Dunnett T3 (P = 0.05) for inhomogeneous variances, respectively. Calculations were performed with the SPSS software package (SPSS Inc., Chicago, IL, USA).

Results

Growth in the first trial was significantly better than in the second trial (Figs 1 and 2). The strains in the first trial reached an average body weight of about 10.0–15.0 g in the first 300 days; the strains in the second trial grew much slower and reached an average body weight of about 2.5 g in this time.

In the first trial of the present work, the tench strain Vodnany 96 reached the highest final body weight of 48.07 ± 33.0 g after a period of 446 days. It was followed by the Vodnany hybrid with 41.32 ± 31.5 g. The lowest body weight after the first trial was observed for the Königswartha strain with 21.0 ± 27.6 g. In the second trial the Tabor strain performed best with a body weight of 21.95 ± 20.5 g after a period of 452 days. It was followed by the Vodnany 98 strain with 14.47 ± 13.3 g and Marianske Lazne with only 10.03 ± 9.8 g. The differences between the final body weights of the three strains in the first trial and the three strains in the second trial were significantly different (P < 0.05).

Data on body weight, specific growth rate, feed conversion ratio and mortality for all strains in both trials during the entire experimental period are shown in Tables 1 and 2.

It is important to note that the final body weights are significantly different between the three tested strains in the first trial as well as in the second trial. The strains which reached the greatest final body weight were also recorded for the best SGR and FCR. However, the strain differences in these traits were statistically not significant. Moreover, the fastest-growing strains did not show the lowest mortality in every case.

In all strains, many fish with deformed bones (head, fins, spine) were observed. Faster-growing fish were much more affected than slower-growing fish. In the best-growing Vodnany 96 strain the share of affected fish was 39.4%. In contrast, in the Königswarta strain with the lowest SGR in this trial, only 22.7% fish were affected.

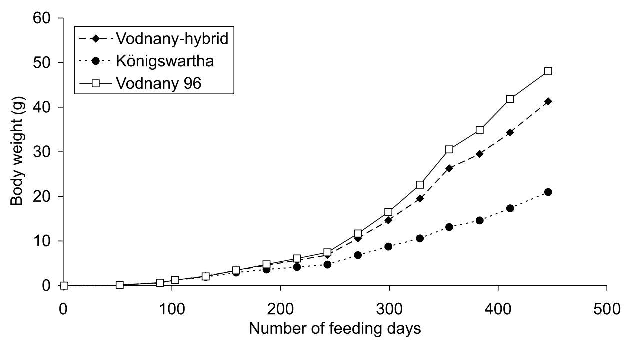

Fig. 1. Changes in body weight of three strains of juvenile tench during a 446-day performance test (first trial). The mean body weights per fish are represented. Differences between the mean final body weights (day 446) are statistically significant (P < 0.05). Vodnany hybrid n = 232; Königswartha n = 193; Vodnany n = 243

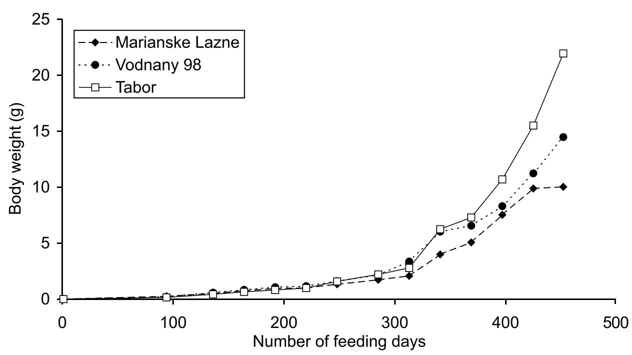

Fig. 2. Changes in body weight of three strains of juvenile tench during a 452-day performance test (second trial). The mean body weights per fish are represented. Differences between the mean final body weights (day 452) are statistically significant (P < 0.05)

Discussion

Little information has been published about tench rearing under controlled warm water conditions and many details are unknown. First attempts were described by Hahlweg (1990), Kamler et al. (1995), Quiros and Alvariño (1998), Quiros et al. (1998), Sierra et al. (1995), Wolnicki and Korwin-Kossakowski (1993), Wolnicki and Gorny (1995) and Wolnicki and Myszkowski (1998a,b). Previous studies involved tench larvae or juveniles, but investigations of fish reaching marketable size have not yet been published. Nevertheless, some authors found that formulated feeds, especially trout feeds, can be used to feed tench under controlled conditions. On the other hand, Wolnicki and Gorny (1995) reported that controlled raising of larval tench seems to be more complicated, especially when applying dry diets. Therefore, tench larvae were fed in our trials during the first 100 days with live food and supplemented with trout starter feed.

Water temperature between 21 and 24°C is comparable with information from other authors (Quiros and Alvariño, 1998; Wolnicki and Myszkowski, 1998a,b).

As expected, in the present study the strains with the highest final body weights showed the best SGR and FCR. However, growth performances presented here are poorer than under pond conditions. Füllner and Pfeifer (1994a,b) reported a body weight of up to 23.0 g in one-summer-old tench fingerlings reared in bi-culture with European catfish. After the second summer the tench reached a body weight of about 160.3 g in the best trials.

In the present study, differences in mortality between the tench strains were found but they were not statistically secure. In the first trial, the fast-growing strains had the lowest losses. Mortalities during the 446 and 452 days of our trials were lower than those reported by Füllner and Pfeifer (1994a) for pond conditions where mortality in some cases amounted to more than 50% during the first summer.

A reason for the poor results compared with pond conditions might be that the tench is a very sensitive fish species with

Table 1
Mean initial and final body weight, SGR, FCR and mortality of the three different strains during the first trial

Strain	Feeding days	Initial body weight (mg) n = 100[1]	Final body weight ± SD (g)	n	SGR ± SD (%)	FCR[2] (kg feed per kg gain)	Mortality[3] (%)
Vodnany 96	446	0.45	48.07 ± 33.0[a]	243	2.52 ± 0.16[a]	2.41	19.0
Vodnany hybrid	446	0.47	41.32 ± 31.5[b]	232	2.48 ± 0.16[b]	2.62	22.6
Königswartha	446	0.43	21.00 ± 27.6[c]	193	2.29 ± 0.19[c]	3.56	35.6

Data in columns with different superscripts are significantly different ($P < 0.05$); [1]random sample; [2]period from day 103 until day 446; [3]period from day 52 until day 446.

Table 2
Mean initial and final body weight, SGR, FCR and mortality of the three different strains during the second trial

Strain	Feeding days	Initial body weight (mg) n = 100[1]	Final body weight ± SD (g)	n	SGR ± SD (%)	FCR[2] (kg feed per kg gain)	Mortality[2] (%)
Marianske Lazne	452	0.42	10.03 ± 9.8[a]	195	2.13 ± 0.16[a]	2.62	23.3
Vodnany 98	452	0.45	14.47 ± 13.3[b]	198	2.21 ± 0.17[b]	2.29	17.0
Tabor	452	0.47	21.95 ± 20.5[c]	194	2.29 ± 0.19[c]	1.75	25.3

Data in columns with different superscripts are significantly different ($P < 0.05$); [1]random sample; [2]period from day 94 until day 452.

many problems under semi-intensive and intensive warm water conditions. It seems that the lack of hiding places in the rearing tanks leads to disturbed behaviour. Tench crowding in dense groups on the tank bottom were observed. They did not readily react to feed as did common carp. Instead, they often swam away when feed was given.

Noticeable were deformed bones at the head, fins and spine. These bones were shortened at the head and fins and curved at the fins, ribs and spine. Also, they were thinner and softer compared with bones of tench from natural waters or ponds. The deformations occurred more often among the fast-growing strains. Among the slow-growing strains, especially the Königswartha strain, only a few deformations were found. The reason for the deformations is unknown. Probably it might be due to imbalanced feed composition for tench. However, other authors (Hahlweg, 1990; Sierra et al., 1995) who also used trout feed did not report such problems.

Despite all of these unsolved questions, our results indicate a great potential for genetic improvement of tench by classical breeding methods. Even the choice of the proper population may remarkably enhance the productivity of the species. Selection between and within populations as well as cross-breeding of populations could be applied. Large family selection programmes which have already appeared to be the most useful tools of production enhancement in some salmonid and tilapia species should give similar results in tench as well. For practical reasons, the search for family specific molecular markers is essential.

Conclusions

Growth performance of different tench strains can vary. In the present study these differences were statistically significant ($P < 0.05$). The ranking of strains for body weight within each trial was identical to that for FCR but the differences for this trait were statistically not significant. Mortality among strains can also vary in tendency. The growth performance obtained under semi-intensive warm-water conditions is inferior to the performance shown under pond rearing conditions. The main reason for this observation might be behavioural problems of tench in tanks which result in stress and reduced feed intake and growth. Additionally, bone deformations occurred in all strains, possibly caused by imbalanced feed.

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