THE EFFECTS OF SALINITY ON GROWTH OF SWORD TAIL, XIPHOPHORUS HELLERI (HECKEL, 1848)

Chinmaya Nanda¹, Mukesh Kumar Bairwa², Sushree Subhasini Behera³ and Saroj Kumar Swain⁴

¹ICAR-Central Institute of Fisheries Education, Mumbai, Maharashtra
²ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha-751002
³College of Fisheries, Junagadh, Veraval, Gujarat
⁴Corresponding author: mukeshbairwa2@gmail.com

This study was conducted to evaluate effect of different salinities (0, 2, 4, 6 ppt) on growth and survival of sword tail, Xiphophorus helleri for 45 days. The species were taken from the water sources, which has the salinity of zero ppt in the experimental unit and then transferred to control and respective treatments (T₁, 2 ppt, T₂, 4 ppt and T₃, 6 ppt). Fifteen sword tail fish were placed in each aquarium (1.5x1.0x1.0 feet³). They were fed with commercial feed along with plankton up to satiation once in a day and individually weighed at an interval of 15 days. The highest final mean weight was recorded in T₁ (1.17 ± 0.09 mg) which was significantly (P<0.05) higher than control and other treatments. The final length of the sword tail reared in the control (4.45 ± 0.102 cm) and T₁ (4.45 ± 0.286 cm) was significantly different than other treatments T₂ (4.35 ± 0.076 cm) and T₃ (3.98 ± 0.19 cm). Survival was significantly different among the three salinity treatments (P<0.05). In conclusion, the species can grow well in water having the salinity of 2 ppt, but it can tolerate salinity of 6 ppt. These findings give us a lead to further upscale the study to understand the scope of culture of the ornamental species in saline affected areas.

INTRODUCTION

Growth is controlled in fish by environmental factors such as temperature, photoperiod and salinity. There are various studies on the effects of these factors on growth (Imsland et al., 2001; Moustakas et al., 2004; Engstrom-Ost et al., 2005; Resley et al., 2006; Kearney et al., 2008; Luz et al., 2008; Overton et al., 2008; Arjona et al., 2009). Nowadays, it is known that salinity affects fish growth rate but how it influences it is not totally understood. There is an accepted hypothesis of how salinity affects energy budget in fish. If salinity is too high or too low in the external environment than fish body fluid (depending on fresh water or marine fish), fish spends more energy to regulate osmotic balance. Therefore, less energy remains for growth in these environments because of the use of too much energy for active ion transport. It is recently cited that fish uses roughly 10% of total energy for osmoregulation (Boeuf and Payan, 2001). Salinity affects fish hormonal activity as well.

Swordtail (Xiphophorus helleri) is a freshwater fish in the family Poeciliidae of the order Cyprinodontiformes. It is one of the earliest bred fish and the most commonly retained ornamental fish. Its original habitat is Mexico and Guatemala. The male grows up to 7.5 cm and female up to 11.5 cm in overall length. In domestic market swordtail male is sold in approximately Rs. 30-50. It is considered as a commercially important species in the market, though scarcity of published information about the salinity effect on growth of ornamental
fishes. Therefore the aim of this study was to assess the influence of salinity on growth performance of sword tail as stenohaline fresh water fish. In this study, the fish is exposed to three salinity treatments (2 ppt, 4 ppt and 6 ppt) for 45 days to evaluate weight gain, specific growth rate, food intake and survival of sword tail in each treatment.

**MATERIALS AND METHODS**

This experiment was conducted in the ornamental fish hatchery of ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha. All the preparation needed for the experiment had been carried out in the unit. Three different salinity treatments ($T_1$ (2 ppt), $T_2$ (4 ppt) and $T_3$ (6 ppt)) along with control were tested for sword tail. There were three replicate for each salinity treatment. Fishes were acclimatized for about 15 days before the experiment started. Sword tail ($n = 15$ i.e. stocking density @1 number/3 liter) $0.062 \pm 0.03$ g body weight, $3.10 \pm 0.11$ cm length) were separately placed in each aquarium tank (27 litre each). Salinity was gradually raised by one ppt per day until desired salinity levels were reached in every treatment. The salinity was measured by Refractometer (Model 3250 Advanced Instruments, Inc.). Siphoning and water exchange (30%) was done weekly with water that had same salinity. Fishes were fed *ad libitum* twice a day for 45 days with commercially available feed (35% protein), Mixed zooplankton was given along with commercial feed once a day. All fish were weighed in each aquarium on days Initial, 15, 30 and 45. Daily feed intake was determined for each replicate. Parameters of fish growth performance (weight gain, length gain and food intake) and survival were calculated (Hargreaves and Kucuk, 2001; Kangombe and Brown, 2008).

**Formulae of growth parameters**

\[
\text{Percentage weight gain (WG\%)} = \frac{[(\text{Final Weight})-(\text{Initial Weight})]}{\text{Initial Weight}} \times 100
\]

\[
\text{Percentage length gain (LG\%)} = \frac{[(\text{Final Length})-(\text{Initial Weight})]}{\text{Initial Length}} \times 100
\]

\[
\text{Survival} = \frac{(\text{Number of fish at start of rearing})-(\text{Number of dead fish during rearing})}{\text{Number of fish at start of larval rearing}} \times 100
\]

**Statistical analysis**

One way analysis of variance (ANOVA) was carried out using SPSS (Version 16.0, Chicago, IL, USA). Duncan’s multiple range test was used for post-hoc analysis. All experimental data were expressed as mean ± SE.

**RESULTS**

Fishes were reared in the salinity range of control (0 ppt), $T_1$ (2 ppt), $T_2$ (4 ppt) and $T_3$ (6 ppt) for 45 day. Water quality parameters such as temperature, dissolved oxygen,
alkalinity, hardness and pH were under the optimum range in all experiments (Table 1).

**Table 1: Water quality parameters.**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value (mean±SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>25.55 ± 0.43</td>
</tr>
<tr>
<td>DO (mg L⁻¹)</td>
<td>6.15 ± 0.04</td>
</tr>
<tr>
<td>pH</td>
<td>7.37 ± 0.15</td>
</tr>
<tr>
<td>Free CO₂ (mg L⁻¹)</td>
<td>4.76 ± 1.19</td>
</tr>
<tr>
<td>Alkalinity (mg L⁻¹)</td>
<td>86.59 ± 1.29</td>
</tr>
<tr>
<td>Hardness (mg L⁻¹)</td>
<td>92.59 ± 1.35</td>
</tr>
<tr>
<td>NH₄-N (mg L⁻¹)</td>
<td>0.04 ± 0.01</td>
</tr>
<tr>
<td>NO₃-N (mg L⁻¹)</td>
<td>0.03 ± 0.01</td>
</tr>
</tbody>
</table>

**Mean body weight**

The mean body weight at the time of stocking was 0.62±0.03 mg. The mean body weight of fishes on 15 day in different treatments was not significantly different (P<0.05). On 30 day the highest mean weight was recorded in T₁ treatment whereas lowest in control. The highest mean body weight on 45 day was also recorded in T₁ (1.17±0.09) group whereas lowest in T₃ (0.91±0.01) group and also had a statistical significant at 5% (Table 2).

**Table 2: Mean body weight of Sword tail, Xiphophorus helleri larvae reared in different salinity at different time point.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0 days</th>
<th>15 days</th>
<th>30 days</th>
<th>45 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.63±0.03t</td>
<td>1.14±0.277t</td>
<td>0.82±0.069t</td>
<td>1.03±0.106t</td>
</tr>
<tr>
<td>T₁</td>
<td>0.66±0.046t</td>
<td>1.05±0.190t</td>
<td>0.99±0.029t</td>
<td>1.17±0.098t</td>
</tr>
<tr>
<td>T₂</td>
<td>0.67±0.025t</td>
<td>0.785±0.037t</td>
<td>0.96±0.014t</td>
<td>0.93±0.014t</td>
</tr>
<tr>
<td>T₃</td>
<td>0.63±0.005t</td>
<td>0.68±0.008t</td>
<td>0.89±0.005t</td>
<td>0.91±0.014t</td>
</tr>
</tbody>
</table>

Mean values (Mean± SE) with different alphabets differ significantly among the treatments (P<0.05).

**Mean body length**

The mean body length of swordtail at the time of stocking was 3.10±0.10 cm. During the entire experimental period body length of fishes were not significantly different among the treatments. However, the highest mean body length was recorded in T₁ (4.45±0.28 cm) group whereas, lowest in T₃ (3.98±0.11 cm) group on 45 day of experiment (Table 3).
Table 3: Mean body length of Sword tail, *Xiphophorus helleri* reared in different salinity density at different time point.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>0 days</th>
<th>15 days</th>
<th>30 days</th>
<th>45 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.13 ± 0.11&quot;</td>
<td>3.65 ± 0.14&quot;</td>
<td>4.06 ± 0.15&quot;</td>
<td>4.45 ± 0.10&quot;</td>
</tr>
<tr>
<td>T₁</td>
<td>3.10 ± 0.10&quot;</td>
<td>3.68 ± 0.13&quot;</td>
<td>4.36 ± 0.15&quot;</td>
<td>4.45 ± 0.28&quot;</td>
</tr>
<tr>
<td>T₂</td>
<td>3.13 ± 0.09&quot;</td>
<td>3.86 ± 0.18&quot;</td>
<td>4.28 ± 0.17&quot;</td>
<td>4.35 ± 0.07&quot;</td>
</tr>
<tr>
<td>T₃</td>
<td>3.15 ± 0.11&quot;</td>
<td>3.75 ± 0.17&quot;</td>
<td>4.20 ± 0.17&quot;</td>
<td>3.98 ± 0.11&quot;</td>
</tr>
</tbody>
</table>

Mean values (Mean ± SE) with different alphabets differ significantly among the treatments (P<0.05).

Weight gain (%)

In present experiment after 45 day rearing of swordtail, the highest weight gain(%) was recorded in T₁ group, whereas lowest in T₃ group. Here weight gain (%) in T₁ was significantly different from other treatment group (Fig. 1).

![Weight gain graph](image)

**Fig. 1.** Weight gain(%) of Sword tail, *Xiphophorus helleri* reared in different salinity at different time point. Mean values (Mean ± SE) with different alphabets differ significantly among the treatments (P<0.05).

Length gain (%)

Length gain (%) in T₁ larval group was significantly higher (P < 0.05) than other groups. In present study, the highest length gain(%) was recorded in T₁ larval group whereas lowest length gain(%) was in T₃ group (Fig. 1).
Survival(\%)

The survival of different treatment was significantly different (P < 0.05) among the treatment than control. The highest survival was recorded in control (88.88 \%) whereas lowest in T3 treatment(73.33 \%). During the experiment more mortality occurred during the initial days of rearing (mainly T1) compare to later.

\[ \text{Fig. 2. Length gain (\%)} \text{ of Sword tail, Xiphophorous helleri reared in different salinity density at different time point. Mean values (Mean ± SE) with different alphabets differ significantly among the treatments (P<0.05).} \]

\[ \text{Fig. 3. Survival(\%)} \text{ of Sword tail, Xiphophorous helleri reared in different salinity density at different time point. Mean values (Mean± SE) with different alphabets differ significantly among the treatments (P<0.05).} \]
DISCUSSION

Aquaculturists are trying to find the optimum salinity conditions for each species so that fish production will increase and brackish water areas will be used more efficiently. In present study, sword tail, Xiphophorus helleri were reared in three different salinities with control as freshwater. The mean weight in T1 group (2 ppt) was significantly higher than control however, mean length was not significantly different among the treatments. This result indicates that low saline water may be good for culture of swordtail.

The lower growth performance of swordtail at higher salinity may be due to that lower uptake of food by the fish. Wang et al. (1997) showed that food consumption rate decreased by increasing salinities in common carp. It began to reduce at salinity of 6.5 ppt. Even in marine fish, if salinity is too low (from 39 ppt to 15 ppt) in sole, it causes stress and fish decreases in feed intake and growth (Arjona et al., 2008). In the present study, salinity increase resulted in reduction of food uptake. Wan et al. (2014) reported that culture of black molly (P. sphenops) in a slight saline condition from 3 to 6 PSU is better than freshwater. Luz et al. (2008) and Wang et al. (1997) found higher growth of gold fish and common carp respectively in low saline water compared to freshwater.

Freshwater fish generally grow well in both freshwater and low salinity environments. If salinity level increases more, growth rate starts declining. In the present study the survival showed significant difference among the treatments. The study indicates that salinity of 6 ppt greatly affect the survival.

In conclusion present study recommends the culture of swordtail in low saline (2 ppt) water compared to freshwater however higher salinity (4 ppt and 6 ppt) does not suit for better growth.

ACKNOWLEDGEMENT

The authors express sincere gratitude to the Director, ICAR-CIFA, Bhubaneswar for encouragement and providing necessary facilities during this study.

REFERENCES


