Revista Brasileira de Zootecnia

ISSN 1806-9290
www.sbz.org.br

R. Bras. Zootec., v.41, n.6, p.1342-1345, 2012

Saline water for juvenile giant trahira during feed training

Ana Lúcia Salaro[1], Daniel Abreu Vasconcelos Campelo[1], Marcelo Duarte Pontes[1], Mateus Moraes Tavares[1], Jener Alexandre Sampaio Zuanon[1], Ronald Kennedy Luz[2]

[1] *Universidade Federal de Viçosa, Departamento de Biologia Animal. Av. P.H. Rolfs s/n, Centro, 36570-000, Viçosa, Minas Gerais, Brasil.*
[2] *Laboratório de Aquicultura da Escola de Veterinária - Universidade Federal de Minas Gerais. Av. Antônio Carlos, 6627, 31270-901, Belo Horizonte, Minas Gerais, Brasil.*

ABSTRACT - The objective of this study was to investigate the effect of different water salinities on juvenile *Hoplias lacerdae* during feed training. Salinity levels of 0, 3, 6 and 9 g salt L^{-1} were used. Juveniles (3.33±0.1 cm and 0.6±0.09 g) were stocked at a density of six fish L^{-1} in aquaria (10 L volume) with supplementary aeration. Weight gain, length gain, and rates of survival, mortality, and cannibalism were evaluated after 20 days. Total mortality was observed in 0 g of salt L^{-1}. The best survival rates of 98.7 and 97.5% were recorded in 3 and 6 g of salt L^{-1}, respectively. The greatest weight gain was recorded in fish grown in 3 g of salt L^{-1} followed by fish grown in 6 g of salt L^{-1}. Length gain was similar in the 3 and 6 g salt L^{-1} groups. No weight or length gain was recorded in 9 g of salt L^{-1}. According to regression equations, the optimum water salinity was 5.15, 4.03 and 4.55 g of salt L^{-1} for survival rate, weight, and length gain, respectively. Salinity between 4.03 and 5.15 g of salt L^{-1} during feed training of juvenile giant trahira improves productive performance.

Key Words: carnivorous fish, formulated diet, *Hoplias lacerdae*, salinity

Introduction

The addition of salt to the culture water is a common practice in freshwater fish production. The use of low salinity water during larviculture has led to good performance and survival results in different species (Britz & Hecht, 1989; Weingartner & Zaniboni Filho, 2004; Campagnolo & Nuñer, 2006; Beux & Zaniboni Filho, 2007; Luz & Santos, 2008; Santos & Luz, 2009; Luz & Santos, 2010). Salt can also be used to control various diseases and parasites (Altinok & Grizzle, 2001b; Garcia et al., 2007) and to reduce the negative physiological effects of stress during the transport of freshwater fish (Carneiro & Urbinati, 2001; Gomes et al., 2003).

Under experimental conditions, water salinity can affect the excretion of ammonia (Altinok & Grizzle, 2004), digestibility (Wang et al., 1997), oxygen consumption (Wang et al., 1997; Altinok & Grizzle, 2003), daytime locomotor activity, feeding behavior and growth (Luz et al., 2008). Therefore, the use of saline water can have a number of implications, either positive or negative, depending on the concentration used.

The giant trahira *Hoplias lacerdae* is a carnivorous species that, during larviculture, can be reared in water with a salinity of up to 4 g of salt L^{-1} with performance and survival results similar to those seen in freshwater (Luz & Portella, 2002). However, the effect of water salinity at later stages, during feed training, which is considered critical in the production of carnivorous fish, is not yet known for this species. Therefore, the present study aimed to investigate the effects of different water salinities on feed training of *Hoplias lacerdae* juvenile giant trahira.

Material and Methods

The experiment was conducted at the Laboratory of Fish Nutrition in the Aquaculture Section of the Animal Biology Department, Universidade Federal de Viçosa, UFV, Minas Gerais, Brazil, from November 27, 2007 to December 16 , 2007.

The experimental design was completely randomized with four water salinity levels (0, 3, 6 and 9 g of salt L^{-1}) and four replicates. A commercial common table salt (Cisne®, Brazilian Industry – 390 mg sodium/g of salt, 25 µg iodine/g salt) was used to create the different salinity. The salt was diluted in water from the tanks prior to distribution of the fish.

Juvenile giant trahira (length 3.3±0.1 cm and weight 0.6±0.09 g) were stocked in 16 white rectangular tanks (55 × 35 × 19 cm) each containing 10 liters of water, at the density of six juveniles L^{-1}. The water oxygen concentration was maintained above 6.0 mg L^{-1} via a supplemental aeration

Received April 8, 2011 and accepted December 13, 2011.
Corresponding author: salaro@ufv.br

system. The pH was 7.0, 7.2, 7.1 and 7.4 in freshwater, 3, 6 and 9 g of salt L^{-1}, respectively. The water temperature was maintained at 26.0±0.5 ºC. To prevent animals from escaping, a 3 mm thick black plastic screen was placed on the tanks.

The technique of feed training consisted of a gradual transition of ingredients using mixtures of bovine heart (H) and commercial ration (F) following the protocol described by Kasai et al. (2011): 20F:80H (diet 1); 40F:60H (diet 2); 60F:40H (diet 3); 80F:20H (diet 4); and 100%F (diet 5). Each diet was offered for 4 days.

The ingredients (extruded commercial feed ground and sieved to obtain a diameter of less than 0.5 mm and crushed bovine heart) were mixed to obtain a homogeneous mass (Table 1).

The juvenile giant trahira were fed to apparent satiety three times daily, at 6:00, 12:00 and 16:00. During feeding, the tanks were uncovered for a period of 5 minutes, for live fish to be quantified and dead fish, removed. Probable cases of cannibalism (ripped animals) were recorded following the methodology of Salaro et al. (2011).

The water in the tanks was completely replaced every day at 17:00. During this procedure, which lasted about 30 seconds, the juveniles were captured with a net and immediately transferred to another clean tank under the same conditions of salinity and water temperature.

At the end of the experiment, length and weight gains were determined using a digital caliper and balance (0.001 g precision), respectively. Survival, mortality and cannibalism rates were also determined.

Data were subjected to regression analysis at 5% probability using the software SAEG 9.1. The appropriate regression model was selected on the basis of the significance of regression coefficients, t-test results, the magnitudes of the coefficients of determination as well as the behavior of the variables in this study.

Table 1 - Chemical composition of commercial diet and bovine heart used during feed training of *Hoplias lacerdae*

	Bovine heart[1]	Commercial feed[2]
Crude protein	81.37	42.00
Crude lipid	9.15	7.00
Crude fiber	2.08	5.00
Moisture	28.27	8.00
Ash	7.19	15.00
Calcium	0.19	4.00
Phosphorus	1.11	1.50
Gross energy (kcal kg^{-1})	5051.98	4490.00

[1] Composition based on dry matter percentage (AOAC, 1999). The commercial diet, with safe levels described by the manufacturer, was enriched with (product/kg diet): folic acid - 6.00 mg; pantothenic acid - 75.00 mg; antioxidant - 185.00 mg; choline - 1,000.00 mg; copper - 6.00 mg; cobalt - 0.30 mg; iron - 75.00 mg; inositol - 12.00 mg; iodine - 2.00 mg; manganese - 30.00 mg; selenium - 0.16 mg; vit. A - 18,000 IU; vit. B1 - 15.00 mg; vit. B12 - 0.06 mcg; vit. B2 - 30.00 mg; vit. B6 - 15.00 mg; vit. C - 300.00 mg; vit. D3 - 3,000 IU; vit. E - 75.00 mg; vit. K3 - 7.50 mg; zinc - 90.00 mg; niacin - 150.00 mg.

[2] Commercial extruded diet for carnivorous fish. Ingredients used: corn, meat and bone meal, fish meal, soybean meal, wheat bran, BHT and vitamin and mineral supplement. Possible substitutes: corn gluten meal, rice bran, blood meal, brewers rice, sorghum, calcium calcite and etoxiquim.

Results and Discussion

All fish kept in freshwater died in the second week of the experiment. The dead fish had a whitish, retracted operculum, thus exposing the gills, plus exophthalmos and opaque eyes. The daily capture of animals in order to clean the tanks may have been too stressful for this species when kept in freshwater.

Survival, mortality ($P<0.001$) and cannibalism rates ($P<0.05$) showed a quadratic effect in different salinities (Table 2). According to the regression equation, the optimal salinity for maximum survival rate was 5.15 g of salt L^{-1}. It is likely that the salt acted mitigating the stress experienced during daily cleaning. The physiological stresses experienced by fish include the increased permeability of the gills to water and consequent hydromineral imbalance (Bonga, 1997). Increasing salinity decreases the osmotic gradient between the water and fish plasma, reducing the loss of ions to the environment and thus favoring osmoregulatory processes and reducing energy expenditure via the active transport of ions. The ability of salt to act as a mitigator of stress during transport and recovery has been reported by several authors (Carneiro & Urbinati, 2001; Tsuzuki et al., 2001; Gomes et al., 2003), along with its role in disease prevention (Altinok & Grizzle, 2001b; Garcia et al., 2007), which is particularly useful, given the common occurrence of disease in fish under stress conditions.

High survival rates were also observed during feed training at 4 g of salt L^{-1} (Kasai et al., 2011). Salinity gradients of up to 6 g of salt L^{-1} did not negatively affect the survival rate of other species of freshwater fish (Altinok & Grizzle, 2001a; Luz et al., 2008; Luz & Santos, 2010).

The increased mortality observed in fish treated with 9 g of salt L^{-1} may be due to difficulties related to osmoregulation, and a consequent increase in sodium levels in body fluids, since some stenohaline freshwater species do not tolerate high salinity. Juvenile freshwater angelfish, *Pterophyllum scalare*, tolerate 7.5 g of salt L^{-1} (Moreira et al., 2011) and juvenile *Colisa lalia* and *Colisa labiosa* tolerate 3.85 and 4.10 g of salt L^{-1}, respectively, during subchronic exposure (Zuanon et al., 2011). However, the tolerance of the species under study to salinity is not yet known.

The high rate of cannibalism observed in the group of 9 g salt L^{-1} may be due to increased stress related to the high sodium concentration in the water. Since stress is an adaptive

Table 2 - Mean values and their equations of weight gain, length gain, survival, cannibalism and mortality rates after the feed training of *Hoplias lacerdae* juvenile in different water salinities

	Water salinity (g salt L^{-1})				
	0	3	6	9	CV (%)
Weight gain (g)[1]	-	0.23	0.20	0.00	37.40
Length gain (cm)[2]	-	0.30	0.30	0.00	29.41
Survival rate (%)[3]	-	98.75	97.50	52.91	15.09
Cannibalism rate (%)[4]	-	1.25	1.67	17.92	146.81
Mortality rate (%)[5]	100	0.00	0.83	29.18	28.59

[1] $y = -0.0094x^2 + 0.0758x + 0.0825$ $R^2 = 0.82$ ($P<0.001$).
[2] $y = -0.0153x^2 + 0.1392x + 0.0175$ $R^2 = 0.84$ ($P<0.001$).
[3] $y = -3.9559x^2 + 40.7592x + 3.7154$ $R^2 = 0.92$ ($P<0.001$).
[4] $y = 0.4242x^2 – 2.0396x + 1.0926$ $R^2 = 0.49$ ($P<0.05$).
[5] $y = 3.5317x^2 – 38.7197x + 95.1920$ $R^2 = 0.92$ ($P<0.001$).

response of animals that prepares them to overcome adversity, the high rate of cannibalism may be related to increased aggression and greed triggered by the increase in adrenaline, noradrenaline and cortisol in the blood.

Other factors that lead to increased cannibalism in carnivorous fish are inadequately management of: quantity and quality of feed, dissemblance in length, stocking density, photoperiod and the presence of refuges (Hecht & Pienaar, 1993; Atencio-García & Zaniboni-Filho, 2006). Probably inadequate management led to higher rates of cannibalism due to the increase in stress.

Quadratic effect of water salinity was recorded for the gains in weight and length ($P<0.001$). The fish cultured in 3 g of salt L^{-1} showed the highest weight gain, followed by those cultured in 6 g of salt L^{-1}, with the optimum concentration estimated as 4.03 g of salt L^{-1}. Similar results were recorded for length gain, with the optimum concentration estimated as 4.55 g of salt L^{-1}. In a previous study, up to 4 g of salt L^{-1} did not affect growth during the larviculture of this species (Luz & Portella, 2002). During the larviculture of *Lophiosilurus alexandri*, 2 g of salt L^{-1} resulted in a greater total length after 10 days of culture when compared with freshwater and 4 g of salt L^{-1} (Luz & Santos, 2008). The osmotic concentration of the body fluids of freshwater fish is higher than that of the environment and may increase the energy required for osmoregulation (Sampaio & Bianchini, 2002). Thus, reducing this gradient can reduce energy consumption for osmoregulation, and consequently result in an increase in fish growth (Sampaio & Bianchini, 2002).

The juvenile giant trahira did not grow at 9 g salt L^{-1}. It is likely that high salinity caused excessive stress to the animals, as also indicated by their darker color in relation to fish grown in 3 or 6 g of salt L^{-1}. This change in fish color can be induced by stressful situations (Oliveira & Galhardo, 2007). Moreover, the increase in salinity may lead to a series of metabolic and physiological changes and a consequent reduction in fish growth. Luz et al. (2008) found higher feed intake in 2 g of salt L^{-1}, but reported a decline in consumption and a decrease in the feed conversion ratio in juvenile *Carassius auratus* as salinity increased from 2 to 10 g of salt L^{-1}. The authors also reported an increase in osmolarity and reduced levels of total protein in the blood, and changes in the pattern of locomotor activity with increasing salinity. Altinok & Grizzle (2004) also recorded increased excretion of nitrogenous compounds by *C. auratus* as salinity increased from 0 to 9‰, reporting that the energy required for the synthesis of these compounds may be related to changes in growth rates. Thus, the growth of freshwater fish may be related to salinity via changes in the energy expenditure required for ionic and osmotic regulation (Altinok & Grizzle, 2001a).

In addition to these factors, Wang et al. (1997) found that juvenile *Cyprinus carpio* showed improved digestibility and lower oxygen consumption in fresh water and salinity of 2.5‰ compared with higher salinity levels. During the larviculture of *Rhinelepis aspera*, 6 g of salt L^{-1} led to a reduction in length gain, compared with freshwater, 2 and 4 g salt L^{-1} (Luz & Santos, 2010). In *Lophiosilurus alexandri* larvae, even 4 g salt L^{-1} led to reduction in growth, compared with freshwater and 2 g salt L^{-1} (Luz & Santos, 2008). Thus, the optimal salinity varies with the species and its size, emphasizing the importance of this type of study at different life stages and in different species of freshwater fish.

Conclusions

Concentrations between 4.05 and 5.15 g of salt L^{-1} during the feed training of *Hoplias lacerdae* juveniles improve the productive performance of the fish.

Acknowledgments

The authors thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the fellowship granted to the second author.

References

ALTINOK, I.; GRIZZLE, J.M. Effects of brackish water on growth, feed conversion and energy absorption efficiency by juveniles euryhaline and freshwater stenohaline fishes. **Journal of Fish Biology**, v.59, p.1142-1152, 2001a.

ALTINOK, I.; GRIZZLE, J.M. Effects of low salinities on *Flavobacterium columnare* infection of euryhaline and freshwater stenohaline fishes. **Journal of Fish Diseases**, v.24, p.361-367, 2001b.

ALTINOK, I.; GRIZZLE, J.M. Effects of low salinities on oxygen consumption of selected euryhaline and stenohaline freshwater fish. **Journal of the World Aquaculture Society**, v.34, p.113-117, 2003.

ALTINOK, I.; GRIZZLE, J.M. Excretion of ammonia and urea by phylogenetically fish species in low salinities. **Aquaculture**, v.238, p.499-507, 2004.

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS - AOAC. **Official methods of analysis of the Association of Official Analytical Chemists**. 16.ed. Washington: AOAC, 1999. 1141p.

ATENCIO-GARCÍA, V.; ZANIBONI-FILHO, E. El canibalismo en la larvicultura de peces. **Revista MVZ Córdoba**, v.11, p.9-19, 2006.

BEUX, L.F.; ZANIBONI FILHO, F. Survival and the growth of pintado (*Pseudoplatystoma coruscans*) post-larvae on different salinities. **Brazilian Archives of Biology and Technology**, v.50, p.821-829, 2007.

BONGA, S.E.W. The stress response in fish. **Physiological Reviews**, v.77, n.3, p.591-625, 1997.

BRITZ, P.J.; HECHT, T. Effect of salinity on growth and survival of African sharptooth catfish (Clarias gariepinus) larvae. **Journal of Applied Ichthyology**, v.5, p.194-202, 1989.

CAMPAGNOLO, R.; NUÑER, A.P.O. Sobrevivência e crescimento de larvas de surubim, *Pseudoplatystoma corruscans* (Pisces, Pimelodidae), em diferentes densidades de estocagem. **Acta Scientiarum**, v.28, p.231-237, 2006.

CARNEIRO, P.C.F.; URBINATI, E.C. Salt as a stress response mitigator of matrinxã, *Brycon cephalus* (GÜNTHER), during transport. **Aquaculture Research**, v.32, p.297-304, 2001.

GARCIA, L.O.; BECKER, A.G.; COPATTI, C.E. et al. Salt in the food and water as a supportive therapy for *Ichthyophthirius multifiliis* infestation on Silver catfish, *Rhamdia quelen*, fingerlings. **Journal of the World Aquaculture Society**, v.38, p.1-11, 2007.

GOMES, L.C.; ARAÚJO-LIMA, C.A.R.M.; ROUBACH, R. et al. Avaliação dos efeitos da adição de sal e da densidade no transporte de tambaqui. **Pesquisa Agropecuária Brasileira**, v.38, p.283-290, 2003.

HECHT, T.; PIENAAR, A.G. A review of cannibalism and its implications in fish larviculture. **Journal of the World Aquaculture Society**, v.24, p.246-261, 1993.

KASAI, R.Y.D.; SALARO, A.L.; ZUANON, J.A.S. et al. Training of trairão fingerlings fed with diets containing different levels of vitamin C. **Revista Brasileira de Zootecnia,** v.40, n.3, p.463-468, 2011.

LUZ, R.K.; PORTELLA, M.C. Larvicultura de trairão (*Hoplias lacerdae*) em água doce e água salinizada. **Revista Brasileira de Zootecnia**, v.31, p.829-834, 2002.

LUZ, R.K.; SALARO, A.L.; SOUTO, E.F. et al. Condicionamento Alimentar de Alevinos de Trairão (*Hoplias cf. lacerdae*). **Revista Brasileira de Zootecnia**, v.31, p.1881-1885, 2002.

LUZ, R.K.; MARTÍNEZ-ÁLVAREZ, R.M.; DE PEDRO, N. et al. Growth, food intake regulation and metabolic adaptations in goldfish (*Carassius auratus*) exposed to different salinities. **Aquaculture**, v.276, p.171-178, 2008.

LUZ, R.K.; SANTOS, J.C.E. Densidade de estocagem e salinadade da água na larvicultura de pacamã. **Pesquisa Agropecuária Brasileira**, v.43, p.903-909, 2008.

LUZ, R.K.; SANTOS, J.C.E. Effect of salt addition and feeding frequency on cascudo preto *Rhinelepis aspera* (Pisces: Loricariidae) larviculture. **Journal of Applied Ichthyology**, v.26, p.453-455, 2010.

MOREIRA, D.M.V.; FERREIRA, P.M.F.; ZUANON, J.A.S. et al. Tolerância aguda e subcrônica de juvenis de acará-bandeira à salinidade da água. **Revista Brasileira de Engenharia de Pesca**, v.6, n.1, p.38-47, 2011.

OLIVEIRA, R.F.; GALHARDO, L. Sobre a aplicação do conceito de bem-estar a peixes teleósteos e implicações para a piscicultura. **Revista Brasileira de Zootecnia**, v.36, p.77-86, 2007.

SALARO A.L.; TAVARES, M.M.; CHAVES, W. et al. Feed training of juvenile giant trahira under different light intensities. **Revista Brasileira de Zootecnia**, v.40, n.11, p.2290-2293, 2011.

SAMPAIO, L.A.; BIANCHINI, A. Salinity effects on osmoregulation and growth of the euryhaline flounder *Paralichthys orbignyanus*. **Journal of Experimental Marine Biology and Ecology**, v.269, p.187-196, 2002.

SANTOS, J.C.E.; LUZ, R.K. Effect of salinity and prey concentrations on *Pseudoplatystoma corruscans*, *Prochilodus costatus* and *Lophiosilurus alexandri* larviculture. **Aquaculture**, v.287, p.324-328, 2009.

TSUZUKI, M.Y.; OGAWA, K.; STRÜSSMANN, C.A. et al. Physiological responses during stress and subsequent recovery at different salinities in adult pejerrey *Odontesthes bonariensis*. **Aquaculture**, v.200, p.349-362, 2001.

WANG, J.-Q.; LUI, H.; PO, H.; FAN, L. Influence of salinity on food consumption, growth and energy conversion efficiency of common carp (*Cyprinus carpio*) fingerlings. **Aquaculture**, v.148, p.115-124, 1997.

WEINGARTNER, M.; ZANIBONI FILHO, E. Efeito de fatores abióticos na larvicultura de pintado amarelo *Pimelodus maculatus* (Lacépède, 1803): salinidade e cor de tanque. **Acta Scientiarum**, v.26, p.151-157, 2004.

ZUANON, J.A.S.; FERREIRA, P.M.F.; MOREIRA, D.M.V. et al. Tolerância subcrônica de juvenis de colisas (*Colisa labiosa* e *Colisa lalia*) à salinidade da água. **Revista Brasileira de Engenharia de Pesca**, 2011 (prelo).