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Short Communication

Comparison of two short-term acclimation methods of channel catfish (*Ictalurus punctatus* Rafinesque, 1818) fingerlings

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ABSTRACT. Two short-term acclimation methods were tested on channel catfish (*Ictalurus punctatus*). Mortality rates were used as the comparison criterion. Significant differences ($P < 0.0001$) in final mortality rates were observed, with the dropping method outperforming the immersion method.

Keywords: bagging densities; dropping method; fingerling survival; fish transportation; immersion method

INTRODUCTION

Acclimation is an adaptation process of poikilothermic organisms to environmental changes involving chemical composition and metabolism alterations occurring in a determined period of days or weeks (Seddon 1997, Khlebovich 2017). Evidence shows that abrupt changes in physical conditions (particularly temperature) can induce stress in fish, reducing their viability and initial survival rates (Fu et al. 2018, Paixão et al. 2024). The poikilothermic biology of fishes governs temperature control of all chemical reaction rates, including metabolism, so water temperature is the main factor that may limit management during breeding and production (Tucker & Robinson 1990, Hargreaves & Tomasso 2004). Channel catfish (*Ictalurus punctatus* Rafinesque, 1808) is an important aquaculture species in Mexico. Its culture and intensive production were initiated in 1970 (Chapa 2009) and have grown significantly during the last decade (CONAPESCA/ SAGARPA 2003, Lara-Rivera et al. 2015). A common practice for catfish producers in Mexico is the median and long-term transportation of fingerlings from hatcheries to raising ponds or dams for its production and sport fishing; these paths could take from some hours to a few days, and the specimens are kept in containers or isolated and refrigerated plastic bags. A latent concern, not always considered, is the initial survival rate associated with introductions and short-term acclimation methods. When this practice is considered, the main monitored factor is temperature, and the general management process to reduce possible

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thermal shock is called short-term acclimation. For catfish, recommended tempering happens at less than 0.558°C min^{-1} if water temperatures between the hatchery and pond differ by more than 2.88°C (Tucker & Robinson 1990). However, other factors act as stressors in manipulating fish, such as dissolved oxygen, pH, density related to waste discharge, and increasing ammonium (Hargreaves & Tomasso 2004, Mischke & Wise 2008). Here, we quantify the differences in mortality between the two methods used for short-term acclimation of channel catfish fingerlings. The first method, immersion, consisted of submerging a fish bag into a small pond with water at an environmental temperature for 10 min. The second method, dropping, consisted of gradually changing the temperature of the fish bags through water renewal for approximately 120 min by using an 8-10 mm diameter rubber hose (Yellow Springs OH, 45387, USA). Both methods included oxygenation by aeration stones. The experiment was performed at CONAPESCA Aquaculture Center "La Rosa" in General Cepeda, Coahuila, México, at the end of the autumn season. Fish were maintained under simulated commercial bagging conditions in triple polyethylene bags 90×60 cm (caliber 300) filled with 10 L of freshwater. Initial physicochemical conditions of water were: pH 8, oxygen 6 ppm, water temperature 22.4ºC, ammonia 0.011 ppm. Dissolved oxygen was measured by a DO200 ISY® oximeter (Yellow Springs, OH, USA) (ppm), and ammonia (ppm) and pH were measured using a Hach® FF-2 kit (Ames, IA, USA). Three groups of different densities were formed: 0.800 kg (80 g L^{-1}), 1.000 kg (100 g L^{-1}), and 1.200 kg (120 g L^{-1}) per bag. The mean size of individuals was 5 ± 0.57 cm, with a mean weight of 2 g (approximately 450 ind per bag). Fish were restricted to food 24 h prior to the experiment. Five groups were formed according to densities and acclimation method; however, the fifth group (120 g L^{-1}) was acclimated only by the dropping method. Opening of bags and acclimation began 24 h after bagging was finished. Final mortality was recorded after acclimation by groups and mortality rates and compared by Chi-square and Fisher exact test using the FREQ procedure of SAS 9.4 (SAS Institute Inc. 2002 Cary NC, USA).

The overall mean final mortality rate observed was 1.52% at 12 h and 3.11% after 24 h. Twenty-four-hour mortality rates were different in all groups, and the highest density group of the drop method presented the highest mortality rate: from 5.33 to 6.20, from 12 to 24 h, respectively (Table 1). Physical and chemical water parameters recorded were: pH 6.5-7.0, oxygen concentration 3.2 ppm (100 g L^{-1}) and 4.6 ppm (80 g L^{-1}), bag water temperature 21.6ºC, ammonia >3.0 ppm. Comparison of mortality rates between densities per bag resulted as not significant at 12 h ($P > 0.05$); however, after acclimation, mortality rates were highly significant ($P < 0.0001$). Interestingly, a slight but significant increase in mortality rates by immersion method was observed ($P < 0.05$) compared with the drop method at different densities (Table 1). A lower mortality rate was estimated for the drop method with lower density (1.78%). Higher density (120 g L^{-1}) was excluded for comparison because no replicate was available. However, an upper limit of mortality rate for this group was noted since the beginning of the experiment (>5%). Equal management conditions in groups indicated no differences based on higher densities, but a proportional increase in density of the 120 g L^{-1} group affected mortality after 24 h. Temperature differences were unimportant at acclimation time. The environmental temperature was 16.6ºC, the temperature inside the water bags was 21.6ºC, and the destination water was 18.6ºC, so only 3ºC differences were observed. The main differences in short-term acclimation methods here tested involve direct and gradual temperature equalization, with or without renewal of freshwater, and testing the time of fish liberation.

Differences in short-term acclimation indicated that stressors other than temperature were acting during the change in the water environment. In catfish, an increase of 0.7 units in pH will cause 10% mortality in 8 days-post hatch fry (Mischke & Wise 2008). The present study observed an average increase in the pH of 0.5. On the other hand, ammonia concentrations >3.0 ppm might be considered lethal after 24 h at pH 7 (Tamasso et al. 1980); however, in this study, it was not possible to determine the major level of ammonia in high-density groups (100 g L^{-1}). High concentrations of ammonia indicate a possible and inefficient feed purge time. Laboratory observations have shown that, in 36 h purged channel catfish, ammonia concentrations are 6 mg L^{-1} after 2 days of transportation with a mortality rate of 1.9% at 17ºC (unpubl. data); these levels are commonly stress-associated, with a manifestation of a broad array of physiological, biochemical, histological and behavioral effects, depending on time and exposure concentrations (Hargreaves & Tomasso 2004). Golombieski et al. (2003) reported an increase in mortality of silver catfish (*Rhamdia quelen*) at a density of 168 g L^{-1} after transportation of 24 h and no mortality for the 87 g L^{-1} group. However, they did not experiment with an intermediate group: they attribute

Table 1. Mortality rates of channel catfish fingerlings in two densities of bagging and acclimation method test. 12hM: 12 h mortality rate = $P > 0.05$. FMR: final mortality rate = $P < 0.0001$. Different superscript letters by trait mean significant differences in pairwise comparison ($P < 0.05$).

Density (g L^{-1})	Acclimation	12hMR (%)	FMR (%)
80	Drop method	0.89^{ab}	1.78^{a}
80	Immersion method	1.22^{b}	3.00^{b}
100	Drop method	0.67^{a}	2.00^{a}
100	Immersion method	0.67^{a}	2.89^{b}
120	Drop method	5.33	6.20

mortality to the increasing density and associated consequences in the depletion of dissolved oxygen and CO_2 increase. In the present experiment, dissolved oxygen reduction was consistent with bag density, perhaps acting as a stress component relative to bag manipulation. Recommended transportation densities for channel catfish fingerlings of 2 g size at 18ºC is 210g L^{-1} for up to 12 h; however, with longer transportation times (≥16 h), densities should be reduced to a half (Piper et al. 1982). Temperature is a limiting factor determining metabolic rates and oxygen consumption. Metabolic effects of stress observed in the assessed organisms are based upon the achievements of this note; however, practical implications on fish management may include the optimal time of feed purge, low bagging densities, and use of dropping short-term acclimation. No literature evidence on short-term acclimation was found. A simpler explanation for the acclimation method mortality differences could be the gradual freshwater renewal by dropping method, assuring better water quality conditions including temperature, oxygen, and removal of chemical stressors; conversely, immersion groups remained in the same water conditions since the only parameter considered was the temperature of the water. As seen in the non-compared group (i.e. 120g L^{-1}), mortality rates were higher according to reported literature (Piper et al. 1982, Golombiesky et al. 2003), pointing out a possible toxic influence of ammonia concentrations influencing dissolved oxygen levels, even in lower density groups. Additionally, and very likely, the temperature difference was not quite contrasting by the region and season in the present experiment; however, in the other areas where channel catfish are also cultured, the temperature differences could show a higher contrast: these differences might be dissimilar giving a purported dramatically impact on fingerling acclimation management. Under the conditions of the present study, short-term acclimation must be considered to introduce fingerlings to a new environment. Consideration of temperature and drop method for water quality renewal could avoid an increase in mortality rates; practical issues to consider are effective diet purge time and a density of 100 g L^{-1} is recommended for 24 h transporting at ~21ºC.

Credit author contribution

A.L. Lara-Rivera: conceptualization, methodology, formal analysis, writing-original draft, supervision, review, and editing; G.M. Parra-Bracamonte: funding acquisition, conceptualization, project administration, validation, methodology, formal analysis, writing-original draft, supervision, review, and editing; I.O. Montelongo Alfaro, F. Benavides González, X.F. De la Rosa-Reyna: supervision, validation, methodology, review, and editing; J.A. González Aguilar: methodology, supervision, validation, data curation; A. Vega-Esquivel: supervision, methodology, review, and editing. All authors have read and accepted the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

Chapa, A.F.G. 2009. Nuevos productos de bagre cultivado. In: Simposio Bagretam 2009, 22 y 23 de enero. Comité Sistema Producto Bagre, Victoria, Tamaulipas, México.

Comisión Nacional de Acuacultura y Pesca/Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (CONAPESCA/SAGARPA). 2003. Anuario estadístico de pesca 2003. CONAPESCA/ SAGARPA, Mazatlán.

Fu, K.K., Fu, C., Qin, Y.L., Bai, Y., et al. 2018. The thermal acclimation rate varied among physiological functions and temperature regimes in a common cyprinid fish. Aquaculture, 495: 393-401.

Golombieski, J.I., Silva, L.V.F., Baltisserotto, B. & da Silva, J.H.S. 2003. Transport of silver catfish (*Rhamdia quelen*) fingerlings at different times, load densities, and temperatures. Aquaculture, 216: 95-102.

Hargreaves, J.A. & Tomasso Jr., J.R. 2004. Environmental biology. In: Tucker, C.G. & Hargreaves, J.A. (Eds.). Biology and culture of channel catfish. Elsevier, Amsterdam, pp. 36-68.

Khlebovich, V.V. 2017. Acclimation of animal organisms: basic theory and applied aspects. Biology Bulletin Reviews, 7: 279-286.

Lara-Rivera, A.L., Parra-Bracamonte, G.M., Sifuentes-Rincón, A.M., Gojón-Báez, H.H., et al. 2015. El bagre de canal (*Ictalurus punctatus* Rafinesque, 1818): estado actual y problemática en México. Latin American Journal of Aquatic Research, 43: 424-434. doi: 10.3856/vol43-issue3-fulltext-4

Mischke, C.C. & Wise, D.J. 2008. Tolerance of channel catfish fry to abrupt pH changes. North American Journal of Aquaculture, 70: 305-30.

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Paixão, P.E.G., Santos, C.C.M., Madi, R.R., Abe, H.A., et al. 2024. Acclimation procedure: a neglected good management practice to mitigate post-transport stress in fish. Aquaculture International, 32: 7747-7769. doi: 10.1007/s10499-024-01539-8

Piper, R.G., McElwain, I.B., Orme, L.E., McCraren, J.P., et al. 1982. Fish hatchery management. United States Department of the Interior, Washington D.C.

Statistical Analysis System (SAS). 2002. Statistical analysis system. SAS Inc., North Carolina.

Seddon, W.A. 1997. Mechanisms of temperature acclimation in the channel catfish *Ictalurus punctatus*: Isozymes and quantitative changes. Comparative Biochemistry and Physiology - Part A: Molecular and Integrative Physiology, 118: 813-820.

Tomasso, J.R., Goudie, C.A., Simco, B.A. & Davis, K.B. 1980 Effects of environmental pH and calcium on ammonia toxicity in channel catfish. Transactions of the American Fisheries Society, 109: 229-234

Tucker, C.S. & Robinson, E.H. 1990. Channel catfish farming handbook. Chapman & Hall, New York.