Salinity tolerance of European catfish (*Silurus glanis* Linnaeus, 1758) larvae

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Abstract

The aim of the study is to establish the salinity tolerance of European catfish larvae towards different concentrations of NaCl. The experiment is carried out with 120 fish (body weight 70.2 ± 12.05 mg and total length 22.07 ± 1.33 mm). Three concentrations of NaCl (1.5%, 3% and 5%) are tested at different exposures. The studied individuals showed tolerance towards 1.5% NaCl solution for 15 and 30 minutes exposure (Variant A_1 & A_2), 3% NaCl – for exposure of 5 minutes (Variant B_1) and 5% NaCl – for 1 minute (Variant C_1), which means that these concentrations at the respective exposures can be used for the prophylactic treatment of larvae. Saline solutions of 3% NaCl for 10 minutes exposure (Variant B_2), as well as 5% NaCl for 3 minutes exposure (Variant C_2), are not in the salinity tolerance range of the studied species due to reported mortality of 5%, respectively, are not recommended for use in fish farming practice.

Key words: European catfish (*Silurus glanis* L.), larvae, salinity tolerance, sodium chloride

Толеранс на личинките на европейския сом (*Silurus glanis* Linnaeus, 1758) към различни нива на соленост

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Резюме

Целта на настоящето изследване е да се установи толерансът на личинки европейски сом към различни нива на соленост. Проучването е извършено в лабораторни условия със 120 броя личинки (тегло 70,2 ± 12,05 mg и дължина 22,07 ± 1,33 mm). Използвани три концентрации на натриев хлорид 1,5%, 3% и 5% при различни експозиции. Опитните индивиди проявяват толеранс към следните концентрации на натриев хлорид – 1,5% при експозиция 15 и 30 минути (Вариант A_1 & A_2), 3% при баня с продължителност 5 минути (Вариант B_1) и 5% за 1 минута (Вариант C_1), което означава, че тези концентрации при съответните експозиции могат да се използват за профилактично третиране на личинки. Солеви разтвори с концентрация на натриев хлорид 3% и експозиция от 10 минути (Вариант B_2), както и концентрация 5% с експозиция 3 минути (Вариант C_2), не са в рамките на солевия толеранс на изследвания вид поради отчетена смъртност от 5% и съответно не се препоръчват за прилагане в рибовъдната практика.

Ключови думи: европейски сом (*Silurus glanis* L.), личинки, солеви толеранс, натриев хлорид

Introduction

In fish farming fish are threatened by various diseases caused by ectoparasites. Prevention and treatment require using various compounds and solutions with certain concentrations. One of the most commonly used compound is sodium chloride (NaCl), also known as cooking salt. Used in proper concentration, the cooking salt negatively affects fish ectoparasites, such as *Ichtiyophtirius multifilis*, *Trichodina* sp., *Dactylogyrus vastator*, *Dactylogyrus extensus*, *Gyrodactylus* sp.

Methods for the prevention and treatment of fish disease, with sodium chloride solution, include baths for 30 sec to 1 min, short baths for 30 to 60 min and long baths lasting from one to several days (Karanikolov and Zaikov, 1998).

A sharp increase in the salinity of the water can cause salt shock in different fish species. This is associated with a decrease in the phagocytic activity of the blood, with larger specimens being more resistant to such changes (Zaikov and Staikov, 2014).

The effect of sodium chloride treatment depends on both concentration and exposure, which are determined by the type and age of the fish. It is known that, most sensitive to sodium chloride treatment are the larvae, i. e. fish up to one month old. In this regard, it is necessary to know the salt tolerance of each species used in freshwater fisheries and to test salinity concentrations before treatment of large number of fish **(**Francis-Floyd, 1995).

The effect of sodium chloride, used for disinfection, prevention of diseases and as a and medicament against certain ectoparasites and bacteria, on various fish species, such as pikeperch, rainbow trout and paddlefish, has been studied by Nemeth et al. (2013), Soumalainen et al. (2005), Zaykov et al. (2006), with the studied concentrations of sodium chloride and exposures varying widely.

A sodium chloride concentration of 0.01% to 0.2% can be used as a continuous treatment and prevention of ectoparasitic infestation in recirculation systems. Such salinity levels are very effective in eliminating single parasite cells (Francis-Floyd, 1995). Another use of sodium chloride in aquaculture, with concentrations of 0.05 to 0.2%, is as an anesthetic, to reduce stress in transporting and handling fish (Wurts, 1995; Bienkiewicz et al., 2007).

Current data on the effect of water salinity on catfish species (order Siluriformes) show that they tolerate higher levels than most freshwater species, including some typical inhabitants of brackish waters (Armitage and Olund, 1962). Kendall and Schwartz (1968) suggested that catfish are able to tolerate higher levels of osmotic stress because their skin is less permeable than the scale coating of most freshwater fish.

A study with catfish cleaner, *Pterygo plichtyspardalis*, from family Loricariidae, established that when transferring fish from water with salinity of 0.02%, they are able to survive in a long-lasting bath with salinity of 1% for more than 10 days with low mortality rate. Few individuals survive in baths with salinity of 1.1% and 1.2% for 20 hours or more, and no fish survive for several hours with a salinity solution of 1.6% (Capps et al., 2011).

An experiment with small fish *Pylodictis olivaris*, from family Ictaluridae, found that when transferred from 4‰ to 14‰ salinity, the survival rate is 95%. Contrary to this result, when transferring fish from 14‰ to clean water, the mortality is 100% within 24 hours. The survival of the specimens in water with a salinity of 18‰ is 0%. The average lethal concentration (LC50) of sodium chloride for this catfish species is 15.8‰ (Bringolf et al., 2005).

Miron et al. (2003) conducted a study related to the treatment of larvae of silver catfish, *Rhamdia quelen*, from family Heptapteridae, infected with the unicellular parasite *Ichtyophthirius multifilis*, with different concentrations of sodium chloride. The test subjects are put in long-lasting (45 day) bath with 4 g/l NaCl, the result being a strong reduction in the symptoms of the disease and 100% survival rate of the fish. The authors conclude that salt baths are an effective method of combating *Ichtyophthirius* infestation in silver catfish.

Tieman and Goodwin (2001) conduct treatment on *Ictalurus punctatus* infected with *Ich-*

thiophthirius multifilis with various compounds, including sodium chloride.

Sandita et al. (2011) treated European catfish stocking material (BW = 33.6 ± 1.7 g, L = 17.5 ± 2.9 cm), infected with *Ichtiophthirius multifilis*, with a 2-day long bath and 1 ppt sodium chloride concentration, whereas Said (2017) investigated salinity tolerance and resistance to *Aeromonas hydrophilia* infection in Nile tilapia applying different concentrations of NaCl.

The study object of this experiment is the European catfish, who due to its rapid growth rate and high market value, is one of the most preferred predator species in the aquaculture sector (Zaikov, 2006). Maintaining optimal cultivation results while maintaining optimal living conditions and good health status is difficults, especially given its vulnerability to ectoparasites (Sandita et al., 2011). Data on the effect of different concentrations of sodium chloride on European catfish, at different exposures, are extremely limited.

Due to lack of sufficient information, we conducted an experiment aimed to establish the tolerance of European catfish larvae to different levels of salinity, in terms of the possibilities for prevention and treatment of parasitic infestations.

Material and methods

The study is conducted at the experimental base of IFA – Plovdiv. For its purpose, 120 larvae with size and weight characteristics, listed in Table 1, are used. The larvae are obtained by semi-artificial reproduction at the experimental base of IFA – Plovdiv, their age at the beginning of the experiment is 25 days. They are cultured in flow-type tubs, at an average water temperature of 23 °C ± 1.5 °C.

Six variants are tested, with three concentrations of sodium chloride – 1.5%, 3% and 5%, at different exposures (Table 2). The experimental concentrations and exposures are changed in a way that keeps animal welfare. The purpose of the methodology is to treat the individuals with a humane ethical attitude. In this regard, the test concentrations and exposures are increased by carefully monitoring their effect on the larvae so that the critical variant can be recorded with a minimum number of victims. The larvae are treated in small tubs with water volume of 10 l without aeration. In each experimental variant, with the corresponding salinity level, 20 fish are used. After the NaCl bath, the treated specimens are transferred to recover in 10 l tubs with fresh water. Micro-compressors are installed for aeration of the water. The amount of dissolved oxygen is 7.5–7.7 mg/l and the temperature is 23.5–24 °C.

Table 1. Body weight and body length of the larvae

	Body weight (BW, mg)	Total body length (TL, mm)
X	70.2	22.07
SD	12.05	1.33
Cv, %	0.085	6.06
Lim.	52.5–95.7	18.30–24.60

Table 2. Experimental salinity treatment variants

Variant	NaCl concentration, %	Exposure, min
A_1	1.5	15
A_2	1.5	30
B_1	3	5
B_2	3	10
C_1	5	1
C_2	5	3

Results and discussion

The behavior of the larvae is monitored during the treatment with NaCl and during the recovery period in the clean water. When placed in Variant A_1 (1.5% NaCl), the larvae move normally all the time. When placed in clean water, 75% of the larvae move as soon as they are released, and after 5 min all larvae are active. The larvae behavior to the saline solution in Variant A_2 is

the same, the difference being in the recovery period, which takes 25 min.

In Variant B_1 (3% NaCl), the larvae move rapidly during the 5-minute exposure period, and during the recovery, all fish regain normal activity within 15 minutes. In Variant B_2, after 5 minutes the larvae are on the surface making uncoordinated movements. The recovery period lasted 42 min, with 5% mortality rate.

The behavior of the catfish larvae in Variant C_1 (5% NaCl – 1 min) is similar to the experimental groups in Variant B and it is expressed in accelerated movements. The recovery period of all larvae took 7 min. In Variant C_2, where the exposure period is 3 min, the time required for the fish to recover is 68 min, with the process being lethal for one individual (Fig. 1).

The survival rate of the European catfish larvae, during its recovery from different variants of water salinity treatments, is presented in Figure 1.

The obtained results show that variants A_1 and A_2, with water salinity of 1.5% and exposures of 15 and 30 min, are within the salinity tolerance of European catfish larvae, who do not change their behavior. The studied subjects showed tolerance to sodium chloride concentration of 3% and exposure of 5 min (Variant B_1), whereas in Variant B_2, a mortality rate of 5% is observed at exposure of 10 min.

Variant C_1 (5% NaCl), with 1 min exposure, is within the salinity tolerance range of the studied specimens, who quickly restore their normal activity. The longer exposure of 3 minutes (Variant C_2) is lethal to one fish.

When comparing the results of this experiment with those of Zaikov et al. (2006), it is established that at 5% NaCl and exposures of 3 min and 5 min, the mortality rate of paddlefish is respectively 2.4% and 5%, whereas in European catfish larvae, treated with the same concentration and exposures, the mortality is 5% and 10%. It is worth to be noted that, one-year-old paddlefish are used in treatment with 5% sodium chloride solution. The conclusion is that European catfish larvae are more sensitive NaCl concentration with the respective exposures, which is probably due to the age of the fish studied.

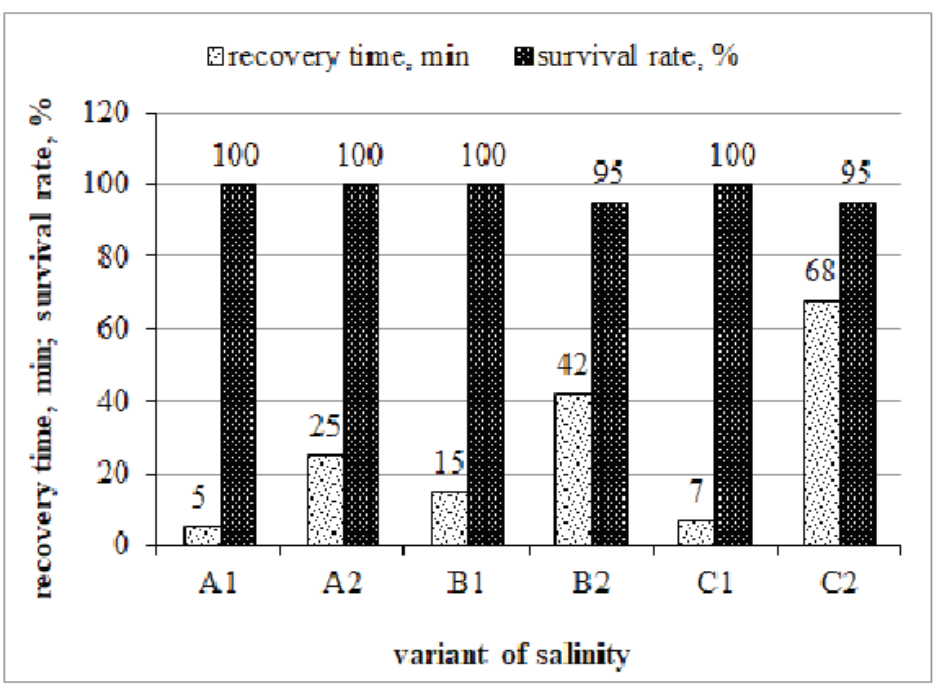

Fig. 1. Recovery time and survival rate of European catfish larvae at different variants of water salinity

In comparing the present results with those obtained from the salinity tolerance study of *Pterygo plichtyspardalis* by Capps et al. (2011), it can be concluded that the latter species is more sensitive to sodium chloride concentrations above 1% than European catfish. This is expressed in low survival rate and concentration of 1.6% is lethal to the representative of the Loricariidae family.

A study conducted by Bianco and Nordile (2008) with *Pseudophoxinus stymphalicus* established that, the increase in salinity from 0.6% to 1.2% for 32 hours, is lethal for the studied subjects, and an increase from 0.6% to 1.4% caused mass mortality to occur within 10 hours. When comparing these data with the results obtained from the present experiment, it can be stated that the larvae of European catfish exhibit tolerance at appropriate concentrations, albeit at shorter exposures. This confirms the assumption of Kendall and Schwartz (1968) that catfish are capable of withstanding higher levels of osmotic stress due to their smooth skin that is less permeable than the scale coating of most freshwater species.

Conclusion

Under the experimental conditions of the study, European catfish larvae are expressed tolerance to water salinity in the following variants: Variant A_1 and A_2 (1.5% NaCl) with exposure of 15 and 30 minutes, Variant B_1 (3% NaCl) with exposure of 5 minutes and Variant C_1 (5% NaCl) with exposure of 1 minute. These concentrations of NaCl can be applied as prevention of parasitic infestations in European catfish larvae. In infected fish, they can also be used, but with caution and prior testing. 3% NaCl concentration and duration of the exposure for 10 minutes (Variant B_2), as well as 5% NaCl and an exposure for 3 minutes (Variant C_2), are not within the salinity tolerance of the studied species, therefore their use in fish farming practice is not recommended.

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