Effect of Transportation Stress on Hepatic Glycogen of *Oreochromis niloticus* (L.)

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Abstract

Oreochromis niloticus was subjected to transportation stress to investigate hepatic glycogen levels and mortality as indices of stress. Mortalities lasted up to three days after transportation, except in highly aerated samples. Hepatic glycogen levels in transported fish were significantly lower than in the controls. Stress appeared to be more intense when fish were transported at a high density and in a high salinity medium.

Introduction

In Nigeria the potential of fish culture is hampered by a shortage of fingerlings (Orji et al. 1996). Mortality is very high during transportation, due to lack of knowledge about appropriate transportation and handling techniques.

Transportation of live fish from the hatchery to the water where they are to be reared is an extremely important aspect in the management of fish culture (McCraren 1978; Berka 1986). Usually, large numbers of fish are transported in a small amount of water. This can result in considerable deterioration of water quality, depending on the time involved. Often fish arrive at the planting site in poor condition and mortality occurs (Shreck and Lorz 1978).

The effects of various stresses in a number of teleostean fish species have been studied by several authors. Working on primary and secondary stress in fish, Madeleine et al. (1977) observed that endocrine changes are early consequences of stress while osmoregulatory dysfunctions are secondary effects. In their work on man-made stress in salmonids, Wendt and Saunders (1973) noted that induced exercise resulted in reduced concentrations of muscle glycogen accompanied by elevated blood lactate levels. Ejike and Shreck (1980) investigated the effects of saltwater and dietary cortisol on handling stress response in coho salmon and concluded that a 0.6% saline medium appears to result in moderate handling stress.

This paper reports the effects of stress on mortality and hepatic glycogen level in fry of *Oreochromis niloticus* transported from a production center (Panyam Fish Farm in Plateau State) to an experimental pond at the Zoology Department of the University of Jos. The transportation time involved was one hour to cover a distance of 70 km.

Materials and Methods

At the production center, *O. niloticus* fry of 11.68 cm (± 1.81) in length were harvested with a cast net and kept in an acclimation tank for one week. They were then transported in four rectangular iron tanks of 98 x 76 cm each. The inside of the tanks was coated with aluminum paint. Fish were transported at the following densities:

a) 40 fry/48 liters of water - (high density)
b) 40 fry/72 liters of water - (medium density)
c) 40 fry/96 liters of water - (low density)

Fish were also transported at the following saline concentrations at a density of 40 fry/96 liters.

a) 0.6% saline - (356.2 g/72 L)
b) 1.0% saline - (720 g/72 L)
c) 0% saline - (normal pond water)

Water in the transportation containers was aerated using commercial-grade oxygen. Dissolved oxygen (DO) levels in the water was determined by the Winkler method.

At Jos, the fish were transferred to a holding basin partitioned into three so that fish with similar transportation conditions could be stored in the same compartment.

Examination of fish (6 fry per treatment) for clinical indices of stress (mortality and hepatic glycogen levels) were carried out before and immediately after transportation. Fish were killed and the liver removed immediately and stored at 20°C until analysis. Hepatic glycogen levels were determined by the method described by Wedemeyer and Yasutake (1977) using 100 mg portions of liver.

Results

There were significant differences ($P<0.05$) in the hepatic glycogen concentration of *O. niloticus* transported under different densities (Table 1). The trend in hepatic glycogen concentration was declining with increasing saline concentration of the transportation media. The glycogen level of fish transported in 1% saline was signifi-

cantly lower ($P<0.05$) compared with the levels in 0% and 0.6% saline concentrations (Table 2).

Mortality was highest in the 0% saline for three consecutive days (8.8%, 21.1%, 2.2%) and lowest in 0.6% (3.3%, 7.7%, 1.1%). Hepatic glycogen levels improved slightly in aerated fry transported in saline media, compared with non-aerated samples (Table 3). There was a decrease in dissolved oxygen content of the water with increasing densities and salinities (Tables 4a and 4b).

Discussion

The results obtained from the physiological indices of stress reveal that transportation of *O. niloticus* led to decreased hepatic glycogen. The hepatic glycogen (fuel molecule) is hydrolyzed by a-amylase (endoamylase) and b-amylase (exoamylase) and later metabolized in the glycolytic sequence. Alternatively, it is degraded by glycogen phosphorylase **a** and **b**, both of which are activated by adenosine monophosphate (AMP) and regulate the rate of hepatic glycogen breakdown. The accelerated rate of enzymatic hydrolysis of hepatic glycogen is a result of stress.

The pattern of variation in hepatic glycogen noted in this experiment is in line with the works of Jurass and Nicolai (1976), Mustafa (1976) and Ejike and Shreck (1979), even though these authors worked on different fish species and under different environmental conditions. Therefore, it may be said as a generalization that there is a high level of depletion of hepatic glycogen in teleostean fishes under stress and this is related to increase in energy demand.

In this investigation the depletion of hepatic glycogen associated with increased water salinity could be an indication that the fish might have been subjected to considerable secondary stress, over and above the primary stress arising from transportation and handling. Moreover, the drastic reduction in dissolved oxygen content necessitated the use of an aerator. Increased depletion of dissolved oxygen may lead to anoxia, which could have accounted for the mortality recorded.

Albaster et al. (1979) investigated the effect of dissolved oxygen and salinity on the toxicity of ammonia to smolts of salmon (*Salmo salar)* and found that low dissolved oxygen and high ammonia could lead to decreased sensitivity of smolts. Also, at concentrations of dissolved oxygen close to the air

Table 1. Hepatic glycogen levels in* O. niloticus *transported under different densities.

Density	Mean total length of fish (cm)	Mean glycogen content (mg/100 mg of liver)
Control (fish before transportation)	12.87 ± 1.2	0.42 ± 0.03
High density (40 fry/48 liters)	11.30 ± 2.7	0.11 ± 0.033
Medium density (40 fry/72 liters)	11.20 ± 0.9	0.19 ± 0.084
Low density (40 fry/96 liters)	11.35 ± 2.4	0.25 ± 0.057

Table 2. Hepatic glycogen levels in* O. niloticus *transported in different salt concentrations.

Salt concentrations	Mean total length of fish (cm)	Mean glycogen content (mg/100 mg of liver)
Control (fish before transportation)	12.17 ± 1.02	0.45 ± 0.03
0% saline	11.70 ± 1.76	0.31 ± 0.75
0.6% saline	13.10 ± 0.70	0.33 ± 0.031
1% saline	12.90 ± 0.92	0.16 ± 0.04

Table 3. Glycogen content (mg) of* O. niloticus *treated with different saline media, with and without oxygen.

Treatments	Mean total length of fish (cm)	Mean glycogen content (mg/100 mg of liver)
Control (fish before transportation)	12.29 ± 0.79	0.48 ± 0.006
0% saline with aeration	12.29 ± 1.40	0.19 ± 0.051
0.6% saline with aeration	13.17 ± 1.24	0.20 ± 0.034
1 % saline with aeration	13.03 ± 1.31	0.18 ± 0.036
0% saline without aeration	12.88 ± 1.83	0.15 ± 0.043
0.6% saline without aeration	13.07 ± 1.58	0.19 ± 0.064
1% saline without aeration	12.20 ± 0.10	0.14 ± 0.053

Table 4a. Dissolved oxygen content (DO) of water samples from different densities of fish after transportation.

Treatments	Dissolved oxygen content (MLS/L)
Control (water before transportation)	10.99 ± 0.29
Low density (40 fry/96 liters)	4.71 ± 0.30
Medium density (40 fry/72 liters)	2.64 ± 0
High density (40 fry/48 liters)	2.46 ± 0.133

Table 4b. Dissolved oxygen content (DO) of water samples for different saline concentrations after transportation of fish.

Treatments	Dissolved oxygen content (MLS/L)
Control (water before transportation)	7.62 ± 0.79
0% saline	5.38 ± 0.31
0.6% saline	5.15 ± 0.29
1% saline	4.69 ± 0.16

saturation value, the 24 h median threshold of unionized ammonia was 0.15 mg/l in fresh water, while in 30% sea water it rose to 0.3 mg/l. The inference is that addition of limited saline media reduces toxicity of ammonia, which is the main product of fish excretion.

References

Alabaster, J.S., D.G. Shurben and G. Knowles. 1979. The effect of dissolved oxygen and salinity on the toxicity of ammonia to smolts of salmon, *Salmo salar*. J. Fish Biol. 15:705-712.

Berka, R. 1986. The transport of live fish, a review. Fisheries Research Institute, Scientific Information Centre, EIFAC Tech. Pap. 48:5-11.

Ejike, C. and C.B. Shreck. 1979. Use of conditioning to reduce handling stress in salmonids. Trans. Am. Fish Soc. 108:103-114.

Ejike, C. and C.B. Shreck. 1980. The effects of salt water and dietary cortisol on handling stress response in coho salmon. Trans. Am. Fish Soc. 109:423-426.

Jurass, K. and B. Nicolai. 1976. Biochemical changes in liver and muscle of rainbow trout, *Salmo gairdneri* during starvation. Zool. Jahrb. Abt. Aug. Zool. Physio. Tierse 1:101-110.

Madeleine, M., F. Mazeud and E. Donaldson. 1977. Primary and secondary effects of stress in fish. Trans. Am. Fish Soc. 106:3.

McCraren, J.P. 1978. Manual of fish culture - fish transportation. U.S. Fish and Wildlife Service, p. 3-9.

Mustafa, S. 1976. Changes of glycogen levels in liver due to increase in salt concentration. Zool. Auz. 197:44-46.

Orji, R., D. Njoku and G. Amaechi. 1996. Studies on induced spawning of African catfish, *Clarias lazera*. J. Tech. Ed. (in press)

Shreck, C.B. and H.W. Lorz. 1978. Stress response of coho salmon *Oncorhynchus kisutch*, elicited by cadmium and copper and potential use of cortisol as an indicator of stress. J. Fish. Res. Board Can. 35:124-219.

Wedemeyer, G. and W.T. Yasutake. 1977. Clinical methods for the assessment of the effect of environmental stress on fish health. U.S. Fish and Wildlife Service Tech. Pap.

Wendt, C.A. and R.L. Saunders. 1973. Changes in carbohydrate metabolism in young Atlantic salmon in response to various forms of stress. International Symposium on Atlantic Salmon, 1973, Ontario, Canada, 230 p.

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