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Preliminary Study on Rate of Oxygen Consumption and Determination of Dissolved Oxygen Required for Transport of Freshwater Shark *Wallago attu* (Schin)

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Abstract: Oxygen uptake by one day fasted juveniles of *Wallago attu* in relation to their body weight was studied in three different concentration of dissolved oxygen, i.e., Saturated (SW), DO 7.6-6.8 ppm, nearly Normoxic (NW) 6.8-4.4 ppm and Hypoxic (HW) 2.5-0.9 ppm at a temperature of 28±1°C in laboratory. With an average body weight of 155 g, oxygen consumption rate was 510.6 and 266.7 mg/kg/h and 120 mg/kg/mL, respectively in three oxygen concentrations. In another group of fishes with an average body weight of 190 g the uptake of oxygen was 492.0 ppm, 263 and 78.88 mg/kg/h, respectively. With an average body weight of 172 g of juveniles, mean rate of oxygen consumption in a DO range of 7.6-4.4 ppm was measured 388.12 mg/kg/h.

Key words: *Wallago attu*, oxygen uptake, transportation, weight, relation, India

INTRODUCTION

The enormous quantity of information on oxygen utilization by major carps, catfishes and other cultivable species have been studied and reviewed by several researchers such as Basu (1950, 1952, 1959), Motwani and Bose (1957), Fry (1971), Singh (1977), Kramer (1987), Kunwar *et al.* (1989) and Battacharya and Subba (2006). However, the literature consulted showed that there is not much knowledge on physiologically worked out dissolved oxygen requirement of the juveniles of non-air breathing catfish *Wallago attu* also commonly known as freshwater shark.

Due to lack of information on this aspect, mortality encountered during transport of this species for culture or for live marketing commonly found in perennial old rural ponds and wild water bodies in India with high market demand, especially in North Western states of India where less spiny fishes are preferred. Though under culture condition, dissolved oxygen demand of fishes depends on many extrinsic and intrinsic factors like feeding status, weight of fish, water temperature, etc. (Andrews and Matsuda, 1975). However, present study was aimed at obtaining information on oxygen requirement of 1 day fasted 2 size group of *Wallago attu* under three dissolved oxygen regime in laboratory condition to arrive at the suitable amount of DO desired for their transportation where specialized facilities are not available.

MATERIALS AND METHODS

About 80 juveniles of *Wallago attu* with a weight range of 143-196 g were collected from a rural perennial pond and segregated in weight groups, i.e., 155 and 190 g depending upon the availability of juveniles and then maintained in two separate 100 L rectangular FRP tanks for conditioning. About 12, 10 L capacity glass were taken for experiment and filled with tape water. With the help of an air compressor, three different concentration of dissolved oxygen, i.e., saturated 7.6-6.8 ppm, normoxic 6.8- 4.4 ppm and hypoxic 2.5-0.9 ppm were maintained in three sets at a water temperature of 28+1°C. Fourth set was kept as control. One to three numbers of conditioned 1 day fasted juveniles transferred into glass gars. After putting juveniles into the glass jars these were sealed and made fully airtight. Total 55 fishes were taken for this experiment. Initial and final dissolved oxygen was measured by centaury kit ck 710. The duration was from 30-80 min. Length and weight of all juveniles were recorded after exposure. Breathing rate at every 10 min intervals and behavior of juveniles was recorded. The rate of oxygen consumption calculated by following equation:

$$\text{Initial DO} \times \text{capacity of respiratory jar} \quad (1)$$

$$\text{Final DO} \times \text{capacity of respiratory jar} \quad (2)$$

Exact weight of fish (g) takes (a-b) MgO_2 in period. About 1000 g (1 kg) fish will take:

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$$(a\text{-}b)\times 1000/c = mg/kg/h$$

On this basis, oxygen requirement for transportation of juveniles was estimated.

RESULTS AND DISCUSSION

The pattern of respiration was different in all 3 oxygen regimes. Breathing Frequency/rate (BF) ranged between 52-55 min^{-1} in fishes having an average body weight of 155 g in Saturated Water (SW) with depth of breathing was normal. In the beginning of experiment, high breathing frequency/rate was observed in 1st few minutes that may probably be due to handling stress and apparently showed normal behaviour thereafter. However, gradual increase of BF with prolongation of experiment and decrease of oxygen concentration level was observed. In nearly Normoxic Water (NW), BF recorded in a range of 80-83 min^{-1} with increases in depth of breathing. Compared to first one high breathing frequency of 95-110 min^{-1} with very high breathing depth was observed in Hypoxic Water (HW). Coming to the surface of the jars and turning up down of body was the abnormal behaviour observed. Although, juveniles in second group with higher average body weight of 190 g showed different breathing rate. However, the trend was more or less same. In SW, breathing frequency was 49-50 min^{-1} with normal breathing depth while in NW it was 65-70 min^{-1} with slight increase of breathing depth. In HW, high breathing rate between 86-89 min^{-1} with deep breathing depth was observed. In majority of non-air breathing catfish, oxygen requirement is met through active breathing process. The breathing frequency and depth determine the amount of oxygen uptake to maintain normal metabolic activities. Availability of DO in water media and interaction between physical and biological processes greatly affect the acquisition and consumption of dissolved oxygen in fishes (Table 1). Fry (1971) has categorized dissolved oxygen as a limiting factor for fish and therefore, its availability influence the normal metabolic activities. Under constant temperature and weight in present study, oxygen consumption was 492, 263 and 78.88 mg/kg/h in SW, NW and HW, respectively, clearly indicating the availability of DO concentration in water as a limiting factor for acquisition of DO by fishes. Zeuthen (1947) reviewed data on respiratory metabolism in different organisms and observed that rate of oxygen consumption decline with increase in body weight. This has been in corroboration to present findings where with an increase of average 45 g in body weight in second group of juveniles led to mean reduction of 20.85 mg/kg/h oxygen uptake by *W. attu*. Stevens and Randall (1967a, b) is in the opinion that due to change in oxygen level the increase of opercular ventilation leading to increase of cardiac output during exercise or hypoxia condition and percent oxygen consumption varies between fish and even among the same fish under different conditions. The increase in oxygen uptake with temperature is associated with an increase in cardiac output and ventricular volume. Rate of oxygen utilization of fish depends on temperature of the water media (Andrews and Matsuda, 1975; Battacharya and Subba, 2006). Fishes those are active swimmer have high dissolved oxygen uptake. However, in present experiment temperature was maintained in both the weight groups as a constant factor. The oxygen utilization rate is greatly depends on the feeding status of fish and fasted fish consume less oxygen than well-fed fish (Andrews and Matsuda, 1975). This fact was considered while measuring the DO demand in present experiment. Andrew *et al*. (1973) demonstrated decline in feed consumption rate with decreasing dissolved oxygen in channel catfish, reared in laboratory tanks. In carp seed hatcheries for long distance transportation, conditioning for 1 day is practiced which gives good results in terms of high survival and low mortality (Mitra, 1942). Oxygen uptake gradually reduced as dissolved oxygen concentration decreased. An abrupt change in behavior was observed below dissolved oxygen concentration of 4.4 mg L^{-1}. This may be the limiting DO level under present conditions for *Wallago attu* juveniles where further reduction of oxygen in water begin to restrict metabolic activities and put stress on juveniles which was evident in the behaviour of juveniles in the glass jars. However, detailed study is imperative to confirm the

Table 1: Rate of oxygen consumption

Water Temp. (°C)	Length (mm)	Mean weight (g)	No. of fish	DO_2 (ppm) 7.6-6.8 Bre rate m^{-1}	DO_2 (ppm) 7.6-6.8 VO_2/mg/kg/h	DO_2 (ppm) 6.8-4.4 Bre rate	DO_2 (ppm) 6.8-4.4 VO_2/mg/kg/h	DO_2 (ppm) 2.5-0.9 Bre rate	DO_2 (ppm) 2.5-0.9 VO_2/mg/kg/h
28±1	290-305	145.0	3	55	502.4	83	288.2	95	125.2
		160.0	3	51	510.6	82	286.7	95	120.2
		160.0	3	53	506.6	80	280.5	98	115.0
		(155.0)							
28±1	320-350	188	3	52	492.5	69	268.6	92	78.6
		188	3	49	476.3	66	268.6	85	76.9
		194	3	48	450.8	65	263.0	86	78.8
		(190.0)							

Mean VO_2 in hypoxic water (0.9-2.5 mg L^{-1}) 99.44 mg L^{-1}; Mean VO_2 in nearly normoxic water (4.4-6.8) 274.85 mg L^{-1}; Mean VO_2 in saturated water (7.6-6.8) 501.3 mg L^{-1}

Table 2: Estimate of the amount of Oxygen required for transport of *Wallago attu* Juveniles for a period of 6-48 h. It is assumed that 1 mg of oxygen is equivalent to about 0.7 mL O_2

Temp. (°C)	Size	Mean VO_2/Juv./h (mg L^{-1})	VO_2/10 Juv./h (mg L^{-1})	VO_2/10 Juv./6 h		VO_2/10 Juv./12 h		VO_2/10 Juv./24 h		VO_2/10 Juv./48 h	
				mg L^{-1}	O_2 in mL	mg L^{-1}	O_2 in mL	mg L^{-1}	O_2 in mL	mg L^{-1}	O_2 in mL
28±2	290-350	2.4	24	144	100.8	288	201.6	576	403.2	1152	806.4

limiting level through others physiological parameters. Basu (1959) reported that incipient limiting level was >7 mg L^{-1} for cannel catfish. Similar to the present study where high breathing frequency was observed with lowering of oxygen. Kramr (1987) reported that opercular ventilation frequency is the best-documented activity change in response to reduced levels of dissolved oxygen (Table 2). In both the group of fishes the frequency of opercular movement in Saturated water (SF) was between 49-55 min^{-1}, however it increased to 65-83 min^{-1} in nearly Normoxic water (NF) and 86-100 min^{-1} in Hypoxic water (HF) where DO content was below 2.5 ppm. In both the groups with lowering of oxygen levels, movement of juveniles in glass gars towards the surface with high respiratory frequency to meet the demand were the behavioral changes observed during the experiment.

CONCLUSION

On the basis of results obtained from this study, volume of oxygen required for safe transport of juveniles of *Wallago attu* was calculated. Mean VO_2 required for the juveniles with average weight of 172.5 g (143-196 g) was 501.3 mg L^{-1} in SW, 274.85 mg L^{-1} in NW and 99.44 mg L^{-1} in HW. Unlike Indian major carps these are shooter and most active. Small sizes of fingerlings of *W. attu* are available in wild water bodies and rural perennial ponds; these could be used for culture in well-managed ponds with proper transportation. Transportation of smaller fishes is always preferred as less oxygen consumption and more number could be transported safely. Present study will be helpful in estimating the transportation oxygen requirement for similar species.

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