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Hormonal effects on oxygen consumption in an air breathing snakehead fish, *Channa punctata*

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Abstract- An attempt has been made to study the effects of hormones on dual mode of oxygen consumption in an air breathing snakehead fish, *Channa punctata* in this present investigation. The treatment of Hydrocortisone and Thyroxine in *Channa punctata* has showed increase in aquatic, aerial and total oxygen uptake. Adrenaline on the other hand showed a slight decrease in aquatic but an abrupt and higher decrease is seen in case of aerial and total oxygen uptake. Progesterone caused significant increase in aquatic but decrease in aerial and total oxygen uptake. Testosterone increased the aquatic and total oxygen uptake but decreased aerial oxygen uptake. The complete details are provided in this paper.

Key words: Hormones, Endocrine activity, snakehead fish, *Channa punctata,* oxygen

INTRODUCTION

Hormones are chemical agents which are released from a group of cells ad its secretions travel via the bloodstream to affect a different group of cell, or the target organ.[1] Ectothermic animals adapt to their range of external environment via the help of endocrine glands which have effect the action of development, growth and reproduction and change to adapt successfully along with their surroundings. Fishes with bimodal respiration differ in the extent of their reliance on air breathing to support aerobic metabolism, which is reflected in their lifestyles and ecologies. Many freshwater species undertake seasonal and reproductive migrations that presumably involve sustained aerobic exercise. The metabolic activities of these fishes depend upon a variety of factors, hormones being the ones with top priority.[2] Endocrine activity of fishes was correlated with the metabolic activity like respiratory metabolism by some important workers like Matty (1957)[3], Punt and Jungbeod (1963)[4] Kaya (1973)[5]. Exact information about air breathing fishes physiological mechanisms and how hormones affect the oxygen consumption is not yet known. Our present study is an attempt to find the degree of relationship among the different hormones on oxygen consumption in the fish *Channa punctata*.

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MATERIALS & METHODS

Fresh and live fish were bought from the local fish market of Madhepura, Bihar (25° 92' N, 86° 79'E). A glass aquarium of dimensions 90x60x60 cm was used to keep the fish. As food the fish were fed with chopped goat liver

on a daily basis and were acclimatized for 15 days in the laboratory. Oxygen consumption from air and still water was measured routinely with the help of glass respire meter after. The aquarium originally contained 3 litres of water and 0.5 ml of air. Wrinklers volumetric method was used to estimate the concentration of dissolved oxygen in the water. The experimental fishes were divided into 6 groups including the controls. Each group has 10 fishes. Different doses of Hydrocortisone, Adrenaline, testosterone, Progesterone, and thyroxin were injected intra peritoneally on the abdominal side of the fishes slightly anterior to the pelvic fin to study the effects of these hormones on the oxygen consumption of fishes. Different doses of hormonal injections in number of days were recorded.

The hormones were bought locally. The effective doses of different hormones were standardized. Oxygen consumption of animals treated with different hormones was measured in every 24 hours. While in case of Adrenaline the oxygen consumption was measured after 48 hours.

RESULTS & DISCUSSION

A summary of the effects of certain hormones on oxygen consumption, the aquatic, aerial and total oxygen consumption after different doses is given in table 1. The mean values or averages of aquatic, aerial and total oxygen consumption were 52.44, 61.56 and 114.0 (ml/kg/hr) respectively.

The fishes were given single dose of hydrocortisone (i.e. 1.0 mg/100gm) for 2 days. An increase in aquatic oxygen consumption was seen in control fishes from 52.44 to 60.76 (ml/kg/hr). The aerial oxygen consumption also increased from 61.56 to 63.24 (ml/kg/hr), while the total oxygen consumption increased upto 124.00 from 114.00 (ml/kg/hr).

Single doses of Adrenaline (0.000006) were also injected for 2 days. However, in this case the aerial oxygen consumption decreased upto 6.96 against 61.56 (ml/kg/hr) in control fishes. The aquatic oxygen consumption slightly decreased to 51.04 (ml/kg/hr) in control fishes. This decrease shows that adrenaline makes the fish sluggish, compelling it to respire via its gills under water. This also decreased the total oxygen consumption from 114 to 58 (ml/kg/hr) in the control fishes.

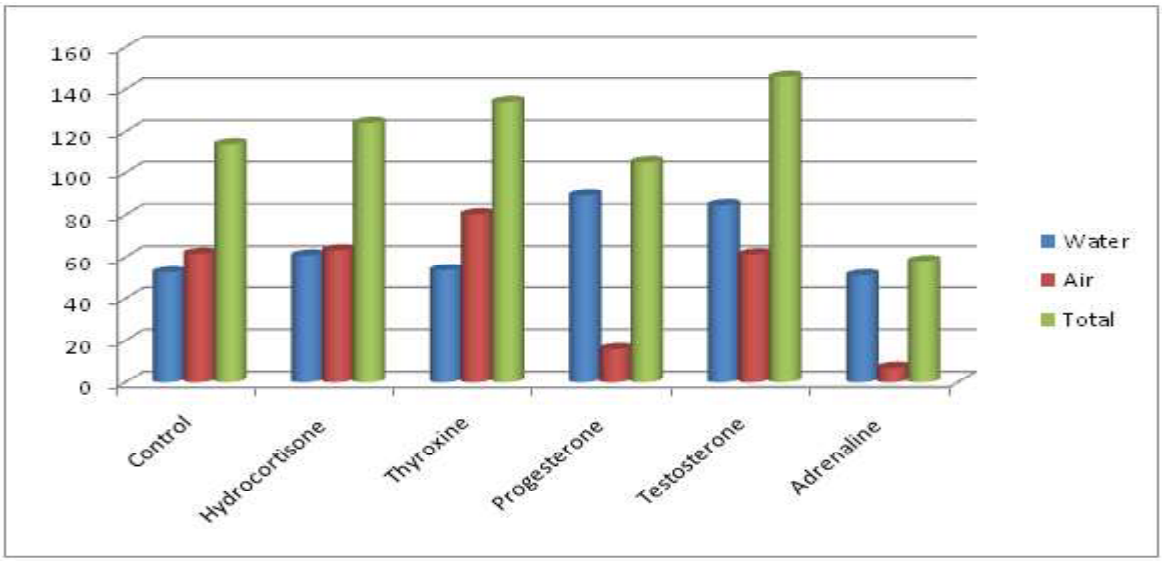
On injecting single dose of testosterone (2mg) for 2 days, an increase in aquatic oxygen consumption was observed upto 84.68(ml/kg/hr). The aerial oxygen uptake remained mainly unchanged but it was slightly lower than that of control ones. The aerial consumption was 61.32(ml/kg/hr) while the total consumption increased upto 146.00(ml/kg/hr). We can conclude that testosterone does not have any effect on the aerial oxygen consumption but it does enhance the aquatic oxygen consumption.

When a dose of 1mg of progesterone is given to the fish for 2 days, we observe an increase in the aquatic oxygen consumption significantly upto 89.25 (ml/kg/hr) as compared to controls 52.04(ml/kg/hr). However the aerial oxygen consumption was reduced to 15.75(ml/kg/hr), decreasing the total oxygen consumption to 105.00(ml/kg/hr). It can be said that progesterone decreased the aerial oxygen consumption but enhanced the aquatic oxygen consumption.

Single dose of Thyroxine (0.5mg) was injected to the fish for 2 days. It showed slight increase in the aquatic oxygen consumption, from 52.04 (ml/kg/hr) to 53.60 (ml/kg/hr). The aerial oxygen consumption also increased upto 80.40, therefore increasing the total oxygen consumption upto 134.0 (ml/kg/hr). Thyroxine does not affect the aquatic oxygen consumption but it elevates the aerial oxygen consumption.

Table 1- The oxygen uptake in *Channa punctata* at different dose of hormones and body weight 40.0±2.5 gm

Sl. no.	Condition	Injection in no. of days	Total dose (mg/100g)	O_2 (ml/kg/hr)		
				Water	Air	Total
1	Control	--	--	52.44	61.56	114.00
2	Hydrocortisone	2	1.0	60.76	63.24	124.00
3	Thyroxine	2	0.5	53.60	80.40	134.00
4	Progesterone	2	1.0	89.25	15.75	105.00
5	Testosterone	2	2.0	84.68	61.32	146.00
6	Adrenaline	2	0.000006	51.04	06.96	58.00



Graph 1- Graphical representation of oxygen uptake in *Channa punctata* at different dose of hormones and body weight 40.0±2.5 gm

A very little information is there about the effect of adrenocortical hormones on the homeostasis of oxidative metabolism in fishes specially *Channa punctata.* In *Gobius melastomus* the treatment of adrenaline induced depression of metabolism, which was reported by Marinescu (1971)[6]. In *Macrognathus aculeatum* it was found that the treatment of adrenaline causes sharp decrease in oxygen consumption,[7] which were similar to the findings of Marinescu (1971)[6]. Decrease in oxygen consumption may be firstly due to carotid sinus response to increase the blood pressure. Secondly, it may be due to relaxation of respiratory muscles and slow heart beat evoked by epinephrine contrary to adrenaline.[8] In *Macrognathus aculeatum* treatment with hydrocortisone shows rise in oxygen consumption.[7] Oxygen consumption may be due to adreno-cortical hormones, however exact reason is not understood that cause the rise in oxygen consumption.[9]

A view consistent with the findings of Marinescu (1971)[6] and Pandey *et al.* (1985)[7] was found in the present investigation in *Channa punctata*. According to it, the treatment of adrenaline caused a decrease in total and aerial oxygen uptake, whereas treatment with hydrocortisone resulted in increase in total oxygen consumption similar to findings.[9]

Gonadal steroids fail to provide any conclusion and are contradictory when attempted to evaluate their effects on the respiratory metabolism in fishes. The effects seen to depend on the concentration of gonadal steroids, as in some cases gonadal steroids have shown stimulating effects while on some they have shown depressing effects on cellular metabolism.

An increase in oxygen consumption, when treated with testosterone have been reported in gold fish by Hoar (1958)[10] and in *H.fossilis* by Pandey (1976)[11]. Significant decrease in oxygen uptake in fishes may be due to fall in concentrations of sex hormones in the circulating blood and it failed to bring any change after treatment with progesterone, was reported by Pandey (1976)[11] in ovary sectomised *H.fossilis*. A significant correlation was found in *Anabas testudineus* in between the cyclic changes in gonadal activity and seasonal variation in oxygen consumption in both sexes.[12] This concludes that gonadal steroids are one of the many factors that affect the oxidative metabolism directly or indirectly through increased locomotion activities. Two possibilities were suggested by Hoar (1958)[10] : **(a)** demand of oxygen is increased by the steroid by increasing the reactivity of neuromuscular mechanism thus promoting locomotion activity. **(b)** steroid can act throughout the body stimulating oxidative metabolism in the tissue.

Male and female hormones do not have same effect on the oxidative metabolism. Males being metabolically more active than females the oxygen uptake is higher in them.[12] Male hormones directly and indirectly shown an increase in oxygen consumption in *Channa*, when treated with testosterone, views consistent with the finding of Pandey (1976)[11] and Hoar (1958)[12]. Female hormones show contradictory effect on the respiratory metabolism.

All female hormones (progesterone, ovacyclin and duogynon forte) lowered the oxygen consumption. Progesterone decreases the aerial and total oxygen consumption.[11-13] It shows a catabolic effect.[14]

With the increase in cell height of thyroid follicles, an increase in oxygen consumption was found in *H.fossilis*.[15] It seems that thyroid hormones are important regulators of oxygen uptake.[16,17] Injection of thyroxine produced an increase in metabolic rate. Injection of iodothyro acetic acid also elevated oxygen uptake after radio thyroidectomy.[16] These findings make thyroid gland an important regulator of oxygen consumption. In cold blooded or poikilothermal animals thyroid glands effect is more metamorphic than metabolic.

CONCLUSION

In the present investigation *Channa punctata* was found to be responding to the treatments of thyroxine by increasing total as well as aerial oxygen uptake. A comprehensive idea is given about the effects of hormones on bimodal oxygen uptake in snakehead *Channa punctata*. A few precautions were taken during the study such as

(a) Same weight fishes must be bought for experimental and control methods as oxygen consumption tends to differ with body weight.

(b) Acclimatization of fishes to the respirometer must be ensured before taking measurements of oxygen consumption

(c) Various dose levels of hormones should be used for experimentation.

(d) Simultaneously one must do the oxygen consumption for both experimental and control fishes.

(e) Minimization of the locomotor activity of the fish should be done by the respirometer.

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