

## Role of cortisol on condition factor in the female freshwater fish, *Notopterus notopterus* during four reproductive phases

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**Abstract:** The condition of the female fish, *Notopterus notopterus* was studied during four phases of the reproductive cycle in control and after cortisol hormone treatment. The condition of the fish including condition factor (K) and somatic condition factor (Ks) was determined based on weight of the body, length of the fish and gonad weight. In control fish the condition of the fish improve during prespawning phase compared to other phases. The hormone cortisol level estimated by radioimmunoassay (RIA) technique was found to be increased in preparatory and decreased during prespawning phase, may be because of the hormone involvement in metabolic activity, vitellogenesis. In cortisol treatment, the condition of the fish decrease during prespawning phase, compared to other phase may be because of extra expenditure of energy for progressing reproductive activity such as vitellogenesis.

**Key words:** *Notopterus notopterus*, Cortisol, Condition factor, Vitellogenesis

### Introduction

Effect of cortisol on the body weight, condition factor and serum cortisol level of the fish *N. notopterus* was studied during four reproductive phases. The hormone cortisol in fish has been identified as a metabolic hormone (Vijayan *et al.*, 1994) having multifaceted action. It is also considered as an important stress hormone produced in fish (Mommsen *et al.*, 1999). One of the responses of fish to most forms of environmental stress is reduction of growth rate, a response which may have important economic consequences for the aquaculture industry (Pickering, 1990). The somatic growth is influenced by many factors some of which, are hormonal. Hormones which are known to influence growth in fish can be divided into two groups, the anabolic and catabolic hormones. One of the anabolic growth promoting hormone is growth hormone but gonadal steroids and thyroid hormones have also been shown to be effective growth promoters (McBride and Fagerlund, 1976; Higgs *et al.*, 1977) and insulin is known to increase amino acid incorporation into the body musculature of teleost fish (Donaldson *et al.*, 1979). The catabolic hormones include, the corticosteroids and catecholamines. Cortisol is the predominant corticosteroid in most of the teleost group (Handerson and Garland, 1980). The catabolic action of cortisol is responsible for the mobilisation of energy reserves (gluconeogenesis) and lypolysis (Leach and Taylor, 1982; Shreidan, 1986). The net effect of this catabolism is a reduction in somatic growth in the rainbow trout *Salmo gairdneri* (Barton *et al.*, 1987) and in the channel cat fish *Ictalurus punctatus* (Davis *et al.*, 1985) has been reported.

There are other reports showing that cortisol stimulates the release of growth hormone in the fish tilapia (*Oreochromis mossambicus*) (Nishioka *et al.*, 1985). Variation in the stimulation

of growth even with sex steroids have been reported. Estradiol 17  $\beta$  stimulates growth, while androgens retard growth in yellow perch (Malison, 1986). Estradiol 17  $\beta$  stimulates perch growth by affecting appetite (*via* hypothalamic appetite control centers) but not metabolism.

In the present investigation, the correlation of condition of the fish with cortisol hormone level and treatment during different reproductive phases of the freshwater fish, *N. notopterus* was studied.

### Materials and Methods

**Fish collection and maintenance:** About 80 fish *Notopterus notopterus* were collected during each period of January to February, April to May, August to September and November to December (preparatory, prespawning, spawning and post spawning) during the year 1998-2001, from Saradagi and Farhatbad village near Gulbarga with the help of local fisherman. The live fish were brought to the laboratory and were kept in large plastic pool tanks having size of 90 cm diameter and 60 cm height. Each tank accommodated 10-15 fish. About 8-10 days were needed for the fish to acclimatise. During acclimatization antibiotic tablets (chloromphenol 80 mg in one gallon of water) were given for prevention from infections. Fish of both control and experimental groups were fed with live earthworms, boiled eggs, small fish (*Gambusia*) and tadpole larvae.

**Hormone treatment:** The hormone cortisol (hydrocortisone), compound F 11 $\beta$  : 17  $\alpha$ : 21-Trihydroxy-4-pregnene 3:20-dione (glucocorticoid) was obtained from S. D. Fine Chemicals Ltd. BIOSAR. It was dissolved in olive oil. The solution was prepared by dissolving 40 mg of cortisol in 20 ml of olive oil and administered during four different phases of the reproductive cycle

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*i.e.* preparatory (January-March), prespawning (April-May), spawning (August-September) and post spawning (November-December). The fish were divided into 2 groups of 20 each. The hormone was injected interperitonally near the caudal region below the lateral line once in a day for 10 days. Group I served as control and received only olive oil and Group II received 60 µg/100g body weight (0.6 µg/g body weight) respectively.

After ten days of hormone administration, the whole fish were weighed and length of the fish was measured in the respective phases. The body weight were also recorded daily in both control and cortisol injected groups with the help of Dockbal Braun weighing machine brought from Dockbel Industries, New Delhi. The final body weights of both control and cortisol injected fish are presented in the Table 1. The sex of the fish was identified after dissecting the fish and gonads were taken for measuring their weights with the help of electronic balance. The average of ten fish were taken for determining mean of the body weight and standard deviation and error was calculated. The difference in the weight and their significance was determined by applying student 't' test respectively, for assessing significance.

The Fulton's conditions factor (K) and somatic condition factor (Ks) was determined in both control and cortisol injected fish in each phase separately by applying the following formula after using the recorded weights.

(i) Conditions factor (K):

$$K = \frac{W \times 100}{L^3}$$

Where, W = Weight of the fish,

L = Total length of the fish,

expression is based on (Nikolsky, 1963) Cub Law.

(ii) Somatic conditions factor (Ks):

$$K_s = \frac{\text{Body weight} - \text{Gonad weight}}{L^3} \times 100$$

This relationship is based on the studies of Scott and Fuller (1976), Settles and Hoyt (1976) and Htun – Han (1978).

**Hormone radioimmunoassay (RIA):** Serum cortisol level was measured by Coat-A-Count method using a solid phase radioimmunoassay kit with <sup>125</sup>I Cortisol: (TC 02) purchased from DPC® diagnostic products corporation, 5700 West 96<sup>th</sup> Street Los Angeles.

**Statistical analysis:** In all the cases six observations were made and the results (data) were expressed as arithmetic means with their standard deviation, standard error (Mean ± S.E.) n=6 and student "t" test were made as described by Snedecore and Cochran (1967) and Fisher (1963), the values were judged almost significant p<0.05, p<0.01 and highly significant p<0.001.

### Results and Discussion

The changes in the condition of the fish after ten days of treatment with cortisol was studied in the female freshwater fish *N. notopterus* during four reproductive phases.

**Condition factor and somatic condition factors:** The condition factor (K) of female fish after cortisol treatment in different phases shows increase in preparatory phase and decreases in spawning phase with an increase during post spawning phase. The somatic condition factor (Ks) also exhibit similar response as that of condition factor however, there is significant decrease during prespawning phase. The results suggests that the reduction in the condition factor during prespawning and spawning in cortisol treated fish may be due to active involvement of whole body towards expenditure of energy for reproductive activity. Thus, it is suggested that in control fish on the approach of breeding period the condition of the fish improves and during spawning the condition of the fish reduces due to the involvement of whole body towards energy investment for spawning activity, since the cortisol is involved in the increase of metabolic process which may result in the extra expenditure of energy for progressing reproducing activity such as vitellogenesis.

**Table - 1:** Showing female condition factor, somatic condition factor and serum cortisol of the freshwater fish *N. notopterus* during four reproductive phases

Phase	Condition factor		Somatic condition factor		Serum cortisol µg/dL
	Control	60 µg	Control	60 µg	
Preparatory	0.704±0.027	0.750±0.012 <sup>NS</sup>	0.784±0.025	0.742±0.110 <sup>NS</sup>	33.41***± 0.741
Prespawning	0.853±0.013	0.677±0.022 <sup>**</sup>	0.832±0.250	0.566±0.031 <sup>**</sup>	10.58***±0.201
Spawning	0.698±0.035	0.680±0.020 <sup>NS</sup>	0.737±0.026	0.677±0.020 <sup>*</sup>	7.60*±0.909
Post spawning	0.709±0.016	0.749±0.018 <sup>NS</sup>	0.705±0.016	0.740±0.017 <sup>NS</sup>	5.16*± 0.021

Serum cortisol hormone are expressed 25 µg/dL of blood. All values are expressed as mean ± standard error (SE) n = 6. \*p<0.05 and \*\*p<0.01 when compared to olive oil treated control and p<0.01, \*\*\*p<0.001 when compared with between the phases. NS = Non significant

**Serum cortisol level:** The serum cortisol was estimated by using RIA method. The level of the hormone ranged between 5 µg/dL to 33 µg/dL in the female. The cortisol estimation during four phases of the reproductive cycle is presented in Table 1. The results indicate that in female fish cortisol level significantly increases during preparatory phase and decreases during other phases. The increase in cortisol during preparatory phase in female fish relates its involvement in the reproductive activity of the fish. In the preparatory phase the fish starts developing gonad, in the ovary and the vitellogenesis gets geared up utilizing hepatic contents and ultimately oocytes begin growing to bigger size accumulating yolk. Thus this vitellogenic activity needs increased metabolism, since cortisol is a metabolic hormone, its increase during preparatory phase, indicates increased metabolic activity probably resulting in the diversion of energy for the vitellogenesis.

Montecchia *et al.* (1990) have studied the seasonal variation in energy content of liver, gonad and muscle and the condition factor (K) of mature hake *M. hubbsi*. High energy content found in the liver after spawning and during gonadal resting period, low energy content values in liver and high energy content in gonads observed during gonadal growth. The condition factor (K) profile was similar to the energy content profile of liver and muscle.

Individual variations from general length weight relationship have been studied, under the general name condition (Le Cren, 1951), such changes, in condition have usually been analysed by means of condition factor or K factor or pondoral index which has been calculated by using different formulae by various workers. The condition of the fish is influenced by the seasonal changes of gonads and also by the feeding intensities. The condition factor is to be calculated seasonwise and also size group wise to see whether there is any variation in the K values.

The condition factors including somatic condition factor are available for the fish studied in relation to reproductive cycle (Neelakantan, *et al.*, 1989; Reddy and Rao, 1992). The present data on the overall condition factor (K) of *N. notopterus* under experimental condition *i.e.*, after the administration of cortisol during different phases indicate that the K values reduced during prespawning and spawning phases in fish indicating that the fish is being exhausted or it may be investing its energy for reproductive processes such as vitellogenesis and the spawning activities. The attainment of increased K values in female prior to the prespawning indicates that the gonadal maturation did not occur at the expense of somatic weight as the female body and gonad weight were increased during the same time. Thus suggesting that the fish were feeding actively during post spawning as well as in the preparatory phases. In the fish, *A. lexagonolepis* reported by Dasgupta (1988) the K value showed an increasing tendency due to increase in length and the higher

K value were observed in higher length groups was found to be associated with the gonadal maturity. It was evident from their results that increase in the weight of the body due to weight of maturing gonad, which is followed by decrease due to spawning has been reflected by the K values of the fish. Hence, in the present study, the increase in K values during preparatory and post spawning after cortisol treatment reflects condition of the gonad in development. The decrease in K values during prespawning and spawning indicates exhaustive condition of the gonads for breeding activity in female. This decline in condition was probably due to release of gametes from the gonads and also utilization of energy source for gonadal activity.

The somatic condition factor (Ks) of the fish *N. notopterus* studied during different phases of the reproductive cycle indicates that the Ks values increase during prespawning phase while, in all other phases the Ks values are almost nearer to each other indicating that the condition of the fish is better in all the aquatic body from which it was collected. In the cortisol treated fish the Ks values are nearer to each other in different phases whereas, there is decrease during prespawning and spawning phases in comparison to controls and amongst the fish treated with cortisol in other phases. The Ks values of treated fish with cortisol during preparatory phase is slightly high compared to control fish, other phases suggests that gonadal growth did not occur at the expense of somatic weight indicating that the availability of food was good and fishes were actively feeding during this phase. Such observation has been also made for other fishes in their study on the seasonal changes of Ks in relation to feeding (Cambray and Bruton, 1984). In view of the divergent results in understanding the relationship between condition factors on the growth, it is rather difficult to propose unifying conclusions for explaining the effect of cortisol on condition factor. However, the cortisol administration did not bring any marked changes in the condition of the fish compared to control indicating that the fish is not under any kind of stress due to cortisol treatment at the dose treated.

Recently Haider (1997) has reviewed hormonal control of oocyte maturation in fish showing  $17\alpha, 20\beta$ -dihydroxy-4-pregnen-3-one ( $17\alpha, 20\beta$ -DP) has been found to be most effective maturation inducing substance in most of the teleostean species studied so far. In the Atlantic salmon, *Salmo solar* histological evidence has been presented implying seasonal changes in pituitary output of ACTH and interrenal secretion of corticosteroids and changes in plasma concentrations have been reported which is associated with smolting (Thorpe *et al.*, 1987). The estimation of cortisol in *N. notopterus* also indicates that the hormone undergoes seasonal changes in the output in relation to reproductive phases.

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