

Oxytocic Efficacy in The Breeding of The Fish, *Cyprinus Carpio* (L.)

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Abstract— *In mammal, oxytocin primarily stimulates the uterine contractions during labour and release of breast milk. Oxytocin is a neurohypophysial hormone. Plasma oxytocin level increase during sexual arousal in both women and men and significantly higher during orgasm / ejaculation. In the present study, Oxytocin were injected 1.5ml/kg body weight once in a week for six weeks in the fish, Cyprinus carpio. It has been observed that oxytocin stimulates the sexual behavior leading into breeding. Histological studies showed that oxytocin stimulate the testosterone and estrogen secretion in the male and female respectively. Thus it had been concluded that oxytocin is associated with induction of spawning reflexes in the fish Cyprinus carpio.*

Index Terms— *Oxytocin, Isotocin, Spawning reflexes, neurohypophysial hormone, plasma oxytocin, testosterone, estrogen.*

I. INTRODUCTION

Oxytocin infusion facilitates feminine behavior. Plasma oxytocin level increases during sexual arousal in both women and men are significantly higher during orgasm/ejaculation then during prior base line testing. Oxytocin increased the sperm numbers in the ejaculate which would be beneficial to reproductive techniques. In addition to effect in sexual behavior, it has been also shown to increase cervical contractions, modulations of sperm production and transport (Bales K.L. *et al.*, 2004). Isotocin, the fish homologue of oxytocin, has received little study in terms of the regulation of behavior since the early reports of Hoyle, 1999; Pickford G. E. and Strecker E.L., 1977. They reported that peripherally injected isotocin had an effect on behavior, but it was simply due to minimal binding to argentine vasotocin (AVT) receptors (Pickford G. E. and Strecker E. L., 1977). Recently, it has been shown that central isotocin has different effect from vasotocin

with regard to the neural activity that drives humming behavior in the plainfin midshipman fish (Goodson J. L. and Bass A.H. 2000 and Kerstin *et al.* 2019). Very little attention has been given to action of the oxytocin like principles though there is evidence for isotocin receptors in both gills and liver of trout (Evans, 1998). Isotocin stimulates the testosterone secretion in the testes of trout in vitro (Rodriguez and Specker, 1991) though it remain to be shown whether this reflects an action of vivo of the synthetic hormone or local paracrine effect as have been reported in the associated with induction of the spawning reflex. Presence of oxytocin and argentine – vasotocin has been suggested by (Sawyer, 1965b) in fish, *Hydrologus colliei* (Perks, 1959) and Dodd (1960) revealed that these fishes contain one oxytocin like principle together with small quantity of argentine vasotocin, but recently much more work has been done with regard to neurohypophysial principles. Existence of oxytocin/ isotocin has been reported by Perks (1959) and Dodd (1960) and also reported its role in reproduction. Studies on the efficacy of oxytocin on reproductive behavior in relation to pituitary gonadal axis in the fish, *Cyprinus carpio* is meager and hence the present work is an attempt in this direction to assess its potency as an inducer to achieve early maturity leading to successful breeding.

II. MATERIALS AND METHODS

Maturing male and female of *Cyprinus carpio* were collected, reared separately in a fibre glass tanks and acclimatized to the laboratory conditions. The experiment was carried out for six weeks. Control and experimental groups were formed by keeping male and female separately up to fifth dose. Male and female of control groups were injected with 1.5ml of distilled water and experimental groups were injected with 1.5ml of oxytocin intramuscularly. After fifth week of treatment, male and female were kept together in the ratio 2:1 for sixth dose to observe the breeding.

At the end of fifth week of treatment, male and female of control and experimental group were sacrificed to study the histomorphological changes in pituitary and gonads

III. OBSERVATION/RESULTS

The pituitary gland of control group consisted of cyanophil, chromophobes and acidophils. In the proximal portion of pars distalis, there were cyanophils as seen from their affinity towards AF and PAS-stain. These cyanophil cells were angular or spindle in shape ($7.55 \pm 0.37 \mu$). Orangeophils measured about $6.82 \pm 0.38 \mu$ (Table 1). The ovary was in the maturing form and histologically, reorganized into young oocytes, early maturing oocytes, advanced maturing oocytes and few mature oocytes (prespawning oocyte). Histologically oocyte showed small clear yolk vesicles and nucleus with undulated nuclear membrane. Testis were opaque and in the maturing phase. In a section, a large number of primary, secondary spermatocytes and spermatids were visible. After injecting distilled water to the control group, no sign of courtship was observed even after the second dose.

In the pituitary gland of experimental group the number of cyanophil cells was increased throughout the PPD (Fig. 02). Some cyanophils were turgid with granular cytoplasm (Fig. 01) and some were in the secretory phase. Some gonadotrops were vacuolated. Ovaries were in prespawning phase at the end of 5th dose. The number of ova could be seen through the thin ovarian wall. The ova were opaque as well as translucent. The fish was gravid with the rounded abdomen and on pressing egg oozed out. Histologically, large number of oocytes were observed in a section with yolk vesicles, migrating nucleus, zonagranulosa and zonaradiata (Fig. 03). A fully ripe gravid female had soft bulged rounded abdomen with swollen reddish vent. There was considerable increase in the weight and volume of testis after the 5th dose which became turgid and yellowish in colour. Increased numbers of seminiferous tubule with intertubular space, spermatids and sperms with other stages of spermatogenesis were observed (Fig. 04). Milt oozed out on pressing the abdomen. After 5th week male and female were kept together (2: 1) in a breeding tank with circulating water. Second dose was

given to the female after three hours. After second dose brooders started swimming actively, became excited and restless. Female was chased by the males pushing her with snout and after 4 hours, spawning occurred.

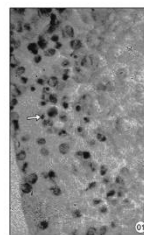


Fig 01: Section showing turgid cyanophils (→). X 45.

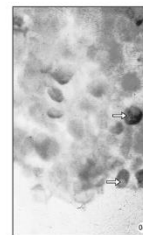


Fig 02: Dorsal and ventral region of proximal pars distalis showing cyanophils (→). X 100.

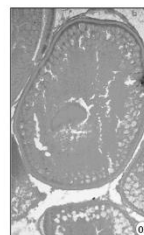


Fig 03: Maturing oocyte with nucleus showing outer zone granulosa and inner zone radiata. X 10.

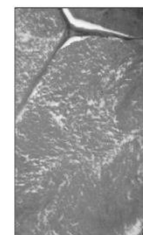


Fig 04: Magnified view of seminiferous tubule with intertubular septa of testis filled with spermatids and sperms.

IV. DISCUSSION

Oxytocin is known to play an important role in almost all aspects of reproduction, including social recognition (Dluzenmet *et al.*, 2000), the formation of pair bond (Cushing, B. S. and Carter, C. S, 1999), the physical act of mating (Gorzalka and Lester, 1987), Parturition (Fuchs and Fuchs 1984), maternal behaviour (Kendrick *et al.*, 1997). Oxytocin also stimulates the sexual receptivity and reproductive behavior. In rodents oxytocin stimulates the spermatogenesis to increase the sperm number in the ejaculate, improves sperm quality and quantity (Huseyin, 2005) which would benefit all assisted reproductive techniques used in animals and also initiate female sexual behavior (Millen Hess, 2002). Very little information is available on the role of oxytocin in fish reproduction. Pickford and Strecker (1977) reported that peripherally injected isotocin had an effect on behavior but it was simply due to minimal binding to arginine vasotocin receptor but recently, it has been shown that central isotocin has different effect from vasotocin with regard to the neural activity, that drives humming behaviour in the

plainfin midshipman fish (Goodson and Bass, 2000). Michael Black *et al.*, 2004 stated that socially induced sex change regulates forebrain isotocin in *Lythrypnusdalli*. He also reported that the reproductive behaviour of *Lythrypnusdalli* changes from female to male following the removal of a dominant male from a social group. On the basis of the above literature, the present investigation is an attempt to establish the role of oxytocin in breeding of the fish *Cyprinus carpio*. In the present study, after the dose of oxytocin, vigorous courtship has been observed followed by spawning. Oxytocin plays a definite role in fish reproduction. The mammalian homologue for isotocin is oxytocin, has been reported to promote female sexual behavior in rats and in fishes (Bale, T.L. *et al.*, 2001). Oxytocin and related neuropeptides play physiological role in the reproduction in both vertebrates and invertebrates. Sex steroids have been shown to influence the oxytocin system in mammals (Johnson A. E. *et al.*, 1989), the same has been observed in *Cyprinus carpio* on the basis of the histological study. Isotocin and Vasotocin have different functions but they may be serving different sexually dimorphic functions which demonstrate a sexual dimorphism in the number of IST – ir cells in the pro-optic area of a fish *Lythrypnusdalli* (Michael Black *et al.*, 2004). This suggests that as oxytocin like neuropeptide i.e. isotocin exists in fish which plays an important role in reproduction and parental care. Results of the present study support the earlier views in the *Cyprinus carpio* as it stimulates the courtship leading to breeding. Courtship is stimulated by the gonadal hormones which have been observed on the basis of the histological structure of gonads. In the present study, two combinations of sex pheromone with prostaglandin and sex pheromone with oxytocin are also used to stimulate the breeding in the laboratory conditions as well as tested in the fish seed farm and received the positive results as explained earlier, but with greater intensity, early maturity resulting into breeding with maximum healthy seed production with high survival rate in the fish, *Cyprinus carpio*.

V. SUMMARY

Oxytocin showed stimulatory effect on the pituitary gonadal axis. Particularly, the gonads were excessively stimulated in to early maturity leading into breeding in *Cyprinus carpio*. Thus, it can be concluded

that oxytocin will be effective in fish breeding technology and can be used as a substitute to costly traditional practices.

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