

# BIOCHEMICAL CONTENTS OF BRAIN IN THE FRESHWATER FISH, *NOTOPTERUS NOTOPTERUS* (PALLAS) IN RELATION TO SEX

SHAHANA BANU\*, R. S. KULKARNI AND KHAJA PASHA<sup>1</sup>

Fish Endocrinology Laboratory, Department of Studies in Zoology, Gulbarga University, Gulbarga - 585 106

<sup>1</sup>Lugman College of Pharmacy, Gulbarga - 585 102

E-mail: shahanapasha@rediffmail.com

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\*Corresponding  
author

## ABSTRACT

The concentration of some biomolecules of the brain in the freshwater fish, *Notopterus notopterus* has been studied to understand the biochemical differentiation of the brain in relation to sex. The biomolecules such as protein, glycogen, lipids and cholesterol were estimated in the brain of freshwater fish, *Notopterus notopterus* of both the sex for comparative assessment. The results indicate that the amount of biomolecules of brain of male fish were higher in comparison to the amount of biomolecules of brain of female fish. The result suggests that the concentration of protein found to be higher in male brain as compared to the female brain. Protein acts both as nutrient and as an energy source. The study of brain glycogen in both female and male reveals that male brain has more glycogen content than the female brain. The variation in the glycogen content in female brain and male brain are due to differences in sex. The comparison of lipid content in brain in both sexes show that male brain has more lipids than female. The data shows that only female brain has more cholesterol than the male brain. The above results indicate that the brain of male and female is biochemically different probably based on their metabolic activity.

## INTRODUCTION

With the advancement of cephalization and aggregation of ganglionic units in the head, the fishes have achieved a well developed nervous system. Of all the internal structures of the body of the fish, the brain is the most fascinating one. Brain is a very important organ in any animal. It is a collection of nerve cells located at the anterior part of central nervous system acts as supervisory centre of nervous system.

Biochemical composition of fish tissues are considerable interest for their specificity in relation to food values of fish and evaluating their physiological needs at different periods of life. Fish exhibit large variations in their biochemical composition from species to species. Hence, the knowledge of proximate compositions of fish is of paramount importance to evaluate it in regard to nutrient value and physiological condition (Gershamovich *et al.*, 1984; Brown and Murphy, 1991). Besides, protein, fish flesh also offers minerals, iodine, vitamins, fat etc. Knowledge of functional properties is important for utilizing the fish in the preparation of value added products. Earlier reports indicate that changes in biochemical composition may occur as a result of gonadal maturity (Dygart, 1990; Montecchia *et al.*, 1997). Such variations might be in all possibility due to differences in the biochemical construction of the tissues in respect to size.

However a detailed analysis of the biochemical composition in brain with respect to sex is highly desirable. Hence the present study was an attempt in this direction and it reports the variations in the biochemical composition (Protein, lipids, glycogen and cholesterol) of brain in female and male freshwater fish *Notopterus notopterus*.

## MATERIALS AND METHODS

The freshwater fish, *Notopterus notopterus* was selected for the present study as this fish is available in good numbers in the freshwater ponds, tanks and rivers in and around Gulbarga. The fishes were collected from Sirnoor nala, which is 10km away from Gulbarga city with the help of local fisherman. The live fishes were brought and maintained in the laboratory for about 8 to 10 days so as to get acclimatized to the laboratory conditions. They were fed sufficiently with live earthworms and boiled eggs to overcome the effect of starvation. The fishes were scarified by decapitation and sexed after dissecting them because this fish don't exhibit sexual dimorphism. Six fishes of each sex provided with the material for further processing.

The biochemical contents such as protein, glycogen and lipid in brain of freshwater fish *N. notopterus* were estimated by using the standard methods such as protein by Lowry's Method (1951); glycogen by method of Carrol *et al.*, (1956) and lipid by Barnes and Black stock (1973)

**Statistical analysis:** In all the cases six observations were made and the results were expressed as arithmetic means with their stand deviation, standard error (mean  $\pm$  S.E) and students 't' test were made as described by (Snedecore and Cochran, 1967; Fisher, 1963) the values were judged almost significant  $p < 0.05$ ,  $p < 0.01$  and highly significant  $p < 0.001$ .

## RESULTS

Based on the local availability and harvesting size of the fish *N. notopterus*. The biochemical constituents such as protein, glycogen, lipid and choleresterol were estimated in brain of female and male freshwater fish *N. notopterus*.

## Protein

Protein is one of the Biochemical components along with glycogen, lipids and amino acids. A protein is a complex, high molecular weight organic compound that consists of amino acids. The amount of protein in the brain of female freshwater fish *N. notopterus* is in the range of  $233.4 \pm 15.8$  ( $\mu\text{g}$  protein/mg of tissue), while the amount of protein in the brain of male fish *N. notopterus* is in the range of  $265.8 \pm 17.83$  ( $\mu\text{g}$  protein/mg of tissue).

The amount of protein is found to be higher in male brain as compared to the female brain.

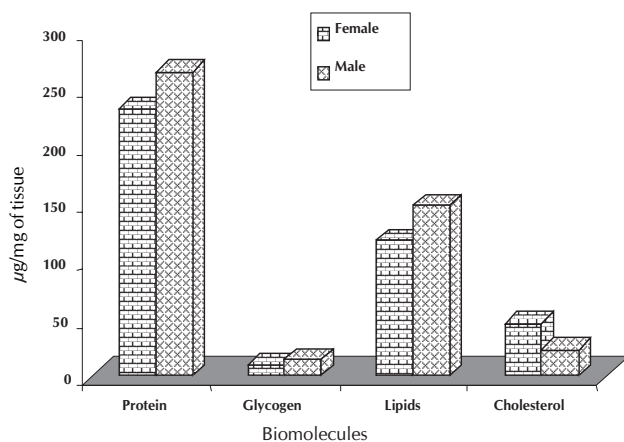
## Glycogen

Glycogen is the chief source of stored fuel in the body. They are chemical compound that acts as the primary biological and consuming energy. The glycogen content in brain of female fish *N. notopterus* found to be  $10.25 \pm 0.65$  ( $\mu\text{g}$  glycogen/mg of tissue) and in the brain of male fish *N. notopterus* is  $14.7 \pm 0.70$  ( $\mu\text{g}$  glycogen/mg of tissue) Table 1 and Fig. 1).

**Table 1: Showing the biochemical contents of brain in the freshwater fish, *Notopterus notopterus* in relation to sex**

Biomolecules/Sex	Male	Female
Protein	$265.8 \pm 17.83$	$233.4 \pm 15.8$
Glycogen	$14.7 \pm 0.70^{***}$	$10.25 \pm 0.65$
Lipids	$14.8 \pm 0.32^*$	$117.9 \pm 11.2$
Cholesterol	$23.4 \pm 4.87$	$45.4 \pm 4.14^{**}$

The values are expressed in  $\mu\text{g}/\text{mg}$  of tissue. All values are expressed as mean  $\pm$  standard errors,  $n = 6$  students 't' tests, NS = Non significant, \* = Significant  $p < 0.05$ ; \*\* = Significant  $p < 0.01$ ; \*\*\* = Significant  $p < 0.001$ , when compared between the sex



**Figure 1: Biochemical contents of the Brain in the fresh water fish *N. notopterus* in relation to sex**

## Lipids

The lipids are mainly stored in adipose tissue, bone marrow and nervous tissues. In animals nervous tissues are rich in lipids. The total lipid content in the brain of female fish *N. notopterus* lied in the range of  $117.9 \pm 11.2$  ( $\mu\text{g}/\text{mg}$  of tissue) and in the brain of male fish found to be  $14.8 \pm 0.32$  ( $\mu\text{g}/\text{mg}$  of tissue).

## Cholesterol

Cholesterol forms a major component of lipids. It plays a major important role in the physiological and metabolic process of the animal.

The values for cholesterol content in the brain of female freshwater fish *N. notopterus* found to be  $45.4 \pm 4.14$  ( $\mu\text{g}/\text{mg}$  of tissue) while  $23.4 \pm 4.87$  ( $\mu\text{g}/\text{mg}$  of tissue) amount of cholesterol found in male fish brain.

## DISCUSSION

Biochemical composition of a particular living system is the level of organic compounds - like proteins, lipids, carbohydrates, amino acids and nucleic acids present in organisms. Proteins, carbohydrates and lipids are the major biochemical components, which act as a source of energy for various physiological functions. As the different tissues and organs in an animal are structurally and functionally designed to carry out different physiological processes, it is possible that they will have different organic compositions (Lockwood, 1968). It is known that intrinsic factors like sex and size greatly influence various physiological processes, in a variety of animals. Such variations might be in all possibility due to difference in the biochemical construction of the tissues in respect to size.

## Protein

The protein found to be higher in male brain as compared the female brain (Table 1 and Fig. 1). Proteins are essential to the structure and function of all living cells, hence named building blocks of life. Protein acts both as a nutrient and as an energy source. Consequently addition of energy to a diet not only increase energy intake but also lowers the protein energy; total energy ratio. Lack of attention to this point has led to loose statement "increasing the protein level with constant energy always resulted in improved efficiency" (Page and Andrews, 1973). The energy harnessed from protein is used for the various maintenance requirements. Protein catabolism right from the commencement of starvation has also be seen to occur in larval place *Pleuronectes plastessa* (Ehrlich, 1974a) *Herring clupeaharengus* (Ehrlich, 1974b) and winter flounder *Pseudopleuronectes americanus* (Buckley, 1980)

## Glycogen

The study of brain glycogen in both females and males reveal that males have more glycogen content than the females. The variation in the glycogen content in female and male fishes is due to differences in sex as well as tissues (Table 1 and Fig. 1). Glycogen is the form of carbohydrates storage in animals. They are chemical compounds that acts as the primary biological means of storing and consuming energy. Most of the energy for metabolic activities in all the organisms is derived from oxidation of carbohydrates. Glycogen is the major if not the only feet of an anaerobic metabolism. The mobilization of glycogen may be extremely rapid so much so that trout muscle may utilize the univalent of about 40% mole of glycogen derived glycogen/second and in 15 seconds depletion about one half of the glycogen stored (Steves and Black, 1966). The glycogen content of cerebro spinal fluid of companion animals has been studied by Robert (2005).

While Mittmann and Scholtz (2003) investigated brain development in the horse shoe crab *Limulus polyphemus* and several other arthropods while the anatomy and fine structure of the neurones in the crayfish.

## Lipids

Lipids seem to be the major energy source in fishes. They are extremely important in maintaining structural and physiological integrity of cellular and sub cellular membranes.

The total lipid content in the brain of female fish lied in the range of  $117.9 \pm 11.2$  ( $\mu\text{g}/\text{mg}$  of tissues) and in the brain of male fish found to be  $148 \pm 0.32$  ( $\mu\text{g}/\text{mg}$  of tissue). While the comparison of lipid content in brain in both sexes reveal male brain has more lipids than its female counterpart (Table 1 and Fig. 1).

The lipids are mainly stored in adipose tissue, bone marrow and nervous tissues. In animals nervous tissues are rich in lipids. The changes in the lipids amounts associated with reproduction have been studied by Mourente *et al.*, (1994). The lipid metabolism and enzyme activities of growing *Macrobrachium borelli* stated an increase in lipid metabolism with age (Gonzalez Baro *et al.*, 2000).

### Cholesterol

The values found to be in the brain of female fish is  $45.5 \pm 4.14$  ( $\mu\text{g}/\text{mg}$  of tissue) while  $23.4 \pm 4.87$  ( $\mu\text{g}/\text{mg}$  of tissue) is the amount of cholesterol found in male brain. The cholesterol content in the brain of both females and males show considerable variation. The data shows that female brain has more cholesterol content than the male brain.

Cholesterol is an important compound of cell membranes. It forms a major component of lipids. The liver, muscle, gonads and nervous tissues of fishes containing certain large quantities of cholesterol. It is a precursor of biological steroid and is synthesized from acetyl CoA. Cholesterol content depends on spawning phase and circulation (Joshi, 1988). Cholesterol in the steroidogenic tissue has been shown to be associated with reproduction (Premjit *et al.*, 1992).

The differential distribution of cholesterol in different regions of the brain in 9 nutritionally important fishes were compartmentalized biochemically. The cholesterol content which was higher in the spinal cord than in the 4 brain regions, varied individually and group wise; the medulla oblongata and cerebrum contained the highest and lowest amount respectively. The piscivorous fishes contain more cholesterol than cat fishes and major carps. A direct relationship was observed between the course of evolution and the cholesterol content in different regions of the brain and spinal cord are discussed in relation to phylogeny, diet and activity of the fish. Phylogeny seems to influence the biochemical compartmentation of the fish brain in relation to its cholesterol content (Shaffi, 1981). Based on the above investigation it is confirmed that the brain of male freshwater fish *N. notopterus* is biochemically different from the brain, of female freshwater fish *N. notopterus* based on their metabolic activity.

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