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Effect of Neuro-Endocrine Manipulation on Lipid Content In Freshwater Bivalve: Lamellidens Corrianus During Summer Season

KEYWORDS: Lamellidens corrianus, ganglia ablation, ganglionic extract injection, lipid content.

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ABSTRACT *Considering the metabolic shifts in freshwater bivalve molluscs due to neuro-endocrine stress, we report here the seasonal variation in lipid content from mantle, hepatopancreas, gonad, foot and gill of adult freshwater bivalve Lamellidens corrianus collected from Jayakwadi backwaters of Godavari river at Paithan during summer (April-may). Adult bivalves of approximately same size were distributed in four aquaria, Ist treated as control, 2nd as cerebral ganglia ablated, 3rd as dist. water injected & 4th as cerebral ganglionic homogenate injected. The variation in the lipid content of L. corrianus from different groups on 2nd, 7th and 12th day during three summer seasons were estimated. During summer season the lipid content in the foot was significantly decreased in cerebral ganglia ablated group and significantly increased in cerebral ganglionic extract injected group on 7th day. The content was significantly increased in the gonad of both ablated and injected group on 7th day. On 12th day the content significantly increased in foot and gonad of both groups. The results are discussed in the light of metabolic shifts in the bivalves due to neuro-endocrine manipulation.*

INTRODUCTION:

Evidence for the occurrence of a wide variety of neurotransmitters in different tissues of Lamellibranchs including the nerve ganglia has been discussed from the functional point of view (Leak and Walker, 1980). From a functional point of view, Lubet (1956) was the first to suggest that a relationship might exist between the neurosecretory cells in the cerebropleural and visceral ganglia and reproduction in two marine mussels, Mytilus edulis and Chlamys varia. Studies on changes in the biochemical constituents in relation to the reproductive cycle in bivalve molluscs have been carried out extensively and have reviewed by many workers (Bayne, 1976; Sastry, 1979). Very little work on involvement of neurosecretion in reproduction and energy metabolism is reported in case of freshwater species (Kulkarni, 1987). To extend the knowledge in this field, an attempt has been made in the present study to demonstrate the effect of bilateral cerebralactomy and its extracts injection on lipid content in freshwater bivalve species Lamellidens corrianus (Lea). In present study the biochemical analysis like lipid was estimated from different body parts of Lamellidens corrianus. This species abundantly distributed along the banks of Godavari river of Jayakwadi backwaters (Nathsagar) at Paithan near Aurangabad, occurs throughout the year abundantly and thus used for the present study.

MATERIALS AND METHIDS:

Freshwater bivalve Lamellidens corrianus (80-85 mm in shell length) were collected from Jayakwadi backwaters (Nathsagar) at Paithan, 45 Km away from Aurangabad in summer season. After 24 h., reservoir water was once again renewed with aeration. After a lapse of 1 h. the animals extended their organs (foot, mantle, siphons) to maximum and soon surgical operations and injection of the ganglionic-extract were done. For removal of both the cerebral ganglia (bilateral cerebralactomy) active animal were chosen from the aquarium and a wedge (4-5 mm thick) was kept between the valves of the shell. Both the cerebral ganglia were removed by performing minimum injury to the animals within 30 seconds, with the help of fine, pointed sterilized forceps. For injection, cerebral ganglionic extract was prepared in ice cold distilled water (10 ganglia in 1ml cold distilled water) was centrifuged and the supernatant (0.2ml/animal i.e. equivalent to 2 ganglia/animal) was injected into the foot (muscular region) of gangliactomized experimental bivalves. In sham operated control animals were injected by 0.2 ml cold distilled water. The comparison was made between gangliactomized and control group and ganglionic extract injected and dist. water injected group of animals only. Soon after the operation and injection of ganglionic extracts, extirpated 30 animals of cerebralactomy, 30 animals of extract injected, 30 animals of control (non-operated) and 30 animals of dist. water injected were transferred to separate aquaria. Each aquarium contained 15 liter well aerated reservoir water and experiment was run for 12 days. The water from each aquarium changed at an approximate interval of 12-13 h. throughout experimental period.

Temperature and pH of the water were recorded daily during the water renewal, and total carbonate and dissolved oxygen were also determined using methods described by APHA et.al., (1985) at regular intervals of seven days over the experimental period. The experiments were conducted for 12 days on freshly collected animals in summer season (April-May). Standard method was employed for estimation of lipid (Barnes and Blackstock 1973). All the values were subjected to statistical analysis for confirmation using student't' test (Dowdeswell, 1957). Statistical and percentage differences were also calculated in experimental animals.

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RESULTS:

The physico-chemical characteristics of the water used in the experiments i.e. temperature, pH, hardness in terms of carbonate and dissolved oxygen contents during different seasons, are given in table-1. The temperature of water was found 30.0-32.5°C in April and 31.5-33.0°C in May, during the study period. The pH of water was ranged between 7.4 -7.8 throughout the study period. The hardness of the water was found 80-105 ppm in April and 83-112 ppm in May.

During the study, the lipid content from mantle was decreased significantly (4.3500 ± 0.4868, 37.38%, P<0.05) in ganglia ablated and (5.5671 ± 0.2434, 19.85%, P<0.05) in ganglionic extract injected group on 7th day. The content also decreased significantly from hepatopancreas (5.2426 ± 0.3718, 34.48%, P<0.01) in ablated and from gonad (8.3261 ± 0.3718, 16.98%, P<0.05) in ganglionic extract injected group. Whereas the content from foot was increased significantly (08.1638 ± 0.3718, 23.28%, P<0.05) and from gill decreased significantly (3.5385 ± 0.2810, 35.49%, P<0.05) in ganglionic extract injected group.

Where as on 12th day the lipid content was decreased significantly (4.9180 ± 0.1405, 34.55%, P<0.05) and (5.6483 ± 0.2810, 36.49%, P<0.05) from mantle and hepatopancreas respectively, in ganglionic extract injected group. Whereas the content from gonad was decreased significantly (19.1185 ± 0.2810, 20.83%, P<0.05) in ablated animals and (11.8154 ± 1.0135, 51.07%, P<0.01) in ganglionic extract injected group. Similarly, the content significantly decreased from foot (5.4048 ± 0.5067, 23.97%, P<0.05) in ganglia ablated and (5.7294 ± 0.3718, 19.40%, P<0.05) in ganglionic extract injected group respectively. The lipid content from the gill also decreased significantly (5.7294 ± 0.3718, 45.93%, P<0.001) and (3.0516 ± 0.2810, 71.20%, P<0.001) in both ganglia ablated and extract injected group respectively.

Table:-1

Physico – chemical characteristics of water during summer seasons

Sr. No.	Seasons	Months	Temperature (°C)	pH.	Hardness (ppm)	Dissolved oxygen content (mg/lit.)
1	Summer	April	30.0 – 32.5 °C	7.4 – 7.8	80 – 105	5.50 – 5.90
		May	31.5 – 33.0 °C	7.5 – 7.8	83 – 112	5.25 – 5.77

Table –2

Effect of ablation of cerebral ganglia and injection of their extracts on lipid content of Lamellidens corrianus on 7th day during summer season. (Bracket values represents percentage difference).

• = P<0.001, •• = P<0.01, ••• = P<0.05 (CG=Cerebral Ganglia)

	Tissues	Control normal	CG Ablated	Dist. Water injectd	CG Extract Injectd
1	Mantle	6.9466 ± 0.2810	4.3500 ± 0.4868 (37.38) •••	7.1089 ± 0.3718	5.5671 ± 0.2434 (19.85) •••
2	Hepato-pancreas	8.0015 ± 0.2434	5.2426 ± 0.3718 (34.48) ••	7.6769 ± 0.6126	6.7843 ± 0.4868 (15.21)
3	Gonad	10.0302 ± 0.2810	11.1662 ± 0.4868 (11.32)	9.9490 ± 0.4216	8.3261 ± 0.3718 (16.98) •••
4	Foot	6.6520 ± 0.2810	6.1352 ± 0.7437 (7.35)	6.5409 ± 0.2434	8.1638 ± 0.3718 (23.287) •••
5	Gill	5.4860 ± 0.2810	5.8106 ± 0.4868 (5.91)	5.5671 ± 0.6440	3.5385 ± 0.2810 (35.49) •••

Table –3

Effect of ablation of cerebral ganglia and injection of their extracts on lipid content of Lamellidens corrianus on 12h day during summer season. (Bracket values represents percentage difference)

• = P<0.001, •• = P<0.01, ••• = P<0.05 (CG=Cerebral Ganglia)

	Tissues	Control normal	CG Ablated	Dist. Water injected	CG Extract Injectd
1	Mantle	7.5146 ± 0.4216	5.3237 ± 0.4868 (29.15)	8.0827 ± 0.3718	4.9180 ± 0.1405 (34.55) •••
2	Hepato-pancreas	8.8941 ± 0.5621	6.2975± 0.4868 (29.19)	9.0564 ± 0.7437	5.6483 ± 0.2810 (36.49) •••
3	Gonad	24.1495 ± 0.5621	19.1185 ± 0.2810 (20.83) •••	24.3930 ± 0.3718	11.8154 ± 0.0135 (51.07) ••
4	Foot	7.1089 ± 0.2810	5.4048 ± 0.5067 (23.97) •••	7.5146 ± 0.2434	5.7294 ± 0.3718 (19.40) •••
5	Gill	10.5982 ± 0.1405	5.7294 ± 0.3718 (45.93) •	11.1662 ± 0.4868	30516 ± 0.2810 (71.20) •

Discussion:

Lipids are considered an important component during gametogenesis for gonad maturation and serve as energy reserve when food supply is insufficient. The study carried out for 12 days at intervals of 5 days are under laboratory conditions and since no food was given to the animals it is expected that the starvation effect might have also occurred. Studies on changes in the biochemical constituents in relation to reproductive cycle in bivalve molluscs have been carried out extensively and have been reviewed by many workers (Sastry, 1979; Voogt, 1983). Very little work on involvement of neurosecrition in reproduction and en-

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ergy metabolism is reported in freshwater species (Kulkarni, 1987). In the present investigation an attempt has been made to find out the effect of bilateral cerebralactomy and ganglionic extract injection on lipid content in freshwater bivalve L. corrianus. For Indian bivalves Nagabhushnam and Mane (1973) reported correlation in organic constituents and the annual reproductive cycle of Katelysia opima. The endocrine control of developmental and physiological process in invertebrates has been amply demonstrated by the results of various kinds of experiments in different phyla (Hignam and Hill, 1978). In case of gastropods it has been reported that the extirpation of cerebral ganglia or destruction of NSCs (Neurosecretory cells) in the cerebropleural area of the brain in the limpet, Crepidula fornicate leads after six months to a very significant fall of total carbohydrate and lipids in the somatic organ (Lubet and Le Gall, 1974), the author further found that the graft of cerebro-pleural ganglia in the cerebralactomized animals is followed by a significant recovery of lipids but total carbohydrates remains very low. In Pila globusa visceral ganglionic extract cause maximal accumulation of lipids in hepatopancreas followed by albumen gland and vaginal tract, it is also found that the extract of cerebral ganglia and pleurapedal ganglia elevated the content in hepatopancreas and vaginal tract but depleted the content in albumen gland. (Ramamurthi et. al., 1982). The author concluded that the endocrine principles from the same anatomical locations of slug (Pulmonate) and snail (Prosobranch) exhibit differential effect on tissue lipid level. The hepatopancreas of active pila globosa show an appreciable level of lipid to carbohydrate convertibility as judged from the grater uptake of label of radio acetate into glycogen fractions than into total lipid fraction (Naidu et. al., 1982). The uptake of glycogen/lipid ratio was enhanced by the extract of cerebral ganglia of normal snail pila globosa, In Lamellidens marginalis after cerebralactomy and visceralactomy in natural populations for a period of three months revealed significant changes in the organic constituents from different body parts (Mane et al., 1990). In Mytilus edulis and Crassostrea gigas, Lubet et al., (1976) suggested a neuroendocrine control over the storage tissue and the germinal cells. Removal of cerebral and visceral ganglia in Mytilus edulis and Mytilus galloprovincialis revealed that the growth and carbohydrate metabolism of extirpated animals are normal but the increase of lipid content in the connective tissue is disturbed as well as RNA in oocytes (Lubet, 1966). Cerebral ganglia removal in Mytilus edulis revealed that natural lipids, phospholipids, glycogen and acid mucopolysaccharids are evenly distributed in oocytes of ablated and of control individuals and characteristic distribution of the cytoplasmic RNA occurs in operated animals (Lubet, 1970). In summer gametogenesis commences at slow rate and lipid globules almost fill up the entire lumen of follicle.

Present study of ablation of cerebral ganglia and injection of their extracts to the normal intact animals revealed that, cerebral ganglia play an important role, mostly inhibitory one, in the regulation of metabolic rate, organic reserves from different body components, gonad development and spawning. This aspect includes the regulation by neurohormones/neurohumors of normal physiological functioning and homeostasis. It is tentatively suggested that the cerebral and visceral ganglia in bivalve molluscs like Lamellidens corrianus elaborate some principles including neurohormones, neurotransmitters and other unknown factors which trigger the metabolic demands of animal during different reproductive phases.

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