EFFECT OF INCREASE IN TEMPERATURE ON THE RATE OF OXYGEN CONSUMPTION AND ASCORBIC ACID CONTENT IN FRESHWATER BIVALVE, *INDONAIA CAERULEUS* (PRASHAD, 1918) FROM GODAVARI RIVER AT PAITHAN, DURING SUMMER

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KEYWORDS

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Ascorbic acid

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Considering the physiological processes and metabolic shifts in lamellibranch molluscs during the period of environmental stress, we report here, the effect of increase in temperature on the rate of oxygen consumption and changes in the ascorbic acid content from mantle, hepatopancreas, gonad and foot of adult freshwater bivalve, Indonaia caeruleus from banks of Godavari river at Paithan on April - May during summer season. Compared to the control the bivalves exposed to increase in temperature (34ºC) during summer, showed significant increase in the rate of oxygen consumption on 2nd, 8th and 16th day. However among the controls of respective days, the rate of oxygen uptake depleted on 8th and 16th day compared to controls of 2nd and 8th day respectively. Among the metabolic shifts, the ascorbic acid content significantly increased from the mantle and decreased from the gonad on 2nd, 8th and 16th days. When bivalves exposed to increase in temperature the ascorbic acid content showed more decrease immediately due to rise in temperature from the hepatopancreas and foot on 2nd day. The results of the tissue synthesizing ascorbic acid due to increase in the temperature are discussed in the light of possible physiological mechanisms involved in these bivalves.

INTRODUCTION

The Jayakwadi project is constructed at Paithan near Aurangabad. Hence due to restricted flow of water during summer season, thousands of bivalves were exposed to rise in temperature. Hence according to considering this situation the present study was taken. In aquatic animals the ascorbic acid is dependent on many exogenous (environmental) and endogenous (endocrine) stress factors, of which water temperature is the most important factor. Many workers have been reported relationship between temperature and metabolic processes in bivalves (Kinne, 1970; Samant and Agrawal, 1978; Alimov, 1981 and Vedpathak et al., 1987).

The ascorbic acid is a water soluble vitamin and it is essential for collagen and bone formation (Halver, 1967) and it is playing an important role in wound healing and tissue repairing (Halver, 1972) in many invertebrates. The fast mobilization of fat by ascorbic acid and formation of glucose from these fats has been shown by Sinha et al., (1978). The ascorbic acid also plays an important role in the process of hydroxylation, oxygenation and oxidation of corticosteroids (Chatterji, 1967).

In mollusca, it has been shown that ascorbic acid also plays an important role in steroidogenesis (Chinoy and Seetalakshmi, 1977) and in endowing the organism with increasing the power of resistance towards the polluting substances (Mahajan and Zambare, 2006). Perusal of literature shows that the ascorbic acid content in different tissues of freshwater bivalve mollusc has received little attention. Hence considering the multiple role of ascorbic acid (Chinoy and Seetalakshmi, 1977; Kachole et al., 1977; Ali et al., 1983; More and Mudkhede, 2009; Pardeshi and Gapat, 2012, Vedpathak et al., 2007 and Kamble et al., 2011) and paucity of information on its level in tissues of bivalves, we report here the effect of increase in temperature (a major ecological factor) on the rate of oxygen consumption and changes in ascorbic acid contents from different tissues of freshwater bivalve Indonaia caeruleus.

MATERIALS AND METHODS

The adult freshwater bivalve. Indonaia caeruleus (46-49 mm in shell length) were collected from banks of Godavari river at Paithan on April-May during summer season. Soon after bringing them to the laboratory, they were brushed and washed with tap water so as to remove the fouling algal and fungal biomass and mud. After 24h. acclimatization in the laboratory conditions, they were grouped in 10(ten) and each group was kept separately in two aquaria, each containing 5L aerated reservoir water. The first group served as control with water of normal temperature (28.5ºC-29.5ºC) and second as experimental with increase in temperature (34ºC) during summer. The temperature of the water in experimental group was maintained by keeping thermostat (AUTOMATIC, RENA) France. In experimental aquarium care was taken that, the animals were kept away from thermostat and experiment was run for 16 days. The water of the control and experimental aquaria were renewed on each day at approximate interval of 12 to 13h. and during experimental period no food was given to the animals.
The rate of oxygen consumption of individual animal from control and experimental group was measured according to (Golterman et al., 1978) on 2nd, 8th and 16th day. Similarly animals from each group were dissected and removed their soft body tissues (mantle, hepatopancreas, gonad and foot). The ascorbic acid from each tissue was estimated according to (Roe, 1967) on 2nd, 8th and 16th day.

All the values were subjected to student ‘ t ’ test for statistical confirmation (Dowdswell, 1957). The physico-chemical characteristics’ of water used during experimentation were also determined (APHA et al., 1985). The results of the experiments are expressed in terms mg oxygen/l/h/g body weight for oxygen consumption and mg ascorbic acid /100mg wet tissue for ascorbic acid.

RESULTS AND DISCUSSION

The physico-chemical characteristics of water used in experiment on April-May during summer season were: Temperature of water (28.5ºC-29.5ºC), pH (7.68-7.79), hardness of water in terms of carbonate (118-125ppm) and dissolved oxygen content (5.68-6.39mg/L). The results of the present study were shown in Fig.1 and Fig. 2.

During experimental period, the rate of oxygen consumption, in control were (0.2513±0.01618) on 2nd (0.2271±0.0105) on 8th and (0.1691±0.01076) on 16th day. In control group the rate of oxygen consumption was decreased (9.63%) on 8th and (32.71%) on 16th day compared to 2nd day control. However, in experimental group the rate of oxygen uptake was significantly increased on 2nd, 8th and 16th day compared to their respective controls. But this increase in the rate of oxygen consumption was found more pronounced on 16th day. Due to the increase in temperature the rate of oxygen consumption showed significant increase (0.3042±0.01573, 21.05%, p<0.01) on 2nd and (0.2599±0.01391, 14.44%, p<0.05) on 8th day. Similarly in experiment group the rate of oxygen consumption was significantly increased (0.1938±0.0119, 26.43%, p<0.001) on 16th day.

The ascorbic acid content was significantly increased from mantle (0.4034±0.03211, p<0.01, 47.44%) on 2nd, (0.2599±0.01391, 14.44%, p<0.05) on 8th day. Similarly, compared to the controls the ascorbic acid content also increased from the hepatopancreas (0.3849±0.03211, p<0.05, 23.88%) on 8th and (0.5888±0.01112, p<0.05, 18.43%) on 16th day due to increase in temperature, while the ascorbic acid content showed non-significant decrease from the gonad on 2nd and 8th day and significant decrease (0.4634±0.0309, p<0.05, 18.69%) on 16th day due to effect of increase in temperature.

In the present study on Indonaia caeruleus during summer the rate of oxygen consumption significantly increased due to increase in the temperature of water on 2nd day. Similar significant increase in the rate of oxygen consumption was also found on 8th and 16th day as compared to their respective controls. While in control as well as experimental groups, the rate of oxygen consumption decreased on 8th and 16th day.

In the present study, on Indonaia caeruleus, as the period of exposure increased, the rate of oxygen consumption decreased in both control and experimental groups, perhaps due to effect of starvation. Mane (1975) stated that the rate of oxygen uptake decreased with respect to starvation period, in estuarine clams, Kateleysis opima. The present study revealed that the rate of oxygen consumption in experimental group increased with increase in temperature on 2nd, 8th and 16th days. It is evident that due to increase in temperature of water(a major environmental stress) the reaction of an organism by a disturbed physio-chemical balance i.e., an abnormal impact of external environment, maintained high rate of oxygen consumption (Dhert, 1992). In the present study the rate was increased because in terms of energy conservation, the organism would...
Figure 2: Effect of increase in temperature on the ascorbic acid content in different tissues of Indonaia caeruleus during summer season

<table>
<thead>
<tr>
<th>Tissues</th>
<th>2nd Day</th>
<th>8th Day</th>
<th>16th Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mantle</td>
<td>0.274±0.03211 (47.44)</td>
<td>0.292±0.03214 (57.11)</td>
<td>0.441±0.03211 (35.45)</td>
</tr>
<tr>
<td>Hepatopancreas</td>
<td>0.293±0.03211 (19.04)</td>
<td>0.311±0.0556 (23.88)</td>
<td>0.532±0.02561 (18.43)</td>
</tr>
<tr>
<td>Gonad</td>
<td>0.255±0.0356 (14.54)</td>
<td>0.274±0.03335 (11.5)</td>
<td>0.496±0.03211 (18.69)</td>
</tr>
<tr>
<td>Foot</td>
<td>0.181±0.02729 (20.48)</td>
<td>0.107±0.0411 (17.36)</td>
<td>0.274±0.03327 (6.76)</td>
</tr>
</tbody>
</table>

In the present study due to effect of increase in temperature, the ascorbic acid content significantly increased from mantle on 2nd, 8th and 16th day, from hepatopancreas on 8th and 16th day and from foot on 16th day. Which perhaps suggest the shift in the ascorbic acid content due to increased demand of energy and fatigue retardants. The ascorbic acid content significantly decreased from hepatopancreas on 2nd day from gonad on 2nd, 8th and 16th day and from foot on 2nd & 8th day possibly suggest that due to rise in temperature the steriodogenesis in hepatopancreas and gonad might have occurred (Chinoy and Seetalakshmi, 1977). They further concluded that formation of corticosteron during stress condition might have occurred in the blood of animal and this increased demand of energy alters the ascorbic acid contents.

In the present study from the above results, it can be stated that ascorbic acid acts as stress stabilizing agent. It can further be stated that due to increase in temperature (high stress) condition during summer, Indonaia caeruleus needs more energy, hence, during more utilization of glucose for energy purpose. Since glycogen content decreased from almost all the tissues during summer (Vedpathak et al., 2007), reduced synthesis of ascorbic acid.

In the reproductive organs of gastropod mollusc, Chinoy and Seetalakshmi (1977), found increased in the ascorbic acid content due to active conversion of ascorbinogen to free ascorbic acid accompanied by increase in the rate of utilization. These authors further stated that, mono-dehydroascorbic acid play an important role in endowing the organism with increased power of resistance. Rise in temperature effect showed decrease in the content of ascorbic acid from hepatopancreas, gonad and mantle during summer season (Vedpathak et al., 2007), observed that decreased the content of ascorbic acid in hepatopancreas, gonad and mantle in freshwater bivalve exposed to desiccation. They have further stated that due to desiccation stress steroidogenesis in hepatopancreas and gonad might have occurred. The present study suggest that increased demand of energy being provided by utilization of ascorbic acid, since summer season provides the drastic environmental condition to the animals on the habitat along the banks of Godavari river. The hepatopancreas in the bivalves is the depot tissue and from this organ that the nutrients supply to the other organs occur.

In case of fishes, Somasundaram et al. (1978) considered that the concentration of ascorbic acid depend upon the physiological state of the fishes. The rise in temperature increases metabolism in bivalves is well known Mane (1975). In acute physiological condition ascorbic acid content has been shown to decrease from the brain and gut and shift to the muscles and other parts in Channa gachua due to increase the demand of energy and fatigue retardants (Ali et al., 1983).

In our findings, in the present study on Indonaia caeruleus also the ascorbic acid content might have acted as fatigue retardants due to rise in temperature effect on the body parts.

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REFERENCES


