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Seasonal changes in the biochemical composition of wedge clam, *Donax scortum* from the Padukere beach, Karnataka

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Abstract
Seasonal variations in protein, lipid and carbohydrate along with dry tissue weight and water in *Donax scortum* were studied for a period of 12 months (from February 2009 to January 2010). Water content remained at high level during monsoon and post monsoon periods. Dry tissue weight parentage exhibited an inverse relationship with water content in all months in the present study. Protein content was high relatively in all months except low during the breeding months. Glycogen content during the maturation period declined showing the utilization active gamete production. Fat content increased during the period of active formation of gametes. Afterwards, it decreased during the spawning period. Ash content in our present study shows similar seasonal pattern in percentages of lipids and proteins. However, changes in carbohydrate percentage show a completely different resulting in an inverse relationship between carbohydrate and protein. Calorific values of *D. scortum* are well within the known limits reported in the literatures for other bivalves.

Keywords: *Donax*, Bivalve, Beach, Spawning, Karnataka.

INTRODUCTION

In general, bivalves are found in abundance in seashores and estuaries and form the food of many coastal people in India. Donacids are suspension filter feeders inhabiting seawaters of tropical and subtropical areas. *Donax scortum* (wedge clam) is a common and important member of the bivalve fauna of muddy beach substrata on southern Karnataka coast. This wedge clam, belonging to the family Donacidae, is found around the Indian coast e.g. north [39], east [21, 45] and west [47] coasts. From Indian waters, the chemical compositions of *D. incarnatus* and *D. cuneatus* have been studied [11, 35]. Amylase and protease activities were studied in the gut of wedge clam, *D. cuneatus* [40]. The biochemical composition of mollusc is influenced by its size, growth and reproductive status. Bivalve molluscs are potential sources of valuable proteins, carbohydrates and minerals and abundantly available in India. *D. scortum* does not occur in dense population at the Padukere beach, Karnataka, but plays a major role in the function of ecosystems near to the mouth of Udyavara river. The present study dealing with the variations in the total protein, carbohydrates, lipids and calorific contents of largest wedge clam from this area may be of help in studying ecological energy models. Martínez-Pita et al. [28] analysed sex-related differences in lipid classes and fatty acid profile. Total lipids were higher in females than in males. Further, they reported that that triglycerides and phospholipids were the major lipid components, and the former dominated in females and the latter in males. Literature on biochemical of the donacid species is scanty in India. Various patterns of fluctuation of biochemical components in different geographical areas have been described by several authors. Some literatures relate to *D. trunculus* [9, 17, 28,] and *D. vittatus* [3]. Several commercially important species of bivalves have been studied for biochemical composition. The analysis of various body components for biochemical constituents would be more informative to elucidate the mobilisation of the tissue reserves to the gonad during gametogenesis [15]. But the organic constituents in the whole tissue of many bivalves have been estimated by several workers, in the case of donacid, *D. vittatus* [3], *D. incarnatus* and *D. spiculum* [4], *D. cuneatus* [35] and *D. trunculus* [9]. The present investigation has been undertaken to study seasonal variations in the chemical composition of *D. scortum*.

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MATERIALS AND METHODS

In *Donax scortum* population, majority are along the middle of the flat intertidal zone of Padukere near to the mouth of the Udyavara river and below this zone, there are less number of population present. This wedge clam is available on the flatter portions of the beach where the wave wash is more uniform. Monthly collections were made from a station on a muddy beach at Padukere (13º 20'N; 74º 41'E) near Udupi town for a period of 12 months from February 2009 to January 2010. A total of 10 individuals ranging from 50 to 60 mm size were individually measured for shell length (maximum antero-posterior distance) accurately to 0.01mm using vernier callipers for each month. The soft parts were removed carefully, washed with distilled water and weighed. Afterwards, they were blotted to remove excess of moisture and dried at a constant temperature of 60ºC for 2 days, reweighed accurately to 0.001 g and the dry materials were homogenised monthly. No distinction was made between sexes in the chemical analysis. Percentage of water content of soft tissue was calculated from the fresh weight and dry weight. Lowry's method [27] was used for the determination of total protein. The carbohydrate contents was not determined by analytically but calculated by subtracting the sum of protein, lipid and ash from 100 percent. The lipid content in the present investigation

was determined by the modified method of Ansell and Trevallion [2]. Ash contents of clam tissue were determined by the standard method of A.O.A.C. [10]. The calorific values of the clam tissues were estimated using the previous practice [3 ,9].

RESULTS AND DISCUSSION

Water content and dry tissue weight

The water content of *Donax scortum* remained relatively high, ranging from 74.25% to 79.11% throughout the year (Figure 1). During the monsoon season, high values of water content were obtained from July 2009 onwards. Low values of water content decreased from November 2009 onwards during the post monsoon season. The average value (75.43%) of water content was low during the pre monsoon season compared to the monsoon (77.76%) and post monsoon (76.06%) seasons. Lowest and highest values of water content were observed in March 2009 and July 2009 respectively. In general, the water content of the tissue of bivalves usually gives an indication of the time of spawning. Increase in water content appeared in *D. scortum* in July and November and these periods coincided with the spawning season. It was observed that water content is minimum when the gonads are fully developed and increased during the spawning season. This seasonal change in water content seems to be associated with the changes in the reproductive cycle, physiological state and nutritional condition of the organism. Maximum values of water contents were reported during the monsoon season and minimum water content in summer months in many species of bivalves, e.g., *Mytilus viridis* [34, 29], *Paphia laterisulca* [32], *D. cuneatus* [35], *Villorita cyprinoides* [1]. The present findings are in perfect with agreement with the observations just mentioned about the bivalves. Seasonal changes in the dry tissue weight of standard sized clam, *D. scortum* from the Padukere beach for a period of 12 months from February 2009 to January 2010 are shown in Figure 1. The dry tissue weight percentage in every month showed an inverse relationship with water content. The average values of dry tissue weight were 24.57%, 22.24% and 23.94% during the pre monsoon, monsoon and post monsoon seasons respectively. Lowest percentage was recorded in July 2009 (20.89%) and highest in March 2009 (25.75%). Dry tissue weight parentage exhibited an inverse relationship with water content in all months in the present study. Jayabal and Kalyani [20] also reported the same pattern for clam, *Meretrix meretrix*. Variation in dry tissue weight of mollusc is always associated with biochemical components. The seasonal variation in biochemical components is not related only to the reproductive cycle but is also influenced by the food availability and temperature as emphasized by Ansell [6. 7, 8].

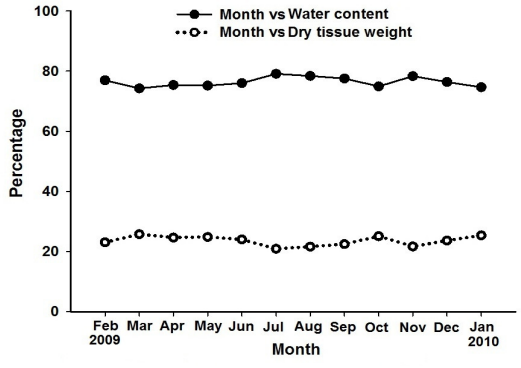

Fig 1. Seasonal variations in water content and dry weight of *Donax scortum*

Protein content

The protein content of *Donax scortum* was at relatively high level throughout the year (Figure 2) being maximum in May 2009 and minimum in November 2010. In the months of March and April, the protein content was high reaching its peak (66.2%) in May 2009. Afterwards, it decreased during the monsoon period. In September, as the spawned wedge clams entered a phase of redevelopment, the protein content increased to some extent and again declined during the second peak of spawning (November 2009). In the present study, the average value of protein content was 62.95%. Generally, seasonal changes in the biochemical constituent are the characteristics of the seasonal activities of bivalves. Variations in biochemical constituents seem to be mainly influenced by reproductive cycle [34, 29, 26] and availability of food [29, 20]. In marine molluscs, the reproductive cycle is governed by a number of factors such as salinity, temperature, day length and density of the surrounding medium. Though discontinuous and continuous spawning has been observed in bivalves from Indian waters, spawning has been recorded during the monsoon in *Meretrix casta* [18] and *Tellina angualata* [23]. From our present findings, it could be seen that the protein content relatively high throughout the year except slight declines during the spawning periods. In general the level of protein build up during the gametogenesis in *D. scortum* is utilised during the peak of breeding season. Similarly an increase in protein content occurs again after the monsoon season, which may be utilised for the subsequent spawning. In almost all lamellibranchs, the protein content remains at a relatively high level throughout the year and decreases during the period of gametogenic activity or during the spawning period [30, 13, 12, 33]. Increase in protein during peak spawning has been reported earlier [31, 38]. An increase in protein during the monsoon season due to low metabolic activities of the species during the low salinity conditions has been reported [38]. But such an increase in protein content has not been observed in *D. scortum*. Nagabhushanam and Talikhedkar [35] observed a high protein value followed by a decrease during the spawning and an increase during maturation period of wedge clam *D. cuneatus.* The level of protein content in *D. scortum* ranged from 59.9 to 66.2 %. The values are lesser than the reported for *D. cuneatus* from Mirya Bay, Ratnagiri, i.e., 56.6-68.3% [35]. However, values of the present study are higher than *D. trunculus* of Azur Plage, Algeria, i.e., 52.9-64.1% [9]. Working on clam, *Marcia cor* population of Karachi muddy coast Perveen et al. [37] found 54.0-74.0% protein. These values are higher than the values reported for wedge clam, *D. scortum* from the Padukere muddy coast. The results obtained with *D. scortum* are in general agreement with those found in other bivalves.

Lipid content

The lipid content of *Donax scortum* is presented in Figure 3 and shows a gradual increase from February and a peak (9.06%) in the gravid population of May before spawning. In June, the lipid content sharply decreased and remained at a low level upto July due to continuous spawning. During the phase of redevelopment and slow spawning the lipid content increased (August: 8.68% and September: 9.86%) and afterwards declined again during the second peak of spawning, i.e., from October to November. The average value of lipid content was 7.33% in the present study. Possibility of an increase in lipid content in bivalves during phytoplankton bloom

has been reported [46]. Lipid levels of almost same magnitude had been reported in the literatures from Indian [35] and Algerian waters [9]. Lipid level increased generally with the onset of gamatogenesis and reached to the maximum prior to spawning of *D. cuneatus* [35] and *D. trunculus* [9]. These findings agree with the present study of lipid content, i.e., lipid accumulates in the developing gonads and depletes during spawning.

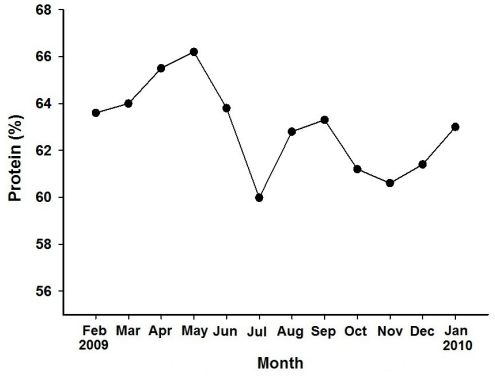

Fig 2. Seasonal variations in protein content of *Donax scortum*

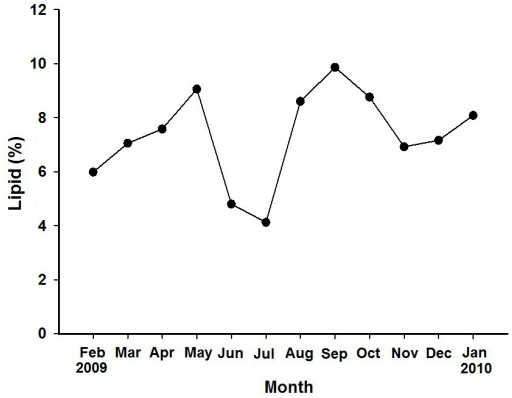

Fig 3. Seasonal variations in lipid content of *Donax scortum*

Glycogen content

Carbohydrate values fluctuated widely in all months (Figure 4). The value ranged between 15.04% and 26.98%. Maximum value was in July 2009 and minimum in May 2009. In general glycogen content showed variations with the breeding behaviour and development of the gonad. Carbohydrate percentage was at the peak in July and it decreased in September. In the month of November, the glycogen level was high again and the lowest value was recorded during the pre monsoon season. In the present study, the average value of carbohydrate content was 21.67%. Glycogen has long been considered to be the principle reserve of marine bivalves [16]. Glycogen content in *Donax scortum* showed great variation in relation to its reproductive cycle. An inverse relationship between changes in protein and carbohydrate was recorded. Increase in the glycogen content in *D. scortum* was during early gametogenic period and the value of the glycogen content showed decreasing trend with the advancement of gametogenesis. This may be considered as its utilisation in the development of gametes. When mature gametes were present in *Tivela stultorom* least carbohydrate storage was present [15]. Nagabhushanam and Deshmukh [36] also noticed a fall during mature condition and high level of glycogen content during the period of gonad development in *Meretrix meretrix.* Similar findings were also observed in *D. cuneatus* [35] and in the edible oyster *Crassostrea madrasensis* [44].

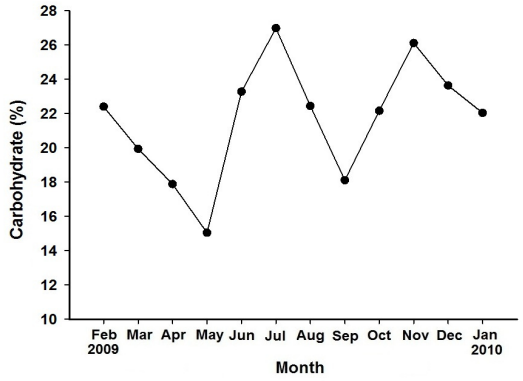

Fig 4. Seasonal variations in carbohydrate content of *Donax scortum*

Ash content

Seasonal changes in percentage of ash content are shown in Figure 5. The highest percentage was recorded in May (9.70%) and the lowest in August (6.16%). The average value of ash content was 8.05% in the present study. Ash content in our present study shows similar seasonal pattern in percentages of lipids and proteins. However, changes in carbohydrate percentage show a completely different resulting in an inverse relationship between carbohydrate and protein. Fatima [14] also reported the same findings for green mussel from Karachi. A distinct feature of changes in ash content was maximum values of ash content in *Donax scortum* were observed when minimum values of carbohydrate were found.

Caloric content

It may be seen that from Figure 5 that calorific content of standard size clams was 5.2658 Kcal/g in May 2009 which declined to reach the minimum (4.9389 Kcal/g) in July 2009. Thereafter the values of calorific content increased somewhat during the post monsoon season and decreased at a uniform level during August-December period. A minor increase was noticed in the month of January 2010. In our present study, the average value of caloric content was 5.1942 Kcal/g. The calorific value of wedge clam, *Donax scortum* tissue varied from 4.94 to 5.34 Kcal/g with an average of 5.19 Kcal/g. These values showed higher than the *D. trunculus* of Azur Page, Algeria [9] which varied from 3.90-4.50 Kcal/g, but the present values are similar with the calorific values of *Perna viridis* (4.93-5.36 Kcal/g; average: 5.22 Kcal/g) of Karachi and *Saccostrea cucullata* of Bombay (4.38-5.43 Kcal/g, average: 4.97 Kcal/g; 4.76-5.65 Kcal/g; 5.09 Kcal/g) [14, 25]. It may be concluded that the calorific values of *D. scortum* are well within the known limits reported in the literatures for other bivalves, i.e., mussel and oyster.

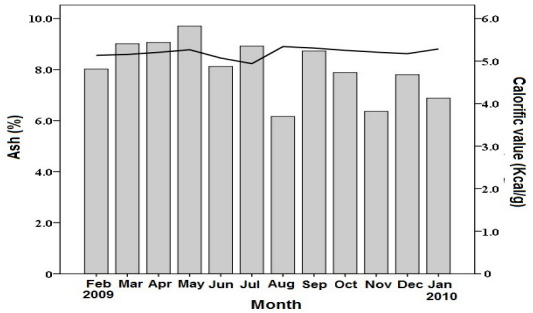

Fig 5. Seasonal variations in ash and calorific content of *Donax scortum*

Values for biochemical composition of other different species

of bivalve recorded earlier are shown in Table 1. Even though the range recorded earlier for protein, carbohydrate, lipid and calorific contents in *Donax scortum* agrees with those reported for other *Donax* species [35, 9]. Ash values were found to be comparatively low in the present study. Recently, Hamdani and Soltani-Mazouni [17] observed a study on the main components in gonads of *D. trunculus* during the reproductive period revealed changes correlated to the reproductive events in the gulf of Annaba. Moreover, there are differences between sex and site. Further, they suggested that the difference between the sites was related to their level of exposition to pollution. Singh et al. [41] reported high concentrations of heavy metals in *D. faba* from the same study area, Padukere beach due to industrialization along the study area. Deterioration in water quality at the Padukere beach due to indiscriminate discharge of waste has been observed by Kumar [22] and Shruthi et al. [42]. However, the variations in the biochemical composition in this species from that of other bivalves reveals that the adverse water quality in this area does not show an alarming state to produce any stress on the fauna.

Table 1. Biochemical composition of different bivalves (values expressed as percentage of dry weight).

Species	Protein	Lipid	Carbohydrate	Ash	Calorific value (Kcal/g dry wt)	Sources
Abra abra	53.38-61.94	3.26-6.83	6.99-17.16	13.51-29.62	3.86-4.53	Ansell[6]
Lima hians	11.25-18.67	4.91-8.23	1.73-6.89	13.05-27.36	3.80-4.70	Ansell[5]
Meritrix casta	50.37-60.73	2.40-3.80	8.81-13.75	-	-	Nagabhushanam and Deshmukh[36]
M. casta	M27.20-41.10 F24.19-36.70 I24.00-37.30	M5.30-19.10 F4.30-15.20 I5.50-14.50	M2.90-14.00 F3.80-10.80 I1.90-12.40	M1.50-11.20 F2.40-9.90 I1.93-12.20	M3.80-5.10 F3.65-4.60 I3.20-4.70	Kumari et al.[24]
Paphia laterisulca	33.13-40.53	3.30-10.80	1.91-7.66	-	-	Nagabhushanam and Dhamne[32]
Donax cuneatus	56.59-68.31	4.56-7.15	11.14-25.85	-	-	Nagabhushanam and Talikhedkar[35]
D. trunculus	52.94-64.13	2.94-6.94	6.47-14.71	18.71-30.00	3.90-4.50	Ansell et al.[9]
D. scortum	59.90 to 66.2	4.12-9.86	15.04-26.98	6.16-9.70	4.94-5.34	Present study
Chlamys opercularis	-	-	1.17-18.50	7.41-25.55	-	Taylor and Venn[43]
Tellina angulata	M39.04-65.72 F42.09-64.02 I50.20-62.03	M8.87-19.78 F8.00-19.81 I7.41-17.45	M9.96-16.24 F9.46-24.89 I4.83-20.75	- - -	- - -	Kumari and Nair[26]
Saccostrea cucullata	142.20-55.12 244.49-58.33	111.83-22.90 213.66-29.33	19.05-20.79 26.05-11.36	112.16-26.22 212.79-18.97	14.38-5.43 24.76-5.65	Kumari and Nair[25]
Perna viridis	57.80-66.50	4.60-9.80	14.70-29.25	4.80-9.00	4.93-5.36	Fatima[14]

Abbreviations: M, Male; F, Female, I, Indeterminate; 1 and 2, stations.

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