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NUTRITIONAL QUALITY OF BIVALVES, *CRASSOSTREA MADRASENSIS* AND *PERNA VIRIDIS* IN THE KALI ESTUARY, KARNATAKA, INDIA

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Abstract

Quality aspects of oysters (*Crassostrea madrasensis)* and mussel *(Perna viridis)* in the Kali estuary, Karwar were examined in different seasons over a 13 month period. Ecophysiological parameters and nutritional quality parameters of oysters and mussel (composition of Protein, Carbohydrate, Lipid and Ash content) were determined at different seasons of the year. Seasonal variations were observed in the nutrient content, with particular regard to protein 52.33% (September 2003) to 63.86% (June 2004); Carbohydrate 14.01% (February 2004) to 25.24% (October 2003), Lipid 8.46% (October 2003) to 18.77% (February 2004) ash 4.21% (February 2004) to 14.82% (September 2004) in oysters whereas in mussels protein 57.39% (March 2004) to 66.51% (November 2003), Carbohydrate 14.69% (November 2003) to 26.81% (March 2004), Lipid 8.09% (Feb. 2004) to 12.62% (November 2003), ash 6.18% (November 2003) to 9.02% (March 2004). In spite of this variability, the nutritional quality of the oysters was generally good, especially just before gamete release (premonsoon) when the concentration of nutrients was at its maximum. A low level of fat was detected in the edible meat of oysters and mussels.

Keywords: *Crassostrea madrasensis*, *Perna viridis*, Kali estuary, Biochemical composition

Introduction

The oyster *Crassostrea madrasensis* and mussel *Perna viridis* are distributed at several places along the east and southwest coasts of India (Rao 1969, Alagarswami and Narasimham, 1973) and has good economic potential but so far resources survey of the shellfish populations and nutritional quality of shellfish has not been carried out in Kali Estuary. As Oysters and Mussels form good protein food, a comprehensive knowledge of their biochemical constituents during different seasons of the year would be valuable for large-scale exploitation from natural resources and to promote culture.

Cyclical changes in biochemical composition of animal tissue are mainly studied to assess the nutritive status of an organism. Seafood is an important contributor to the diets of many individuals because of their unique nutritional composition. The shellfishes are known to be high in protein, low in fat and low in calories. The green mussel, *P. viridis* enjoys a wide distribution along the west coast (Nair and Rao, 1985). Small patches of oyster beds of *Crassostrea madrasensis* are found distributed all over Kali estuary but mussel *Perna viridis* is restricted to a small patch near the bridge. The present investigation is carried out in order to provide a more complete nutritional picture of *Crassostrea madrasensis* and *Perna viridis.* The exploitation of bivalves has been observed to be only as a subsistence occupation, but the growing demand for protein food and multiple uses of the molluscan shell in lime-based chemical industries have created tremendous awareness of the benefits of exploiting and developing these resources.

Local people for food exploit these highly nutritious shellfish resources. And shells are transferred to small-scale industries for preparation of lime. The general features of the estuary, hydrological conditions, ecological associated fauna and flora, distribution and magnitude of standing stocks of oysters and mussels, and seasonal changes in meat of oyster and mussels have been studied and the results are presented here.

Material and Methods

The investigations were undertaken using the Oyster and Mussel samples (*Crassostrea madrasensis* and *Perna viridis*) for a period of 13 months (Sept. 2003 to Sept. 2004) at fortnightly interval. All collections were made at low tides. After collections the Oysters and Mussels were brought to the laboratory and thoroughly cleaned of the encrusting material, washed and kept in clean aerated seawater for at least 24 hours for depuration. These specimens were sorted into different size groups and used for morphometric measurements and biochemical studies. The size range from 55mm to 115mm was selected and the meat was separated and used for the biochemical analysis. Samples of at least twenty specimens were pooled together and the biochemical levels were determined. The soft tissues were further analysed for

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Wet Meat Weight, Dry Meat Weight, water content, Protein, Carbohydrate, Total lipids, ash content, calorific content and Condition index

General features of Kali estuary

The River Kali is northern most important estuarine system in Uttara Kannada district. The estuary has considerable impact on adjoining coastal waters and also influences the fishery, fish and shellfish seeds and molluscan resources. The estuary spreads approximately about 23 km in axis until the edge of the elevated plateau of Sahyadri (14^0 54' 25" N and 74^0 19' 30" E) and drains into the Karwar Bay (14^0 50' 21" N and 74^0 10' 05" E) on the central west coast of India. The tides are of semidiurnal nature and the time and range between two floods and two ebbs show marked variations. The water is free from pollution as there are no major industrial set-ups on the upstream.

In the present investigation four stations were selected. Station-1 is connected with the Kali estuary through a channel (Sunkeri Creek). But the creek water is cut off from the channel of estuary by serial gates constructed for fishing purpose. This restricts tidal flow during high tide where as low tide flow is almost complete and free. The bottom is mainly sand mixed with silt and clay. Second Station is located at the southern side river mouth (Kodibag), and is characterized by brackish water and the bottom composed of sand and silt, with small boulders spread all over which is an ideal habitat for oysters and mussels. Out of four sampled points, this is the only station where *Perna viridis* is found. Station-3 is located at northern side of the mouth (Sadshivgad). The bottom mainly composed of sand mixed with silt. The study area comprised of rocks having rough surface, which is suitable for settlement of oyster spat. Fourth Station (Savarpoi) is located 1 km away from Sadasivgad station. Sparse patches of mangroves were noticed towards bank in the intertidal region. On the old trunks, on small boulders and sandy floor large quantity of oysters and barnacles are seen growing. Lot of shell mining is carried out near the study area. On the western side of the study site there are plots of abandoned gazni lands.

Hydrology of the Estuary

Recorded data on the temperature, salinity, dissolved oxygen, pH, calcium content and suspended load of Kali estuarine water over the four stations of oyster beds in the period September 2003 to September 2004 are given in tables 1 and 2.

Table 1: Recorded data of temperature, salinity and dissolved oxygen at study stations

Month	Temperature (^{0}C)				Salinity (%)				Dissolved oxygen(ml/l)			
	Stations				Stations				Stations			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Sep-03	27.9	28.1	28.0	27.8	8.1	8.0	8.1	7.8	4.5	4.4	4.4	4.7
Oct-03	28.1	28.3	28.6	27.9	8.4	8.6	7.9	7.9	4.0	4.1	4.1	4.4
Nov-03	28.2	28.1	28.5	28.0	18.4	17.6	17.9	16.7	4.0	3.9	4.0	4.3
Dec-03	28.7	28.5	29.0	28.3	24.6	21.3	22.2	21.5	4.2	4.2	4.1	4.2
Jan-04	29.4	29.4	29.8	29.0	31.9	32.1	31.0	32.1	4.8	4.7	4.8	4.4
Feb-04	29.0	29.1	29.3	29.2	32.2	32.1	32.2	32.3	4.7	4.6	4.5	4.6
Mar-04	29.7	29.8	30.0	29.3	30.7	30.6	30.0	29.5	4.6	4.6	4.5	4.8
Apr-04	31.0	30.3	30.4	30.1	31.8	32.6	31.8	30.9	4.8	4.7	4.6	5.1
May-04	30.5	30.1	30.0	30.0	32.5	32.7	31.9	31.1	4.3	4.4	4.7	4.7
Jun-04	30.6	30.0	30.2	30.2	28.4	28.2	28.1	28.3	4.2	4.2	4.4	4.8
Jul-04	28.1	28.2	27.9	27.5	2.8	2.4	2.6	2.5	4.0	4.1	4.3	4.5
Aug-04	26.9	27.1	27.3	27.2	2.4	2.2	2.2	2.6	3.9	3.9	4.2	4.6
Sep-04	27.0	27.1	27.2	27.1	2.7	2.9	2.7	2.2	3.9	3.9	4.0	4.5

Table 2: Recorded data of pH, Calcium and Suspended Load at study stations

Months	pH				Calcium (mg/ltr)				Suspended Load (mg/ltr)			
	St -1	St -2	St -3	St -4	St -1	St -2	St -3	St -4	St -1	St -2	St -3	St -4
Sep-03	8.52	8.19	8.03	8.16	145.6	180.2	195.0	183.6	0.285	0.204	0.288	0.308
Oct-03	8.43	8.51	8.21	8.31	138.0	185.7	188.9	178.0	0.130	0.214	0.180	0.251
Nov-03	8.38	8.02	8.05	8.18	145.6	155.6	161.0	152.3	0.253	0.158	0.165	0.281
Dec-03	8.15	8.34	8.43	8.15	185.0	168.2	173.0	179.6	0.310	0.446	0.496	0.456
Jan-04	8.08	8.04	8.18	8.28	160.2	160.5	166.3	161.5	0.413	0.486	0.501	0.474
Feb-04	7.31	8.15	8.03	8.20	152.2	172.4	185.0	167.2	0.434	0.453	0.439	0.385
Mar-04	6.91	8.01	8.51	8.41	160.5	170.2	203.6	200.8	0.384	0.418	0.406	0.448
Apr-04	6.85	8.09	8.61	8.50	172.0	185.0	187.3	170.5	0.331	0.318	0.348	0.310
May-04	7.02	8.53	8.20	8.28	206.2	216.3	220.4	201.6	0.386	0.421	0.484	0.391
Jun-04	7.31	7.39	7.30	7.98	261.5	270.1	281.2	260.2	0.218	0.246	0.251	0.223
Jul-04	7.56	7.04	7.01	7.89	270.5	292.3	295.6	286.8	0.316	0.328	0.339	0.355
Aug-04	7.05	7.59	7.59	8.50	203.8	309.2	305.6	290.5	0.201	0.231	0.212	0.211
Sep-04	8.12	7.81	7.81	8.20	180.2	234.2	232.6	235.2	0.082	0.096	0.154	0.217

St: Stations

It may be seen from the table 1 that temperature of the estuary varied from a minimum of 27.0^{0}C to maximum of 31.0^{0}C. In monsoon and winter temperature was low, being 27.9^{0}C and 26.9^{0}C and during summer temperature was high. Salinity varied from 2.2‰ to 32.7‰. In all four stations salinity was steadily increasing from the month of November. Salinity was very high throughout the summer and sharply declines by onset of monsoon *i.e.,* from the month of June. The dissolved oxygen concentration showed a range of 3.9ml/ltr to 4.8ml/. High content of dissolved oxygen 4.2 to 4.8ml/ltr was noticed in all four stations during winter and summer. Clearly marked differences in the dissolved oxygen concentrations between the four stations of the estuary were, however not discernible.

Hydrogen ion concentration (pH), Calcium and Suspended load is shown in Table 2. Range of pH varied between 6.91 and 8.53; pH was always slightly high through out summer but during monsoon it declined. In station I, during pre monsoon pH deceased due to deposition of humus in the mangrove creek. Station II, Station III and station IV pH was little high. It could be because of dead oyster shells. Kali estuary being one of the well known fishing grounds for bivalves, always bestowed with huge quantities of molluscan shells, mainly clam shells and these keep the high calcium content of the estuary throughout the year. The highest dissolved calcium value recorded was (309.2mg/L) and the lowest value recorded was (145.6mg/L).

The importance of the study of particulate organic matter lies in the fact that most of the bivalves are directly feeding on the suspended materials in the water medium. The range of suspended matter varied between 0.0821 mg/L and 0.5013 mg/L. Suspended matter values show increasing trend from post monsoon.

Seasonal variation of meat of Oyster and Mussels

Proteins

Protein is the major biochemical constituent of oyster meat forming 52.33% to 63.86% and mussel meat 57.39% to 66.51%. The average protein content of oyster varies between 59.08%(St.1) to 59.60%(St.2) where as in mussel it was 62.23%. In case of oysters it was noticed that as temperature increases protein content also increases. During monsoon season gradual fall in protein content can be seen. While in case of mussel two peaks can be seen during post monsoon (66.51%) and pre monsoon (63.54%).

Carbohydrates

The second major biochemical content is carbohydrate in both species. Carbohydrate exhibited large fluctuations in all months of the year. It was varied from 14.01% to 25.24% in oyster whereas in mussel it was varied from 14.69% to 26.81%. The

average carbohydrate content of oyster varies from 17.75% to 19.11%. In mussel average carbohydrate content was 21.31%

Lipids

The lipid content showed a range of 8.46% to 18.77% in oyster and it was 8.09% to 12.62% in mussel. The average lipid content of oyster varies between 12.32% and 14.07% where as in mussel it was 6.99%. Like carbohydrate content lipids also exhibited large fluctuations in all months of the year. Lipid content in oysters was very high in December to May But in monsoon months as temperature and salinity decreases sharply lipids also decreases sharply. In case of mussel lipids shows inverse relation with carbohydrates. As, lipid increases carbohydrate decreases.

Ash

The ash content showed a range of 4.21% to 14.82% in oyster and it was 6.18% to 9.02% in mussel. The average lipid content of oyster varies between 8.58% and 9.36% where as in mussel it was 9.48%. Ash content in oysters was very high in monsoon whereas in summer months it was low. In both the species Ash content shows inverse relation with protein content.

Biochemical composition in the whole body of C. madrasensis and P. *viridis* at Station 1 to Station 4 are summarized in Table 3 and 4.

Table 3: Biochemical composition in the whole body of *C. madrasensis* at Station 1 to Station 4

Months	Proteins				Carbohydrates				Lipids				Ash			
	St -1	St -2	St -3	St -4	St -1	St -2	St -3	St -4	St -1	St -2	St -3	St -4	St -1	St -2	St -3	St -4
Sep-03	52.33	56.13	58.72	57.77	23.18	21.03	19.03	19.03	12.60	10.48	11.31	10.31	11.89	12.36	10.94	12.89
Oct-03	52.80	57.38	55.68	52.80	25.24	22.01	22.98	25.18	11.30	10.13	9.30	8.46	10.66	10.48	12.04	13.56
Nov-03	58.98	60.83	61.10	60.98	18.99	16.99	17.23	18.99	12.82	14.77	12.32	11.01	9.21	7.41	9.35	9.02
Dec-03	58.60	61.39	60.18	59.74	17.18	14.76	16.46	20.76	16.65	16.05	15.42	11.40	7.57	7.80	7.94	8.10
Jan-04	60.19	60.48	61.21	60.14	15.40	15.08	14.91	18.08	18.03	17.13	17.20	13.23	6.38	7.31	6.68	8.55
Feb-04	63.01	61.61	62.42	62.60	14.01	17.00	14.66	16.66	18.77	15.29	17.94	13.80	4.21	6.10	4.98	6.94
Mar-04	60.19	60.28	59.15	57.89	17.74	18.21	19.03	21.27	16.35	15.06	14.41	12.39	5.72	6.45	7.41	8.45
Apr-04	62.12	60.72	60.17	59.02	16.57	19.01	19.08	20.66	15.08	15.16	15.07	13.12	6.23	5.11	5.68	7.20
May-04	61.58	62.92	62.00	60.66	17.31	15.18	15.28	17.19	15.10	17.01	17.88	16.09	6.01	4.89	4.84	6.06
Jun-04	63.86	61.13	60.43	63.10	15.46	15.99	17.00	15.06	13.39	16.19	16.31	16.35	7.29	6.69	6.26	5.49
Jul-04	62.10	57.97	58.08	59.28	15.48	18.09	19.44	18.41	13.00	13.25	12.83	12.70	9.42	10.69	9.65	9.61
Aug-04	57.24	56.08	55.81	56.77	20.51	19.03	20.10	19.45	9.83	10.90	10.33	9.79	12.42	13.99	13.76	13.99
Sep-04	54.98	57.85	57.14	58.90	21.21	18.37	19.63	17.72	8.99	11.52	10.74	11.52	14.82	12.26	12.49	11.86
Mean	59.08	59.60	59.39	59.20	18.33	17.75	18.06	19.11	13.99	14.07	13.93	12.32	8.60	8.58	8.62	9.36

St: Stations

Table 4: Biochemical composition in the whole body of *P. viridis*

Month	Protein percentage	Carbohydrate percentage	Lipid percentage	Ash percentage
Sep-03	63.97	20.22	8.49	7.32
Oct-03	66.30	16.09	10.18	7.43
Nov-03	66.51	14.69	12.62	6.18
Dec-03	62.80	19.75	10.87	6.58
Jan-04	62.23	20.13	10.25	7.39
Feb-04	59.70	24.08	8.09	8.13
Mar-04	57.39	26.81	6.78	9.02
Apr-04	60.02	23.89	9.23	6.86
May-04	63.54	24.05	9.26	6.32
Jun-04	61.43	24.34	8.05	6.18
Jul-04	62.21	21.83	9.63	6.33
Aug-04	60.37	19.30	10.67	6.49
Sep-04	62.53	21.79	9.06	6.62
Mean	62.23	21.31	9.48	6.99

Discussion

The hydrological parameters play very important role in the life of aquatic organisms. The estuarine representatives are subjected to both diurnal and seasonal changes in these parameters. The impact of this will be more on resident species particularly oysters, clams and mussels etc. (Ansell, A.D. 1974a.). Location specific variations in growth and survival of bivalves have been demonstrated for *Mytilus edulis* (Incze *et al*., 1980), *Mya arnaria* (Appeldoorn, 1983), *Crassostrea virginica* (Mallet and Haley, 1983), *C. gigas* (Brown and Hartwick, 1988a) and *Ostrea edulis* (Utting, 1988). In the present investigation an effort is made to correlate the impact of temperature, salinity, pH, dissolved oxygen, calcium to the growth of meat quality, water content, protein, carbohydrate, fat, ash content, calorific value and condition index. In the present investigation it is found that the seasonal changes have greater influence on meat quality and weight.

The average meat weight of *Crassostrea madrasensis* shows slightly increasing trend from end of winter. Meat weight was generally high during summer. The average percentage edibility which is an index of meat shows similar trend and higher throughout summer. But in case of *Perna viridis,* average meat weight and percentage edibility shows increasing trend twice in year.

Nutritional quality of meat in both species was very high, during summer season. Protein was the major organic constituent found in *Crassostrea madrasensis* as well as *Perna viridis.* Carbohydrate was the second major organic component found. The present studies indicate inverse relation between water and protein content.

In the present investigation, *Crassostrea madrasensis* and *Perna viridis* of Kali estuary shows very high calorific values throughout year.

It has been observed that, condition index of *Perna viridis* was very high compare to *Crassostrea madrasensis*. In *C. Madrasensis* condition index increases gradually from post monsoon. Whereas, in *P. viridis* two peak seasons were noticed during study period.

The above-mentioned two species have good demand as food and consumed in different parts of the country. If systematically cultured, there is a possibility of extending the produce to the foreign market also. The present investigation identifies suitable hydrological condition for better meat yield. Under controlled condition if oysters and mussels are cultured, this activity can generate employment as well as revenue.

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