Condition Index and Percentage Edibility of *Crassostrea madrasensis* (Preston) inhabiting the Cochin Harbour

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Monthly variations in condition index and percentage edibility of the population of oysters, namely, *Crassostrea madrasensis* (Preston) is reported for males, females and indeterminates for the period October 1981 to September 1982. Condition index and percentage edibility showed more or less similar trend for the total population and also for males, females and indeterminates. The condition index and percentage edibility were maximum during October 1981 which declined progressively and reached the lowest in February--March, 1982. From April it showed steady increase and reached the maximum again in October 1982 and this coincided with the gonadal cycle in oysters.

Depending on physiological conditions, fluctuations in environmental factors and seasons, oysters show considerable variation in the quality of their meat. The quality of fatness or the physiological condition of oysters is determined by several methods. Oysters of good quality have been observed to contain large amounts of meat in relation to their total volume (Galtsoff, 1964). Dry weights, glycogen contents and total chemical analysis were employed by Coulson (1933), Humphrey (1941), Galtsoff *et al.* (1947) Jacobs (1951) and Frieger *et al.* (1958) to determine the condition in oysters. These methods are time consuming and are not suitable when large number of oystrs are to be examined. Condition index and percentage edibility determinations are objective methods employed by various workers for determining the quality when they had to deal with large number of oysters.

Some of the notable works on the nutritive value and quality of meat of oysters are those of Coulson (1933) from the North American coast, the biochemistry and the proximate constituents of oysters inhabiting Australian waters by Humphrey (1941), the influence of temperature and salinity on the condition of oysters by MedCof & Needler (1941), the ecological and physiological studies on the effect of sulphate pulp mill wastes on oysters in York River, Virginia by Galtsoff *et al.* (1947), chemical analysis of oysters by Jacobs (1951), estimation of quality in mussels and oysters (Korringa, 1955), the seasonal variation of meat and glycogen content of seven populations of oysters by Walne (1970) and changes in the condition index and biochemical content of oysters under hatchery conditions by Gabbot & Walker (1971). These workers have employed either dry meat weight or shell cavity volume or the general biochemical composition to study the condition in bivalves.

Assessment of quality by objective methods such as estimation of condition index and percentage edibility have been employed by Odlaug (1946), Ingle (1949), Venkataraman &

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Chari (1951), Korringa (1955), Rao (1956), Baird (1958, 1966), Durve (1964), Durve & George (1973), Shafee (1976) and others.

The condition index in *C. virginica* has been studied by Medcof & Needler (1941) employing the relation between dry meat weight and shell cavity volume. However, Odlaug (1946) used meat volume-shell cavity volume relationships in *O. lurida*. The glycogen content in *C. virginica* could be used to determine the index of condition according to Galtsoff *et al.* (1947). However, Ingle (1949) attempted to correlate the values obtained from dry meat weights and glycogen contents in *C. virginica* and found that estimation of glycogen content as the most suitable method in determining condition index in oysters. Korringa (1955) employed the ratio of dry meat weight to shell contents as the index of condition. Baird (1958) has used a simple and quick method to evaluate the condition index. He suggested that the index of condition is the percentage of shell cavity occupied by the wet meat and is given by the ratio,

$$\frac{\text{Meat volume} \times 100}{\text{shell cavity volume}}$$

Rao (1956) employed a relationship between meat weight and whole weight (Total weight) to determine the condition of *Crassostrea madrasensis* from Ennur, near Madras. He attributed the changes in the condition of oysters to gonadal and spawning activities. Durve (1964) used condition index and percentage edibility in *C. gryphoides* from the Kelwa Backwaters to determine their quality. He employed Bairds index of condition mentioned earlier (Baird, 1958). The percentage edibility was obtained by the ratio,

$$\frac{\text{Meat weight} \times 100}{\text{whole weight}}$$

He also ascribed fluctuation in condition index and percentage edibility to seasonal gonadal cycle of the oyster.

Studies on condition index in bivalve molluscs are also aimed to determine the physiological and ecological requirements in these animals. Dame (1971) studied the ecological energies of growth, respiration and assimilation in the American inter-tidal oyster *C. virginica*. The present study is aimed at collecting information on the condition index and percentage edibility with a view to assessing the quality of meat in *C. madrasensis* inhabiting the Cochin Backwaters.

Materials and Methods

For determining the index of condition and percentage edibility, monthly samples of oysters were collected from the feral population of oysters inhabiting the Cochin Backwaters. The oysters were washed in water with the help of a brush to remove the silt adhering to the shell. The fouling organisms found on the shell were scrapped off. Individual oysters were weighed separately in an Owa Labor, German single pan electrical balance correct to 0.1 g, determined the total volume and then shucked. The meat weight, shell weight, meat volume, and shell volume were also determined. Baird's (1958) method was followed to determine the index of condition, namely,

$$\frac{\text{meat volume (ml)} \times 100}{\text{shell cavity volume (ml)}}$$

An apparatus with a graduated side tube was used to determine the total volume, shell volume and meat volume (Displacement method). The sex of individual oysters was determined by examining a gonadal smear under the microscope. Percentage edibility was computed using the equation,

$$\frac{\text{Meat weight (g)} \times 100}{\text{whole weight (g)}}$$

Results and Discussion

Monthly variations in the index of condition values for the total population and sexwise for males, females and indeterminates from October 1981 to September 1982 are presented in Table 1. As seen from Table 1, the condition index attained peak values in October 1981 (49.31) for the total population. Considerable fall in the index was noticed in the subsequent months reaching the lowest in February and March 1982. From February onwards there was steady increase in the index of condition reaching the maximum again in August and September 1982. The same trend was exhibited by males, females and indeterminates when examined separately. After reaching the peak in August–October months, the average values of the index of condition declined and reached the minimum in February–March.

Table 1. *Index of condition. Monthly variation from October* 1981 *to September* 1982

Month	No. of oysters examined	Male	Female	Indeterminates	Sexes pooled
October 1981	56	48.95	49.68	0	49.31
November	113	24.70	22.51	0	23.50
December	204	32.56	33.82	0	33.39
January 1982	140	23.24	22.80	0	22.98
February	61	9.50	9.43	0	9.46
March	126	9.20	9.93	18.68	21.07
April	86	20.22	22.51	22.67	24.06
May	80	23.72	27.07	24.67	37.90
June	35	47.63	30.63	34.67	37.90
July	50	32.74	37.20	25.29	36.40
August	45	39.58	44.80	37.52	41.15
September	50	40.20	40.30	40.00	40.16

Table 2. *Percentage edibility. Monthly variation from October* 1981 *to September* 1982

Month	No. of oysters examined	Male	Female	Indeterminates	Sexes pooled
October 1981	56	10.41	9.66	0	10.03
November	113	6.62	6.21	0	6.42
December	204	6.50	6.51	0	6.55
January 1982	140	5.67	5.42	0	5.52
February	61	5.54	5.52	0	5.52
March	126	5.34	5.64	0	5.51
April	86	4.83	5.32	4.55	5.02
May	80	5.91	6.23	5.45	5.95
June	35	7.44	6.94	8.19	8.00
July	50	8.22	8.37	7.86	8.29
August	45	7.98	7.32	7.31	7.51
September	50	6.96	7.81	6.68	7.05

The indeterminates appeared in the population in March/April and persisted till September (Tables 1 and 2). The highest values in condition index for indeterminates were also noticed in August–September 1982 (40)

Table 3 represents the percentage distribution of oysters in various class intervals of condition indices. Fig. 1 shows the trend in the shifting of monthly modes of condition indices. The modes of class group 46–50 (modal index 47.5) in October 1981 declined to lower values in November (class group 21–25 with modal index 22.5). December witnessed a slight increase and the modal index was observed to be 27.5. Excepting this increase in December, the decline of the modal values started in October 1981 continued till it reached the lowest value of 7.5 in February and March, 1982. During April and May it rose and remained at 17.5. The modes of class groups 16–20 (32.5) in June shifted to higher values steadily, reaching 37.5 in July (class group 36–40), 42.5 in August (class group 41.55) and 47.5 in September, (class group 46–50) 1982 (Fig. 1).

Table 3. *Index of condition: Percentage frequency distribution of the average values (K) noticed during October* 1981 *to September* 1982

Frequency	Oct. 81	Nov.	Dec.	Jan. 82	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
0–5	—	—	—	—	9.84	8.73	—	—	—	—	—	—
6–10	—	5.31	4.9	7.86	68.85	57.14	3.49	3.75	—	—	—	—
11–15	—	24.80	7.35	12.14	16.39	27.78	17.44	2.50	2.86	—	—	—
16–20	5.36	23.00	13.24	32.85	3.28	5.56	38.37	35.00	2.86	4.0	4.4	—
21–25	12.30	23.89	9.31	16.42	—	0.79	19.76	25.00	8.57	14.0	15.56	2.0
26–30	5.36	6.19	16.18	15.71	1.64	—	12.79	17.50	11.43	16.0	17.78	30.0
31–25	12.20	1.77	13.24	3.57	—	—	4.65	5.00	31.43	16.0	13.33	24.0
36–40	7.14	1.77	14.22	5.71	—	—	3.48	5.00	14.29	28.0	8.79	6.0
41–45	7.14	0.88	6.37	0.71	—	—	—	—	8.58	8.0	17.78	4.0
46–50	12.50	5.31	8.82	3.57	—	—	—	2.50	14.29	8.0	6.67	34.0
51–55	3.57	—	2.94	1.43	—	—	—	1.25	2.86	—	4.44	—
56–60	8.93	2.65	1.96	—	—	—	—	1.25	2.86	6.0	2.22	—
61–65	3.57	0.88	—	—	—	—	—	—	—	—	—	—
66–70	3.57	0.88	0.98	—		—	—	—	—	—	—	—
71–75	3.57	—	0.49	—	—	—	—	—	—	—	—	—
76–80	3.57	1.77	—	—	—	—	—	—	—	—	2.22	—
81–85	—	—	—	—	—	—	—	—	—	—	—	—
86–90	3.57	0.88	—	—	—	—	—	—	—	—	2.22	—
91–95	—	—	—	—	—	—	—	—	—	—	2.20	—
96–100	7.14	—	1.96	—	—	—	—	1.25	—	—	2.20	—

The monthly variations in the average values of percentage edibility for the total population as well as for males, females and indeterminates are presented in Table 2. Table 4 gives the percentage frequency distribution of average values of percentage edibility. As in the case of condition index, the percentage edibility also followed the same trend. The mean value for the whole population was the highest being 10.03 in October, 1981 which declined gradually reaching 5.02 in April 1982. From April onwards it started increasing and reached 8.29 in July. However, there was a slight fall in the values during August and September 1982. Sex-wise also, percentage edibility followed the same trend (Table 2). Fig. 2 shows the trends in the shifting of monthly modes of percentage edibility for the same period. During October 1981, the modal value of percentage edibility (Fig. 2) was 10.5 (10.1–11 class group). This declined to 5.5 (5.1–6 class group) in November and December, 1981. In January 1982, it further declined to 3.5 (3.1–4 class group) and shifted to 5.5 (5.1–6 class group) during February and March, 1982. In April the mode was at 4.5 (4.1–5 class group). During May and June, the modal values shifted to 6.5 (6.1–7 class group). In July there was further shifting and reached 8.5 (8.1–9 class group) and in August 10.5 (10.1–11 class group). There was again a decline to 6.5 in September. The highest values of percentage edibility were observed in October, 1981 (10.5) and August, 1982 and the minimum in January and April 1982.

The results clearly indicate that the quality of the meat of *C. madrasensis* shows a definite seasonal variation. The index of condition showed a delining trend from November, 1981 to March, 1982 (excepting December). The following months, namely, April to September witnessed a rapid increase in the values of condition index (Table 1) for the total population and the same trend was observed for males and females when considered separately. After reaching the maximum value in October, it further declined, and thus presented a definite seasonal cycle. This seasonal cycle in condition index

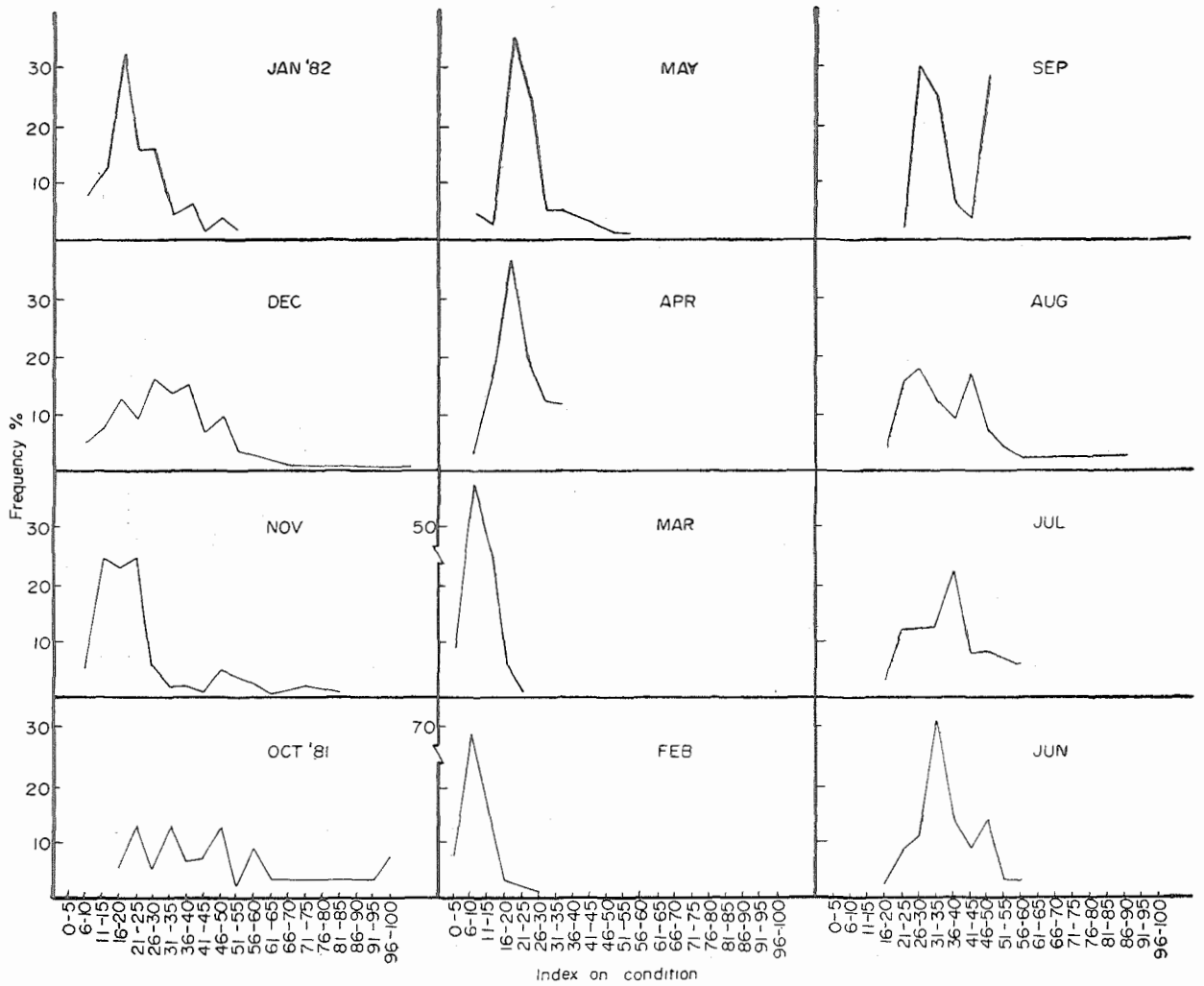

Fig. 1. The monthly variations in the frequency distribution of *C. madrasensis* in different classes of index of condition from October 1981–September 1982.

Table 4. *Percentage edibility: Percentage frequency distribution of the average values during October* 1981 *to* September 1982

Frequency	Oct. 81	Nov.	Dec.	Jan. 82	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
0–1	—	—	—	—	—	—	—	—	—	—	—	—
1.1–2	—	—	—	—	—	0.79	2.33	—	—	—	—	—
2.1–3	—	1.77	1.96	7.86	—	5.56	11.62	1.25	—	—	—	—
3.1–4	—	6.19	6.86	20.00	16.40	11.90	16.28	8.75	2.86	2.0	6.12	8.0
4.1–6	8.93	11.50	11.27	19.29	18.03	23.02	26.74	22.50	5.71	4.0	10.2	6.0
5.1–6	1.79	23.00	25.00	17.85	37.70	26.19	16.27	22.05	11.43	14.0	10.2	20.0
6.1–7	7.14	24.78	19.11	17.14	16.40	12.69	11.63	23.75	22.86	14.0	14.29	24.0
7.1–8	14.20	15.04	18.63	6.43	6.56	10.32	10.47	11.25	17.14	10.0	16.33	6.0
8.1–9	16.07	7.96	9.80	8.57	1.64	4.76	3.49	5.0	8.57	20.0	14.29	18.1
9.1–10	19.64	7.08	3.43	2.14	—	2.38	1.16	3.75	11.42	16.0	12.25	10.0
10.1–11	19.64	1.77	2.94	0.71	—	2.38	—	1.25	11.42	10.0	16.67	4.0
11.1–12	7.14	0.88	0.98	—	1.64	—	—	—	2.86	4.0	—	4.0
12.1–13	—	—	—	—	1.64	—	—	—	2.86	4.0	—	—
13.1–14	—	—	—	—	—	—	—	—	—	2.0	—	—
14.1–15	—	—	—	—	—	—	—	—	—	—	—	—
15.1–16	—	—	—	—	—	—	—	—	2.86	—	—	—

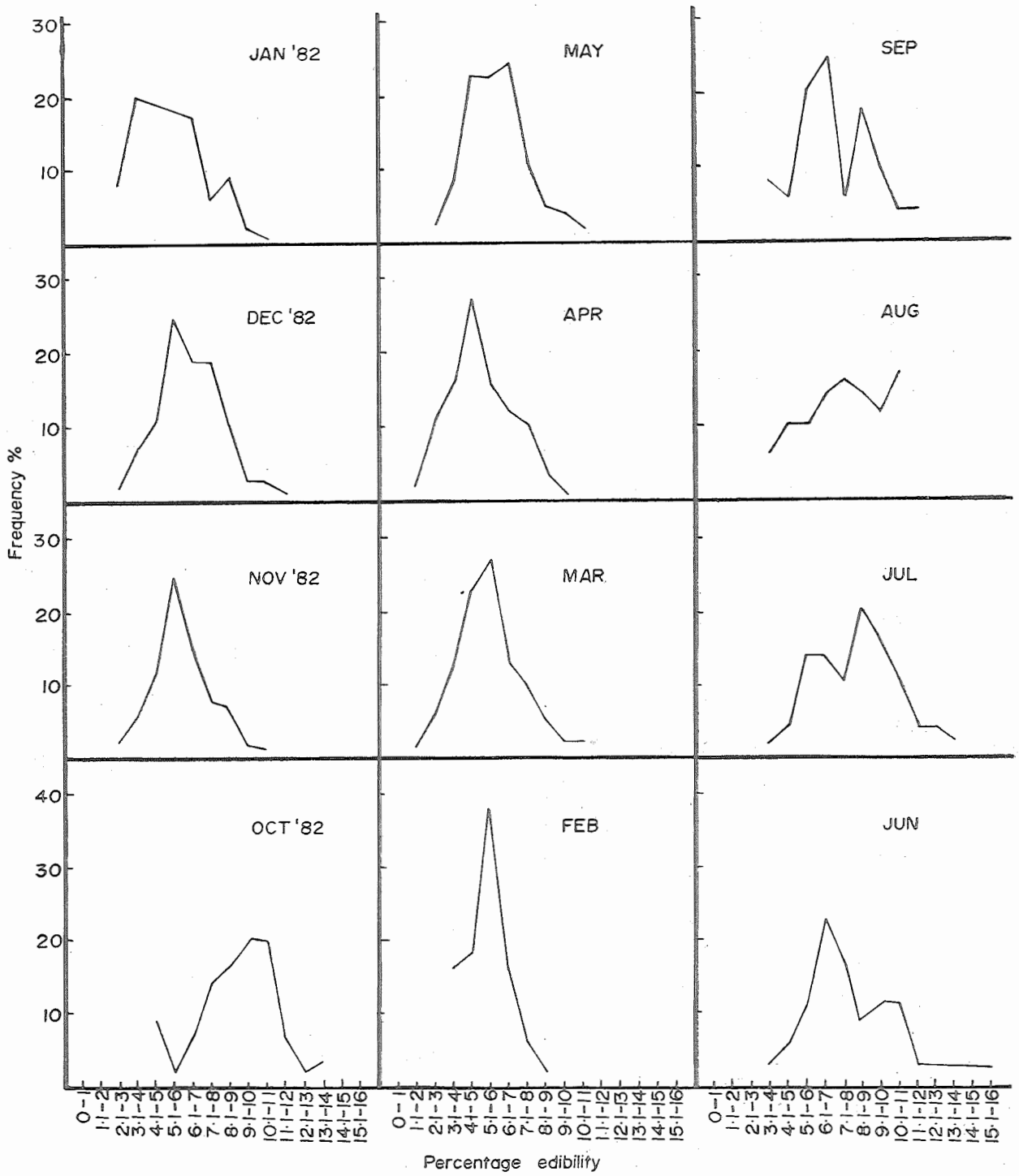

Fig. 2. The monthly variations in the frequency distribution of *C. madrasensis* in different classes of percentage edibility from October, 1981 to September, 1982.

closely followed the sexual cycle in oysters. Soon after the monsoons, oysters started spawning from October onwards and fully spent forms were observed during March–April. They built up the gonads from April onwards and during this period sexually indeterminate forms appeared in the population (Table 1 and 2). Oysters accumulated large quantities of carbohydrates during this period and became bulky and this condition extended from April to October. This accounted for the progressive increase

in condition index values from April onwards attaining the maximum during October. Thus the oysters were in the best condition from April to October in the Cochin Backwaters.

Durve (1964) observed close correlation between the gonadal cycle and condition index in *C. gryphoides*. The oysters were fatty and cream coloured from late October to November or June when they were not spawning and were in the best condition for human consumption according to him. Coulson (1933) observed fluctuation in condition indices correlated with the sexual cycle in the American oyster *(C. virginica)*. The quality of the meat of oysters and mussels show variation according to Korringa (1955). In the English oyster, *Ostrea edulis,* Gabot & Walker (1971) also observed variation in the condition indices. In the Pacific oyster *C. gigas,* Askew (1972) reported a fall in condition index values as a result of spawning.

Fluctuation in percentage edibility was also found to be similar to the variation in condition indices and thus followed a distinct seasonal cycle correlated to the sexual cycle in oysters. Similar to condition index values, the maximum percentage edibility (10.03) was observed in October, 1981 and the minimum from January to April, 1982. From April, 1982 onwards it showed a steady increase. Venkataraman & Chari (1951) recorded the highest value of 17.36 for percentage edibility in October and the lowest in July (5.03). In *Crassostrea madrasensis,* Rao (1956) observed higher values during August–November and lower values in February, July and August. Compared to the Ennur oysters reported by Rao (1956), the Cochin oysters had similar percentage edibility, as the mean values ranged from 5.02 to 10.03 in the present study. (Table 2). Very high values for percentage edibility (17.36) are reported by Venkataraman & Chari (1951), 16.6 in *C. gigas* by Fujiya (1970) 22 and 20.9 in the United Kingdom and Israel respectively by Hughes Games (1977). The highest values of percentage edibility coincided with the inactive phase of the oyster in this study similar to that observed by Durve (1964) in *C. gryphoides*.

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