ON THE MICROALGAL SPECIES AS FEED FOR CONDITIONING ADULT OYSTER *CRASSOSTREA MADRASENSIS* (PRESTON)

ABSTRACT

The rate of removal of different microalgal cells in suspension at specific time interval in respect of six species differing in sizes such as *Tetraselmis* sp., *Cheatoceros* sp., *Chlorella* sp., *Dicrateria* sp., *Isochrysis* sp., *Chromulina* sp., by *Crassostrea madrasensis* has been studied. The study revealed that oysters exhibit a significant degree of selectivity in the rate of filtration of certain algae. Further it is recorded that the filtration rate is not uniform throughout the experimental period of 24 hours. Oysters showed periods of high filtering activity and periods of relative quiescence. This study helps in developing proper feeding protocol for oyster broods based on the species of algae, quantification of cells and timings.

MICROALGAL feeds are widely used for conditioning the broodstock of oysters and clams in the hatchery (Dupey *et al.*, 1977; Nayar *et al.*, 1987; Castagna *et al.*, 1981). Though there have been several studies on filtration and pumping rate of oysters by several authors (Loosanoff and Nomejko, 1946, Mattiessan and Toner, 1966; Pruder *et al.*, 1976; Galtsoff, 1964) the daily requirement of algal species for adult oysters has received only little attention (Epifanio and Ewart, 1977; Gerdes, 1983). Mattiessen and Toner (1966) calculated that an oyster could filter 1.1×10^9 of microalgal cells per day. Pruder *et al.*, have stated that an oyster weighing 50 g wholeweight cleared a maximum of 1.05×10^8 cells per g of wholeweight per day which would support both growth and conditioning of oysters. Epifanio (1977) and Gerdes (1983) have tried a few species of microalgae known to be good food for adult oysters to study the filtration rate and rate of removal in different concentration of algal cells, which differ markedly in size. Epifanio and Ewart (1997) have proposed a discontinuous feeding regime based on the results and formulated an equation for the maximum daily ration of oysters in respect to various sizes.

In the present study, the rate of removal of microalgal cells in suspension by the oyster *Crassostrea madrasensis* at given time intervals in respect of six species of microalgae which are available in the CMFRI Molluscan hatchery at Tuticorin has been investigated.

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Six species of microalgae namely *Tetraselmis qracilis* (12 μ), *Cheatoceros calcitrans* (9 μ), *Chromulina freibergensis* (8 μ), *Isochrysis galbana* (7 μ), *Dicrateria inornata* (7 μ) and *Chlorella salina* (3 μ) were selected for study. Initial concentration of the algal cells in suspension ranged from 0.06 to 1.8 million cells per ml. The cell count was made by hameocytometer. The cultures were poured into 10 1 of glass trough and made up to 7 1 with filtered sea water. Two oysters of same size group (100-110 mm) weighing nearly 150 gms were placed in each glass trough. The oysters were starved for 24 hours before the start of the experiment. The troughs were covered by a black cotton cloth to prevent passage of light and arrest multiplication of algae. Aeration was provided and temperature maintained at 25 ± 1° C. The pH was maintained at 8.2 and salinity at 31 ± ppt. At hourly intervals aliquot samples were drawn from each trough and microalgal counts made.

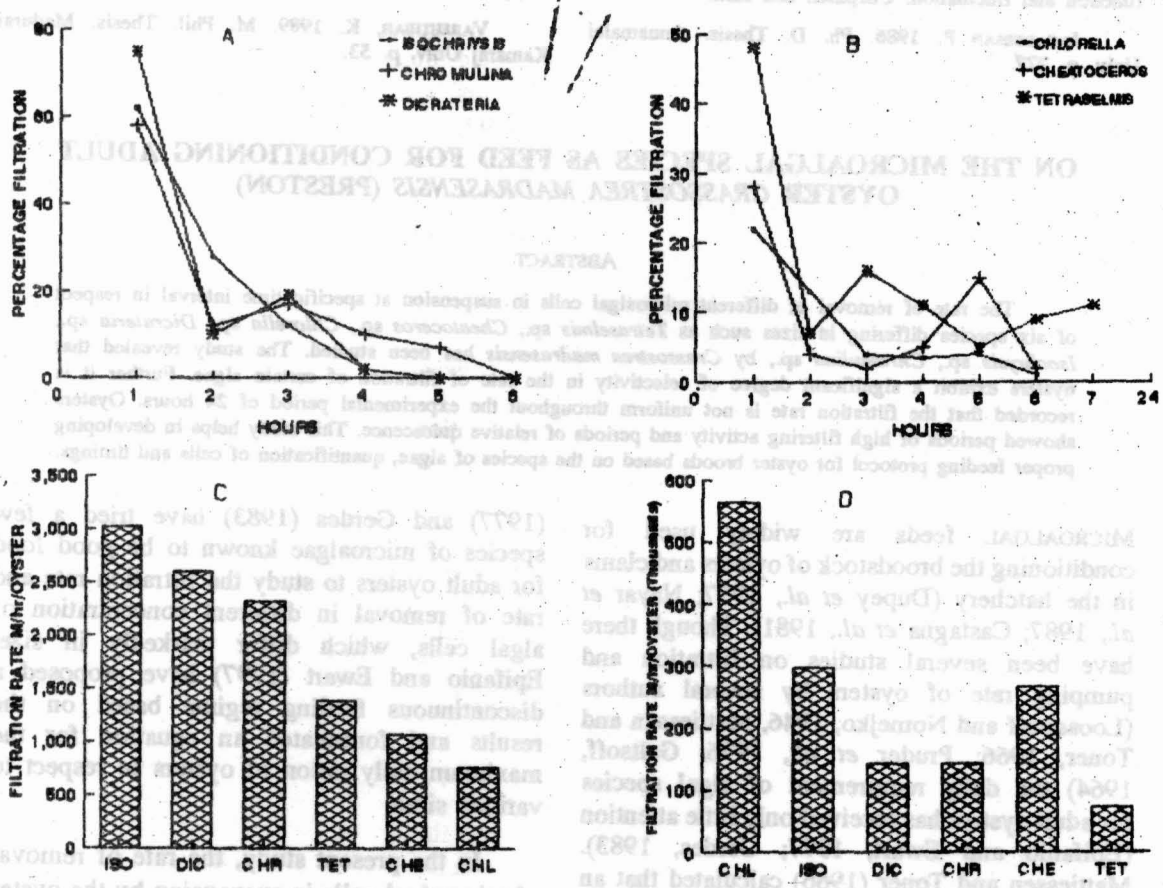

FIG. 1. A-B. Percentage of hourly filtration of cells., C. Filtration rate of different microalgal species in suspension and, D. Total number of cells removed/hr/oyster in respect to different algal species.

The filtration rate F, expressed in ml/hr/oyster was calculated using the formula F=R/C where R is the mean number of cells

removed from suspension per hour per oyster and C is the number of cells per ml in suspension (Epifanio and Ewart, 1977). The total number of cells removed per hour per oyster was calculated using the formula :

$$F = \frac{\ln C_1 - F_i C_2}{T} \times V$$

Where in C_1 is the initial concentration in the suspension and T is the time and V is the volume of the sea water in the container (Gerdes, 1983).

The results on the percentage of cells in suspension at hourly intervals in respect of the six algal species tested are given in Fig. 1 A-B. The total time for the partial or complete removal of cells was found to exceed 12 hours in the experiments with *Tetraselmis* sp., *Cheatoceros* sp., and *Chlorella* and the complete removal of cells occurred within 4 to 6 hours in the experiment with *Dicrateria, Isochrysis* and *Chromulina.* Only 44.7% of *Chlorella* and 60.5% of *Cheatoceros* were removed at the end of 6 hr. At the end of 12 hours they were found in decomposed state at the bottom of the tank. During the first hour of experiment the rate of removal was high for *Dicrateria, Isochrysis* and *Chromulina* showing 74.5%, 60.1% and 58% of removal respectively. Subsequently the removal of cells was continuous but there were periods of high filtration and periods of relative quiescence.

The filtration rate of oysters (Fig. 1C) were 3019, 2601, 2314, 1384, 1068 and 754 ml/hr/oyster respectively with *Isochrysis, Dicrateria, Chromulina, Tetraselmis, Cheatoceros* and *Chlorella.* The volume of the water filtered by oysters in these experiments also varied with the algal species. *Isochrysis* gave better result than *Dicrateria* and *Chromulina* which are almost similar in size.

The total number of cells removed per hour per oyster from suspension were 5,64,666 $\times 10^3$, 2,97,500 $\times 10^3$, 1,43,500 $\times 10^3$, 1,42,800 $\times 10^3$, 2,66,000 $\times 10^3$ and 73,228 $\times 10^3$ in the case of *Chlorella, Isochrysis, Dicrateria, Chromulina, Cheatoceros* and *Tetraselmis* respectively (Fig. 1D) Larger the size of cells, lesser their numbers were removed. For example *Tetraselmis* and *Chlorella* having 3 μ size showed the highest removal of cells per hour per oyster. Among *Isochrysis, Dicrateria* and *Chromulina,* the first one showed comparitively better result than the other two.

The results obtained in the hourly removal of cells are comparable to those obtained by Epifanio and Ewart (1977) in *Crassostrea virginica.* It is observed that there was appreciably a higher rate of removal of cells in the first hour and in the subsequent hours both high and low filtering activity have been noted during the experimental period of 24 hours. This is explained by Epifanio and Ewart (1977) that the period of low filteration coincides with period of maximum digestibility. Once the digestive process is completed the filtering activity increases. These authors further stated that the periods of high filtering activity and periods of relative quiescence depend on the quantities of the algal material present in suspension and also vary with different species of algae. They observed this rhythm in the filtration of cells in certain concentration of different algal species. In higher concentrations of *Cromonas* and *Carteria* and at intermediate concentration of *Isochrysis* a well defined rhythm has been observed by Epifanio and Ewart (1977). They stated that this feature was absent in higher concentrations of *Isochrysis* and lower concentration of *Cromonas.* This rhythm was observed invariably in all the six species used in the present study, though it is less pronounced in the case of *Isochrysis* and *Chlorella.* Epifanio and Ewart (1977) opined that there may be a threshold in the number of cells in suspension for each species of algae and below this level will not be ideal for the oysters to utilise a maximum ration. They also proposed a discontinuous feeding regime, based on the periodic filtering activity of the oysters. The results of our experiments also support

this type of discontinuous feeding pattern and the minimum and maximum algal concentrations in the suspension for effective filteration. Since *Cheatoceros* and *Chlorella* were not completely removed by the oyster in the given time, feeding them in higher concentrations is not advisable. *Dicrateria* and *Chlorella* which were completely removed at 4 and 5 hours respectively showed more than 60% of cell removal in the first hour. This is significantly higher than that of the other species of microalgae.

Estimates of the rate of water transport by an adult oyster vary from several litres to 34 litre/hr. (Loosanoff and Nomejke, 1946). Galtsoff (1964) has stated that the rate of water transport depends on the size of the oyster, its physiological state and the environmental condition. From the present study it is clear that *Crassostrea madrasensis* exhibits specificity of algae with regard to the filtration rate. *Isochrysis* which gives good results (3019 ml/hr/oyster) is widely accepted as the best food for adult oysters and larvae (Walne, 1981; Epifanio and Ewart, 1977; Nayar *et. al.*, 1987). Gerdes (1983) found that the filtration rate and the quantity of algae filtered out increase from 47.6 to 2383.3 ml/hr/oyster with increase in the body weight of oyster. This result cannot be compared with our data since we have not used oysters of different body weights. The filtration rate of *Chlorella* is the lowest (754 ml/hr/oyster) and 44.7% of the cells were left in the medium being unfiltered. This may be due to the poor digestibility by the oysters since *Chlorella* has a double cell wall made up of an inner chitinous and an outer cellulose material.

Epifanio and Ewart (1977) have observed that the total number of cells removed from suspension was clearly less for bigger cells and vice versa. An adult oyster removed around $5,64,666 \times 10^3$ cells of *Chlorella* whereas it was only $73,288 \times 10^3$ in the case of *Tetraselmis* which is almost 4 times bigger in size than *Chlorella*.

It is inferred that it is desirable to provide algal cells in the medium at alternate periods which coincide with the active filtration phase, rather than maintaining the same cell concentration throughout. It is also clear that feeding *Chlorella* and *Cheatoceros* to adult oysters in higher concentration is not advantageous. The present study also indicates that the optimum filteration rate of the oyster depends on several factors such as starvation level of the oyster and digestibility, size and density of the algal cell concentration. To prepare the mixed algal diet for conditioning adult oysters, *Isochrysis*, *Dicrateria* and *Chromulina* were recommended in view of their suitability for high filtration and faster utilisation of the cells.

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